The Origins, Development, Decline and Reuse of the Cloth Mills of the Stroud Valleys of Gloucestershire

A Study in Industrial Archaeology

By

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The thesis, which opens with a critical review of the primary and secondary literature on the British woollen industry and trade generally, examines the development of the Stroud industry, its rise to an area of considerable industrial importance, and its eventual decline. Important factors that influenced its development included gradual mechanisation and transition from water to steam power over a protracted period. Following woollen’s decline, many mills were reused by a variety of successor industries. At the core of the study are three chapters based largely on site visits that review and analyse power sources, power transmission systems and the construction and architecture of mill buildings. A methodology pioneered by the RCHME’s survey of Yorkshire mills is used; this combines the use of maps, record office archives, printed sources, site visits and record making.

The focus on industrial enterprises, mill sites and buildings reveals some similarities with competing areas but also significant differences. In Gloucestershire, a capitalism system of organisation was adopted early, with clothiers living in or near their mills. Most mill sites developed in a piecemeal fashion over protracted periods. Their owners were cautious and conservative men who adapted only slowly to new ideas and change and many remained heavily dependent on water power long after competing areas had switched to steam. Mechanisation of the industry in Gloucestershire was relatively trouble-free as a result of a compliant workforce.

Overall, the woollen industry in the Stroud valleys was characterised by a history of tradition and reluctance to change in the face of changing market requirements. However, even after woollen cloth’s demise, a surprisingly high degree of industrial activity continued in the region.
Frontispiece:

An early Boulton & Watt Steam Engine and Spinning Jenny (after Rees, 1819)
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<td>AJ</td>
<td>Architects Journal</td>
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<tr>
<td>BC</td>
<td>Bath Chronicle</td>
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<tr>
<td>BGAS</td>
<td>Bristol &amp; Gloucester Archaeological Society</td>
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<tr>
<td>Cal. Close</td>
<td>Calendar of Close Rolls</td>
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<td>Cal. Pat</td>
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<td>CL</td>
<td>Country Life Magazine</td>
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<td>CSP</td>
<td>Calendar State Papers (Domestic Series)</td>
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<td>D&amp;WG</td>
<td>Devon &amp; Wiltshire Gazette</td>
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<tr>
<td>EcHR</td>
<td>Economic History Review</td>
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<td>Jnl EH</td>
<td>Journal of Economic History</td>
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<tr>
<td>EM</td>
<td>Eastington Magazine</td>
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<tr>
<td>Enc Brit</td>
<td>Encyclopedia Brittanica</td>
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<td>GBR</td>
<td>Gloucester Borough Records</td>
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<td>GC</td>
<td>Gloucester Citizen</td>
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<td>GCL</td>
<td>Gloucester County Library</td>
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<td>GCR</td>
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<td>GHS</td>
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<td>Gloucester Journal</td>
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<td>GL</td>
<td>Guildhall Library, London</td>
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<td>GM</td>
<td>Geographic Magazine</td>
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<td>Journal of the Gloucestershire Society for Industrial Archaeology</td>
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<td>IAR</td>
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<td>JTI</td>
<td>Journal of the Textile Institute</td>
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<td>Jnl MWWG</td>
<td>Journal of the Midland Wind &amp; Watermills Group</td>
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<tr>
<td>PMA</td>
<td>Post-Medieval Archaeology</td>
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<td>PRO</td>
<td>Public Record Office</td>
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<td>RCHME</td>
<td>Royal Commission on the Historic Monuments of England</td>
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<tr>
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<td>Stroud District Council</td>
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<td>SJ</td>
<td>Salisbury Journal</td>
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<td>S&amp;WJ</td>
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<td>SN</td>
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<tr>
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<tr>
<td>SPAB</td>
<td>Society for the Protection of Ancient Buildings</td>
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<td>TA</td>
<td>Trowbridge Advertiser</td>
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<td>Trans.BGAS</td>
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<td>Trans. Newc.Soc</td>
<td>Annual Transactions of the Newcomen Society</td>
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<tr>
<td>VCH</td>
<td>Victoria County History of Gloucestershire</td>
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<td>VCH Wilts</td>
<td>Victoria County History of Wiltshire</td>
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<tr>
<td>WRO</td>
<td>Wiltshire Record Office</td>
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Many individuals and organisations have helped during the course of this research project and their invaluable assistance is gratefully acknowledged. The contributions of the following have been of particular note:

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My thanks are also due to the staff of the Records Offices in Gloucestershire and Wiltshire. In the case of the former, they without fail located and provided me with a seemingly endless stream of documents, and in the case of the latter, responded promptly and courteously to a number of requests for further information on mills in that county. Similarly, the staff of a number of Gloucestershire libraries are thanked, especially those of the Gloucestershire Collection, which forms part of the City's main library. Here, innumerable requests for both manuscripts and published material were met with interest and speed. Their good advice in helping me locate material was much appreciated. Staff at several local libraries, especially those of Stroud and Stonehouse, also provided information in various forms, including books, maps, newspaper collections and scrapbooks.

Libraries outside the county were also visited and once again, requests were always dealt with effectively. Of particular help were the staff of the Guildhall Library, London, who steered me through the fire insurance records deposited there, and the staff (particularly Michael Birtchnall) of the library of the University of Bristol, for advice and access to their collections of parliamentary papers. Thanks are also due to the staff of the Patents Office in Cardiff; they successfully located and provided copies of all of the early patents that I requested. Similarly, a debt of gratitude is owed to Birmingham Library Services, particularly Phillipa Bassett of the Boulton & Watt Collection, for providing me with copies of various letters, orders, engine drawings and engine house plans relating to mills in the Stroud area. Nicholas Kingsley also deserves praise for compiling an initial list of steam engines supplied to Gloucestershire; this served as a most useful starting place from which to pursue this avenue of research.

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a significant contribution the completion of the project and I give her my heartfelt thanks.
INTRODUCTION

In Britain, woollen cloth came to be produced primarily in two major centres. In the North, manufacture was concentrated largely in the Yorkshire region, and in the West, in the counties of Wiltshire, Somerset and Gloucestershire. In the latter, production was centred in two main areas: in the southern part of the county, important cloth mills developed in several small towns and villages including Wotton-Under-Edge, Charfield and Kingswood. The other important manufacturing district comprised the town of Stroud and the valleys radiating out from it. In the latter, numerous cloth mills were built along the major, and many of the minor, streams flowing towards the Vale of Gloucester. In fact, it was the expanding woollen industry that led initially to the transformation of a sparsely populated backwater into the bustling industrial town of Stroud, long the "capital" of the Gloucestershire industry.

Great Britain, showing main textile manufacturing areas in 1965
In Gloucestershire, and indeed, the West in general, manufacture centred largely on the production of traditional woollen broadcloth, some 54-63 inches in width. This was made from short carded wool which was fulled, raised and sheared to give a smooth surface finish. Although some narrow cloths were also made at times, production of broadcloth predominated throughout much of the history of the region. The Stroud region became famous for several speciality products and was especially noted for its "Stroud Scarlets"; these were often regarded as the finest reds in England and were frequently used for the manufacture of military uniforms. In a smaller, but locally equally important way, Uley was noted for its "Uley Blues". Despite this perhaps understandable preoccupation with scarlets, Stroud also produced many cloths that were sold in an undyed state as well as others that were dyed in a range of colours. Like the scarlets, these were often of great repute. Not surprisingly, local clothiers were convinced of the superiority of their products and were perhaps reluctant to introduce changes. Ironically, this attitude may have later contributed to the local industry's decline.

During the 19th century, cloth manufacture in the southern part of the county faded and mills in this region were demolished or reused for other purposes. The trade in the Stroud region proved to be more durable and many manufacturing concerns survived long after the demise of cloth-making in the southern part of the county. Over the course of several centuries, as with competing clothing districts elsewhere, the Gloucestershire industry changed and evolved. Businesses based around small fulling mills gradually gave way to fewer, but larger and increasingly mechanised mills. At some point in their working lives, the majority of these were powered by combinations of water and steam power.
The present thesis looks at how the woollen cloth industry came to develop in and around the Stroud valleys and examines its gradual evolution and mechanisation in the face of changing market requirements. The effects on the workforce during this period of change is examined. In addition, in the wake of woollen's eventual decline, successor industries and the adaptive reuse of redundant cloth mills are considered.

Dawson's map of 1831, showing the town of Stroud and the majority of the surrounding clothing parishes. The other part of the county involved in cloth production was settled further south, primarily around Wotton, Kingswood and Charfield.
CHAPTER 1
LITERATURE REVIEW

In examinations of the history and technology of the English woollen cloth manufacturing industry, some regions have fared better than others. Although the major woollen areas have all been examined at various times, some have been reasonably well documented whilst coverage of the others could be described at best, as sketchy. However, most textile districts, even those where the RCHME has carried out mill surveys, would benefit from further research. In this respect, the Gloucestershire woollen industry is perhaps in a worse position than some other areas as no such investigations have been carried out.

Over the years, a considerable body of knowledge has been built up on the woollen trade, although general treatments of the subject almost invariably focus attention predominantly on Yorkshire. In fact, there have been a number of publications supposedly examining the industry on a national basis that entirely fail to even mention the once-important manufacturing area of the West of England. Thus, the overwhelming impression that Yorkshire was the only major centre of cloth production is propagated. Other publications examining the trade on a national basis make passing note of the West of England although frequently, this appears to be included almost as an afterthought. For instance, The Textile Revolution (Addy, 1976) mentions the West of England trade in its introductory passage then studiously ignores it thereafter, concentrating solely on the North. This is just one of many publications that virtually overlook the entire West of England trade, let alone that of the Stroud valleys. This regular omission is surprising in that the Gloucestershire trade was of national importance, especially from the 17th century. By this time, the trade was dominating much of the industrial and social life of the region. In 1757, Bishop Pocock noted the region's industry during his travels and described Stroud as "a sort of capital of the clothing villages" (Pocock, 1757: p70). By now, the woollen trade was firmly established as the reason d'etre for Stroud's steady evolution from muddy hamlet to thriving industrial town and the Gloucestershire historian, Sir Robert Atkyns, described the clothing trade as being "so eminent in this county that no other manufacture deserves a mention" (Atkyns, Sir R, 1712: 42), much of which was centred on the Stroud valleys. Atkyns refers to Stroud as "the metropolitan town for the clothing trade"; in a similar vein, the Wiltshire antiquarian John Aubrey, described the inhabitants of the Stroudwater region as comprising "a little Commonwealth of Cloathiers and Clothworkers, not the like in the Nation" (quoted in Walmsley, 1994: 17).

Although much of the woollen trade was concentrated around Stroud and the five valleys, it was not wholly exclusive to the area and up to the 19th century, other important centres of manufacture also existed within the county. A string of mills ran down the valley from Uiey to Cam and Dursley, the latter being described by the much-travelled Tudor antiquary John Leland as "a praty clothings town" (cited by Perry, 1986: 46). In the southern part of the county, considerable quantities of cloth were manufactured in and around the towns of Kingswood and more importantly, Wotton-under-Edge. The
latter had long been a seat of the woollen industry and in 1527, when Leland visited the town, he described it as a "pratty Market Towne, well occupyed with Cloathiars" (ibid). Its long-running importance in the trade would eventually succumb to competition from the Stroud region. The omission of these formerly important areas of cloth manufacture are a recurring theme in published works on the subject.

However, the West of England trade has not been ignored completely and there have been several authoritative works published that examine the woollen cloth industry in this region of which the Stroud valleys form part. Of these, works by Julia de Lacy Mann and Kenneth Ponting are the most detailed, reflecting an in-depth understanding and appreciation of the subject. This is perhaps not so surprising given the background of both writers. In the case of Ponting, a lifetime in the woollen trade followed by involvement in the Pasold Research Fund clearly endowed him with great experience and knowledge of the subject. However, despite the undisputed usefulness of both writers' contributions, the claims that both The Cloth Industry of the West of England 1640-1880 (Mann, 1987. 2nd edtn) and The Woollen Industry of South-West England (Ponting, 1971) cover the entire industry of the West cannot be fully substantiated; both in fact, concentrate heavily on the experiences of the Wiltshire cloth industry. Both writers (and others) have tended to lump the Gloucestershire/Stroud trade in with the general activities of Wiltshire and Somerset and all have failed to recognise the uniqueness of the Stroud trade in many respects, both technically and sociologically. There has been a general tendency to regard the Stroud trade merely as an offshoot of the West of England trade at large, and this was frequently far from the truth.

In terms of the historical background of the industry in the various woollen cloth areas, once again, coverage has been patchy. Yorkshire, presumably because of the magnitude, success and relatively recent survival of its industry, has been well documented both nationally and through an extensive tranche of local studies. Similarly, parts of the West of England have received attention although this has been limited largely to Wiltshire. Investigation of the trade in Gloucestershire, in particular the Stroud trade, has been limited essentially to one book, namely Jennifer Tann's Gloucestershire Woollen Mills, published in 1967, and the contribution of Esther Moir who examined the early structural organisation of the Gloucestershire cloth industry between 1750-1835 (Moir, 1957).

Tann's book remains the only one to contain a gazetteer of individual mill sites in the valleys and beyond, and as such, forms the starting point for any further examination of the subject. However, following publication, a series of errors and omissions became apparent and several lists of corrections were made by reviewers (eg. in GSIA Newsletters n10. 1967 and n11. 1968). They concluded that apart from many errors (particularly in the gazetteer section, relating to names, places and dates) the work could not be considered to be comprehensive as a significant number of important mills and sites had been omitted.

With hindsight, at least some of the problems connected with the mill sites can be attributed to a lack
of local knowledge, knowledge that only comes as a result of familiarity with a particular district, coupled with a close examination of remains and surviving mill structures. Perhaps Tann placed over-reliance on documentary sources which at the time, were more widely scattered and not as comprehensive as they now are. Doubtless, archaeological examination of mill sites would have avoided some of the problems. Despite these reservations, Tann’s book remains a useful source of data although as noted, the gazetteer cannot be viewed as comprehensive. Tann’s treatment of the rise and eventual decline of the industry, plus its organisation throughout this period was not materially affected by the errors referred to.

There are facets of the Stroud trade that Tann does not cover in her work. Despite the general examination of the local industry, little attention was paid to a number of areas. For example, there is no examination of how the industry came to settle initially in the area or its gradual migration from the traditional hub of cloth making, the City of Gloucester. This is an important point as it helps to explain the origins of the Stroud trade. Similarly, although there are references to the introduction of new machinery in the area, little attention has been paid as to why the Stroud workers appear to have generally accepted this without a fight, unlike their peers in Yorkshire and their traditional competitors in Wiltshire. Precisely why the Stroud workforce was different in this respect is not addressed.

Apart from Tann’s work, other published sources include papers published occasionally in the journals of several relevant societies such as the Bristol & Gloucester Archaeological Society (BAGAS) and the Gloucestershire Society for Industrial Archaeology (GSIA). Papers from these sources are generally well written and researched although they naturally tend to concentrate on very specific areas of examination, such as the history of a particular mill or individual. For instance, in the annual journal of the GSIA, Wilson published a series of reports on the history, development, and subsequent reuse of Dunkirk Mills at Nailsworth, one of the most important surviving sites in the valleys (eg. Wilson, 1990). This thorough piece of work examined the mill through a combination of industrial archaeology, archival research and where possible, interviews with surviving workers. As such, it was able to give a clear picture of the mill’s history in terms of both the woollen and post-woollen periods. Such examinations are very helpful in examining perhaps a certain geographical region or area of technology and can be (as here) immensely useful in building up the larger picture.

A few other books have examined small pockets of the Gloucestershire trade in reasonable detail. For instance, these include one by Angus Buchanan and Neil Cossons, The Industrial Archaeology of the Bristol Region (1969). However, the area examined is small and only included as a result of its proximity to Bristol. Thus, a handful of mills along the Little Avon in the south of the country are examined.

Overall, a full-scale examination of the background and history of the Stroud trade remains lacking. Although papers and other publications examining specific points can be immensely useful, they
generally fail to give an overview of the prevailing situation or to compare/contrast contemporary events in competing woollen manufacturing districts.

**Roots of the Stroud Trade**

The industry relocated predominantly from the original hub of industrial activity based in the City of Gloucester. Here, it is possible to trace the gradual decay of guild-based manufacturing and the relocation to the valleys around Stroud, these being free of guild restrictions and liberally peppered with water-powered sites suitable for the construction of fulling mills. Little or no attention has been paid to this transferral of the industry, a process that was occurring in various other locations throughout the cloth making areas of Britain. Because Mann’s work was limited to an admittedly important period in the development of the cloth trade in the West of England, she includes no examination of the roots of the Stroud industry. Although Ponting devotes some time to this earlier and formative period, his writings are somewhat generalised on this point. Overall, little attention is paid to Gloucestershire or Stroud.

Although no studies have addressed specifically the early formative period of the Stroud industry, in some respects, the writings of Richard Holt are useful and enable a number of suppositions to be made and parallels to be drawn with other regions. In his examination of (predominantly) corn milling and to a lesser extent, fulling, in the Middle Ages, he suggests various reasons as to why a particular region could have a much higher preponderance of mills than might be suggested by the population existing there at the time. Similarly, in general terms, he follows their development and history through ensuing centuries. As such, his book (Holt, 1988) and an earlier journal article (1986) further exploring these issues form a useful base of data from which to examine the Stroud valleys, an area that had a large number of Domesday mills yet only a relatively low rural population. Thus, from Holt’s writings it is possible to build up a reasonably sound picture of the situation in the Stroud valleys and how the abundance of water power was to lead ultimately to the existence of a thriving industrial base.

There tends to be a general misconception that the relocation of the cloth trade from the cities to the countryside was almost an overnight affair. However, in the case of the Stroud trade, its relocation from Gloucester and subsequent development took place over several centuries, somewhat longer than is often implied. Likewise, there are indications that despite the exhortations of the urban guilds for no contact with the rural industry, in Gloucestershire there were firm trading connections in place from a relatively early period. Neither Mann nor Ponting consider this important aspect in any depth and one is left with the assumption that interactions between the two never occurred. Even the volume of the Victoria County History which deals with the City of Gloucester itself does not pursue this important point. Although it alludes to the decay of cloth making and the attendant guilds within the City, it fails to address the relationship between the two areas of manufacture that occurred over a period of at least several centuries and that one effectively prospered at the expense of the other. The
overwhelming impression created is that cloth making simply petered out in the City and hence, the county at large. By implication, this appears to be the end of the story although this was clearly not the case. This crucial area covering the gradual relocation and subsequent expansion of the Gloucestershire industry is not examined.

The relocation of industry to rural locations is thus left to the likes of Professor Carus-Wilson and Joan Thirsk to explore. Both have written extensively on early industries and many of the points concerning the relocation of various industries to the country can be applied to the transfer of the Gloucester woollen trade to Stroud (for instance: E Carus-Wilson, An Industrial Revolution of the 13th Century (1954) and J Thirsk, The Rural Economy of England (1984). Although the depth of both writers investigations cannot be doubted, they understandably fail to consider the specific situation prevailing in the Stroud valleys. However, in this respect, the pattern of the transfer of the trade from the city to the country was in some respects following similar trends occurring with other industries and in other locations, hence their writings are of considerable use in determining the events in Gloucestershire. Where occasional specific references are made, these are of considerable importance; for instance, Carus-Wilson’s investigations into the dates and locations of early fulling mills in England located what is still considered to be the earliest example located in Gloucestershire. Subsequent investigations have failed to locate any sites that predate the one she discovered at Barton (1185). In addition, her discovery of an early fulling mill at Wheatenhurst on the lower reaches of the Frome, effectively extended the area of woollen manufacture almost to the banks of the Severn itself.

Carus-Wilson in her Industrial Revolution of the 13th Century equates the rise of the rural fulling mill directly with the decay of urban cloth manufacture. An important assertion of her work is that the increase in rural fulling mills was the prime cause of much of the relocation of trade from urban centres. However, this view of events has not gone unchallenged (eg. Miller, 1965). He suggests that the rise of the rural fulling mill was a consequence of the industry’s shift, as opposed for the reason for it. There is some logic to this view as in the Stroud area, from the 13th century onwards, the rural industry was already in the ascendancy, a period when fulling mills were still a relative rarity in the entire West of England region. It may be that in the case of Stroud, the increasing number of fulling mills could have been both a causative factor and a result of the industry’s relocation. The major written works on the West of England cloth trade fail to address this and even studies of a more localised nature do not appear to have considered it.
In terms of examination of the individual stages involved in the manufacture of woollen cloth, there are two sources that give considerable detail at several points in the 19th century. *A Practical Treatise on Dying [sic] of Woollen, Cotton, And Skein Silk with the Manufacture of Broadcloth And Cassimere* by William Partridge describes the situation prevailing in the Stroud valley mills in 1823. This useful volume was republished in 1973 by the Pasold Research Fund and included an introduction by Mann and helpful technical notes by Ponting. In this, Partridge comments on a variety of technical and organisational matters that range from dyeing to factory management, employment issues and wastes generated. Clearly, because of Partridge's background as a dyer, dyeing techniques and raw materials (including cochineal, alum, woad, madder, indigo, etc) assume a major role in the treatise. Crucially, he also devotes considerable attention to issues relating to the various process stages involved in cloth manufacture and describes these in some detail.

Partridge's fascinating account of processes in use during the 1820s is greatly enhanced by a second source published by Henry Mayhew during the 1860s. Here, Mayhew describes his three day visit to examine manufacturing processes in use at Hunt & Co.'s Lodgemore and Fromehall Mills near Stroud. Again, like Partridge, he delves into great detail into each stage of cloth manufacture and as such, provides a useful comparison of techniques in use during both the 1820s and 1860s. There seems little that can be usefully added to these sources of data, at least in terms of the techniques, organisational methods and machinery in use at these times.

Although by no means devoted to the Stroud industries *The Mills of Gloucestershire* by the present writer and Dr Pierce Riemer (1989) did unearth a good deal of previously unrecorded detail related a number of the Stroud mills (eg. Dunkirk Mills - Fig 1), although only limited attempts within the context of the book were made to consider the background of the woollen industry in depth. Rather, the book could be regarded as a fairly comprehensive gazetteer of major mill sites although it covered mills throughout the entire county. As such, it is therefore possible to draw some useful comparisons between various industrial activities, both textile and non-textile-related, within the county itself. However, apart from following the development of the industry through the detailed histories of individual mills, it did not attempt to consider many of the points examined in the present thesis. The book was at least based largely on reliable source material coupled with careful site examination, although this cannot be said of all publications relating to the Stroud mills. In 1982, Mahler and Marshfield published a book entitled *Stroudwater Valley Mills*. This examined a number of the mills along the lower Frome and others further up its watercourse. This could have formed a useful source of data, however there are so many errors packed between its covers that it makes reliance on any of the evidence presented impossible. Some errors indicate a lack of local research and some are fundamental. For instance, on a single page describing several mills at Whitminster and Eastington (eg. Millend - Fig 2), there are no less than seven confirmed errors. All of the facts to support these and many other points were available from easily accessible sources and/or even a cursory examination of some of the mill sites.
Most of the data appears to have been abstracted from the *Victoria County History* (VCH. Glos. xi) but even here, facts are frequently misconstrued. Overall, this publication, from the point of view of any serious study, lacks depth, is misleading and in many instances, simply incorrect. Far from assisting any study, it seriously misinforms and misleads.

**Background and Reasons for the Stroud trade**

The main reason for the evolution of the Stroud valleys as a thriving centre for cloth manufacture is popularly cited as being the availability of suitable sites for the construction of fulling mills. Although this was undoubtedly a significant factor in the creation of the industry, it is interesting to consider what other factors may have had an influence. Joan Thirsk has explored some of the factors that influenced the creation of particular industries in the countryside (Thirsk, 1984) and although there is no specific mention of the Stroud woollen industry, useful parallels can be drawn from her work. As Thirsk points out, with industries in the countryside, local circumstances often played a significant role in the creation and success of a particular trade or occupation; access to a suitable workforce is often overlooked in this respect. It is interesting to explore why similar cloth making regions, apparently operating under similar conditions, faded away, whilst industry in the Stroud valleys survived. No serious consideration has been given to this although Thirsk’s studies form a useful background from which to work.

Thirsk notes the rise of the rural woollen industry, usually at the expense of the urban-based trade. Thus, as the industry evolved in the region around Stroud, the pattern of human settlement clearly changed from that of earlier centuries. In the region, it came to comprise mills located primarily along streams in the valley bottoms, with clothiers houses attached or adjacent, and isolated cottages and small hamlets scattered along the often-steep valley sides. In some instances, jumbled squatter settlements of cloth workers cottages grew up on common land. Thus, the impact of the local topography ensured that much of the workforce was scattered over a wide geographical area and did not inhabit discrete settlements. Even Stroud itself grew in a largely unregulated, haphazard fashion. In this respect, Stroud was not alone, as the settlement pattern was similar to that developing in much of West Yorkshire. Here, strings of mills were developed along the valleys, with scattered weaving settlements occupying upland hillside sites. Parts of Wiltshire, Gloucestershire’s near neighbour and traditional competitor, were characterised by similar patterns although much of the industry in this county came to be organised along rather different lines. Thus, although the latter two were geographically close, significant differences in the organisation of the industry developed. Overall, little attention has been paid to the development of settlement patterns in Gloucestershire and how they differed with competing woollen areas.
Influence of the Workforce

There has been virtually no consideration given to the workforce employed in the Stroud mills. Perhaps inevitably, published works have tended to focus on technical details of processes, and to a lesser degree, how the industry was operated and controlled at specific periods. Whereas notable mill owners/clothiers sometimes had their biographers, the individual worker had little attention paid to him. In this respect, the Stroud industry is no different from that in other woollen areas, although some efforts have been made in recent years to remedy this situation in Yorkshire (eg. Howarth, E (ed) Textile Voices (1989). There appears to have been little examination of the type and nature of the Stroud workforce, in this case, one which seems to have been characterised by a combination of characteristics not necessarily encountered in other industrial workers. It is the present writer’s opinion that these characteristics formed an important feature, one which had a significant effect on how the industry developed over several centuries.

Whilst industrial relations in the Stroud region between masters and men were not always amicable, overall, unrest was limited largely to a few outbursts, mainly during difficult periods in the first quarter of the 19th century. The major strike of 1825 did lead to disturbances and some acts of violence but this was limited in duration and was more notable by virtue of its rarity unlike, for instance, some parts of the Wiltshire clothing districts. Overall, the history of the Stroud industry was characterised by the workers’, at least tacit, acceptance of change and progress. It may be that the high incidence of nonconformity in the workforce was a significant factor in their overall behaviour and attitudes. This area would benefit from further examination.

Influence of Immigrants

A further aspect of the individuals that comprised the workforce and perhaps more importantly, some of the major clothiers, also appears to have been overlooked. In this case, their point of origin, namely different parts of Europe, does not appear to have been considered seriously. The importance of various groups of, for instance, Flemish cloth workers, has long been a bone of contention for some writers. Apocryphal tales abound in general literature as to their importance to the English cloth trade although Mann attributes relatively little impact on their presence and Ponting is almost entirely dismissive of their influence on the trade in general in the West of England (Ponting, 1971). He asserts that the trade was essentially a native one and effectively scotches any idea that their influence could have been of more than marginal. In overall terms he may be correct, as the impression often created in popular literature is that immigrants were at the root of each and every advance in cloth-making technology. Although there can be little doubt that immigrants were responsible for bringing additional skills to the West’s cloth trade, overall, their influence may have been overemphasised in the past. For instance, Bishcoff quotes at some length (Bischoff, 1841) and in rather romantic terms, as to the impact of immigrants on the English trade. In this respect, Ponting is probably correct although despite claims in several of his works that
purport to examine the cloth trade in the entire West of England, the situation pertaining to the Stroud area has been overlooked. Here, several Huguenot immigrant families built up large cloth-making empires and played a significant role in the way the Stroud industry was controlled and developed. Hence, although in overall terms, immigrants may not have had such a great influence of the cloth trade in the West of England, there can be no doubt that in Gloucestershire, their influence, although perhaps concentrated geographically, was profound.

Buildings

In terms of consideration given to the buildings themselves, once again, relatively little has been published, although surveys carried out by the RCHME form a useful source of data with which to compare mill structures in the Stroud region (e.g. Calladine & Fricker, *East Cheshire Textile Mills* of 1993; C Giles & I H Goodall, *Yorkshire Textile Mills 1770-1930* of 1992; and M Williams & D A Farnie, *Cotton Mills in Greater Manchester* of 1992). The major sources of information specifically on the West of England, Ponting and Mann, tend to concentrate on aspects of organisation and development and markets associated with the trade, but neither devotes a great deal of space to mill design and construction or how this evolved in line with new requirements brought about by the introduction of advancing techniques and machinery. Once again, Gloucestershire’s near neighbour, Wiltshire, has fared somewhat better as two books in particular, describe the structure and evolution of that county’s mills in somewhat greater detail. Kenneth Rogers in *Wiltshire and Somerset Woollen Mills* (1976), and latterly *Warp and Weft* (1986) devotes some space to describing the size, layout and sometimes construction of a number of mills in this area. Some of this data comes from the gazetteer section of the former book although much of this appears to have been based on documentary sources rather than site surveys. However, there is no corresponding equivalent source for the Stroud valley mills and overall, relatively little information has been made available. Tann, for instance, only makes reference to structural details where appropriate, as parts of individual gazetteer entries, and these are brief. Similarly, scant attention has been paid to the changes in construction and layout resulting from technological changes. That this aspect of the Stroud mills has not been examined in any detail is confirmed by Falconer, whose overview article (Falconer, 1993) was most welcome. In this, various aspects such as construction and gradual evolution of typical mills was followed. Consideration was given to the builders/architects who were responsible for the building of the various mills, although with a few exceptions, this remains something of an unknown quantity. In addition, although not of direct relevance to mills in the Stroud region, the work of Stanley Chapman on Arkwright-type mills (Chapman, 1981-82) provides useful indications as to the size and scale of typical textile mills of the period, allowing comparison to be made between those in Gloucestershire and elsewhere.

With a few exceptions, the vast majority of the surviving Stroud valley mills await a systematic recording followed by an investigation into the data generated. In the few cases where this has been carried out, the results have been illuminating. Apart from Falconer’s useful overview, full
recording has remained the prerogative of the RCHME who have surveyed both the fire-proof Stanley Mill (see Stratton & Trinder, 1988) and more recently, the Longfords Mill complex (RCHME Historic Building Report. Longfords Mill, 1990). The contrasts between the two sites could not be greater and both surveys yielded a great amount of useful data, allowing comparison between the two extremes of mill construction in the area. On the one hand, the iron-framed brick-built Stanley Mill, logically laid out and dating largely from a single period, and Longfords Mill, grown in a piecemeal fashion over several centuries. However the usefulness of both surveys is tempered by the lack of data on the remaining mills, an area that merits further work.

Thus, little effort has been expended on an examination of the Stroud mills although those in some other regions have been examined for their architectural content and construction methods although geographically these tend to be located predominantly in the North. Jones, in Industrial Architecture in Britain. 1750-1939 (1985) examines a number of the trends and influences that were prevalent and devotes some time to discussing the evolution of the mill from its early days, through to the large integrated mill complexes of the 19th century. Much of his work is fairly general in nature and appears to have been based on documentary sources as opposed to site visits/surveys. Despite this, the book is useful in as much as it catalogues the major architectural styles and themes that dominated different parts of the country at different times. Thus, Palladian, Gothic, Italianate, etc. had their (sometimes visually remarkable) day. As interesting as this undoubtedly is, the book understandably fails to address the more mundane vernacular mill structures typical of the West of England and especially the Stroud region. The reasons are essentially twofold; firstly, by the time of the construction of many of the architecturally "themed" mills of the north, mill building had all but ceased in the Stroud valleys. By the time that many of the grandiose structures of the North were going up, most of the Stroud mills were going through the "patch up and make do" part of their lives. The changing state of the industry in the region effectively precluded anything else but such a system. The other main reason that the architectural flourishes of the North passed the region by was due to the conservative nature of the manufacturers themselves. Often cautious, many doubtless viewed such extravagances as unnecessary and indeed, were no longer in a financial position to consider such ideas. Hence, much of Jones’ book is of little more than academic interest when considering the Stroud mills and indeed, many of the mills throughout the West of England clothing districts, although it enables useful comparisons to be drawn.

Further information is given by Cruickshank (1985) who devotes a chapter to commercial and engineering buildings, specifically mills and warehouses. Essentially a country-wide overview, it provides useful pointers as to trends and ideas in general, with reference to specific examples of structures throughout the country. Perhaps inevitably, such well known mills as Lombe’s and Arkwright’s mill at Cromford are considered and in the discussion on fire-proofing and the increasing use of structural ironwork, Stanley Mill is mentioned. The latter is the limit of the examination of the Stroud mills and in this respect, Cruickshank has followed in the footsteps of many others in that as interesting as Stanley Mill undoubtedly is, it can by no means be considered
typical of the region's mills, quite the reverse.

Further data on the evolution of the mill is provided by Markus in Buildings and Power (1993). Markus considers some of the major causative factors behind the gradual development of the mill and comments on the introduction of the main technical advances such as the spinning jenny and the mule and equates these with the subsequent changes in mill layout and construction. Although most references and examples cited refer to structures and events predominantly in the North, the general conclusions drawn are equally valid with regards changes taking place in the West of England, albeit not necessarily at the same time. Markus concludes that mill form responded to changes in the machinery used, advances in structural technology (such as the increasing use of iron) and the type of power source. He also concentrates on the relationship between workers and mill layout. As with most books examining textile history or even industrial history in general, Markus confines his attentions predominantly to the North. Specific reference to the Stroud region is limited to a brief mention of Stanley Mill by way of example of fire-proofing and the use of ironwork. Despite this, the section of Buildings and Power examining mill structures does emphasise the sequence of events with regard to the changing nature of mill layout and construction in general and once again, helps to highlight the significant differences between the textile industry North and West.

 Builders and Architects

What of the design and actual construction of mills in the valleys? There appears to be virtually no reliable way of identifying the men who designed and built most of the Stroud mills and only through occasional chance references is it possible to shed any light on this often overlooked aspect. Even with the much larger structures of the 19th century that replaced some early mills, designers remain frustratingly anonymous. Remarkably, even in the case of the unique fire-proof Stanley Mill, the designer is unknown, although Falconer speculates on several possibilities (1993). No study appears to have addressed how this activity was organised in Gloucestershire.

It may prove possible, by drawing parallels with the known design and construction practices adopted for some of the larger country houses within the county, to arrive at some conclusions as to how this activity was organised and controlled, but even here, records are few. In this respect The Country House in Gloucestershire, a slim volume published in 1981 by Gloucestershire County Council, is useful in as much as it gives some general indications of the way in which architects and builders operated in Gloucestershire during the 17-19th centuries. Some aspects of design and build were common to grand domestic structures and mills and it seems likely that the same men may have been responsible for examples in both spheres. It may prove that an examination of the builders and architects responsible for the valley mills will be self-defeating. However, in an area where virtually nothing is known of these individuals and their mode of operation, any additions to current knowledge would be useful.
Transport/Communication Issues

Transport issues related to the passage of goods into and out of the Stroud valleys have always been an important feature of any examination of the local trade. In the industry's infancy, there are repeated references to the poor state of what were in reality, little more than muddy tracks or steep winding pack roads running almost vertically up the steep valley sides. The majority of the mills were not surprisingly, situated in the valley bottoms but what roads existed often meandered up and down the valley sides in an effort to stay out of the swampy areas below the spring line. Consequently, production was hampered by the difficulties in transporting raw materials in, and finished goods out of numerous relatively isolated locations. It was not until the advent of the turnpike roads that the problems began to diminish. In particular, when the new roads were driven along the valley bottoms, mills were at last linked directly to the main population centres and thus, to the markets that lay beyond. The pack horse gave way to the waggon and the flow of materials into and out of the valleys improved, at least to a degree.

The impact of these early road improvement schemes was significant although with a few exceptions, not a great deal of data is currently available. Only one writer, Christopher Cox, appears to have spent any appreciable time researching their evolution although their impact on the operation of the valley mills has not been examined in detail. Cox contributed a section to The Cotswolds - A New Survey (1973) in which the growth of major road schemes was addressed. This was informative but did not examine specifically the impact on the valley mills. In several of his papers published in the GSIA Journal (eg. GSIA Journal n4. 1965), greater attention was paid to this area, although detailed examination remains outstanding. Hence, further investigations of this important aspect would be useful. At present, Cox's papers remain the prime source of data.

Perhaps of even greater significance than road improvements, was the eventual creation of the Stroudwater and Thames & Severn Canals. This long awaited link at last opened up a reliable connection between the coalfields of the Midlands and the Forest of Dean and many of the valley mills. Although cargoes carried varied widely, coal was to remain the staple commodity throughout the canals' history. Once open, the price of coal in Stroud fell rapidly from the previously exorbitant levels but even so, was set to remain higher than in many competing woollen areas. As is often the case, both canals have attracted a great body of writers who have delved into their history and in this case, impact on local industry. Their impact on the Stroud woollen trade was significant, perhaps not surprising as many of the canals' promoters were also involved in the cloth trade in one way or another, many as clothiers and mill owners.

In terms of published work on the impact of the canals to the region's economy, the contribution of Charles Hadfield is significant. The very reason for the canals existence was as a long sought-after lifeline to the Stroud mills and this is made clear in Hadfield's treatment of the subject. His contribution in The Cotswolds - A New Survey takes the form of a brief overview and he examines
these aspects in greater detail in his book *The Canals of South and South East England* (1969). In addition, Humphrey Household also examined the impact of the Thames & Severn Canal in his book of the same name. There seems little that can be added to these thoroughly researched and authoritative treatments of this topic apart from examination of specific company histories and the canals’ impact on their operation. Similarly, for the Stroudwater Canal, Michael Handford’s book *The Stroudwater Canal* (1979) is the logical starting point. This concentrates on the background and construction of the canal and contains a great deal of detail. However, this reflects mainly the canal’s construction and little attention is paid to its impact on the local industries.

![Figure 3. Stroudwater Canal. Eastington section. c1900](image)

In a similar way, the impact of the railway on the Stroud industry has received only slight attention. There has been little in the way of published work addressing the direct impact on the Stroud woollen industry although there are a number of publications devoted to railways within the region. Throughout such works, it is usually a case of abstracting the odd fact from here and there as most deal predominantly with locomotives, rolling stock and the usual hardware associated with the iron road. More often, only passing mention or generalised comments are made to the effect that “the railway served the local cloth mills” etc. with little additional data being presented. In this respect *The Last Days of Steam in Gloucestershire* by Ben Ashworth (1983) is typical of many of the railway-oriented books that cover the region. There is little on the direct impact of the railway on the local industries.

![Figure 4. Map of proposed Stroudwater Canal. 1775.](image)
One useful exception to this trend is the paper published by Hoy (1987) The Stonehouse & Nailsworth Railway. In this he meticulously charts the rise and fall of the one local line in the region specifically financed, promoted and built by local men for the benefit of local industry. The Stonehouse and Nailsworth Railway was intended to provide a much needed transport link into the cloth mills of the Nailsworth Valley, however by the time of its final arrival in Nailsworth, many of its potential customers had gone. Hoy’s paper is particularly useful as it not only describes the construction of the line and its associated hardware, but also addresses the reasoning behind its conception. Not only does it describe this very "local" undertaking in some detail, it provides a fitting backdrop to the industrial decline that the cloth industry in the valleys was now experiencing.

Hence, in general, with a few exceptions, there has been little investigation into the importance of the coming of the railway on the cloth mills of the valleys although it seems likely that it may not have played such an important role as in, for instance, Yorkshire, as unlike the latter, the industry in many valley locations was already contracting significantly by the this time.

Power Sources

Examination of individual histories of mills in the Stroud valleys reveals that in general, they were slow to adopt the steam engine as the prime source of power. There are likely to be a number of reasons for this cautious approach although these do not appear to have been examined in any detail. The reasons are likely to have been both economic and social in nature and although the cost of coal was clearly a major factor, it appears that it was not the only one to influence manufacturers. Even in many of the larger, more conveniently-sited mills in the main valleys around Stroud, steam power did not usurp water as it had done so in other clothing districts such as Yorkshire and Wiltshire. Hence the reasons behind Stroud’s restricted uptake of the steam engine are likely to have been several in number, some fundamental and some site-specific. Little investigation appears to have been carried out on this important aspect of the Stroud trade.

Even up to the 1920s and beyond, there were instances where some manufacturers stuck doggedly with water power. Hence, Stroud’s long-running love affair with water power carried on at a time when steam was the prime all-year source of power in competing areas. Little detailed examination has been carried out specifically on the Stroud area although useful data on Gloucestershire may be gleaned from a variety of sources. Parliamentary papers (eg. Replies to the Factory Inspectors) hold considerable information on a variety of aspects of the local trade, including that on the types and capacity of power systems in use. Such data allow useful comparisons to be drawn between Gloucestershire and its competitors. These sources, when used with other published works by writers such as Mann, Ponting, Rogers and Gregory, enable a reasonably accurate assessment to be made of power sources in textile mills at different times. However, "local" sources of information (eg. sales particulars) frequently contain further detail that may be lacking in other works and their importance should not be underestimated. Thus, data derived from a variety of documentary
sources is the most appropriate route to pursue in the examination of this aspect of the Gloucestershire woollen industry.

Post-woollen Industries and Adaptive Reuse of Redundant Mills

Despite the gradual collapse of the woollen cloth trade in the valleys, overall, industrial prosperity appears to have continued through the channelling of activities and resources into other commercial and manufacturing areas. The various publications cited in the present work make little comment successor industries and hence these have been little reported. In reality, this important element of Gloucestershire's industrial life falls outside the scope of these publications, despite its overall importance to the area. Thus, for example, Tann limits her examination of this area to occasional brief mentions in the gazetteer section. Their importance in revitalising the valleys following the demise of woollen cloth, cannot be overemphasised. However, scant attention has been paid to this important area. Tann is not alone in this, as relatively little, apart from a few local studies, has been published on this important aspect of the Stroud industries.

Apart from the more general forms of industry likely to be found in any zone of commercial activity, a number of "specialities" came to the fore following the protracted demise of the cloth trade. There has been no systematic survey or examination of what came to be the daily providers for many of the workers laid off during the decay of cloth manufacture. A number of these replacements came to be of more than local importance and achieved some fame on a national and possibly even international basis.

Thus, there has been little reported work concerning these important successor industries. Rather, brief mentions occur in a variety of sources dealing predominantly with more general matters. For instance, Hadfield (1973) devotes limited space to these industries although most are barely mentioned. The theme of sporadic references to the successor industries is found in a number of other "local" books. For instance The Mills of Gloucestershire by Mills & Riemer (1989) contains short sections describing a few of the major successors such as walking sticks, paper making, millboard manufacture, the silk trade and pin making, as well as a section devoted to mill engineering. Of necessity, these descriptions are fairly short and clearly encompass the entire county, although there are numerous references to the Stroud valley industries. Other sources of limited value are to be found in a series of books of old photographs published locally by Alan Sutton Ltd. Although primarily visual in their impact, some contain useful views of Stroud trades and industries, mainly from the latter part of the 19th and early years of the 20th centuries. Several books were compiled from the collections of local historians Padin and Gardiner (eg. 1984). Their explanatory captions are often helpful and shed a certain amount of light on the successor industries. However, such books are clearly of limited value for serious study although they clearly have their place.
In a similar vein, several books, with largely photographic content, have been published which describe the Stroudwater and Thames & Severn Canals. As the very reason for the existence of these two canals was to supply coal to the local mills, there is inevitably some interesting material to be gleaned from their pages. Both the books of Handford (1979) and Viner (1982) on the Stroudwater and Thames & Severn Canals have provided useful captions although the impact of successor industries is not examined in any depth. Overall, it is a case of pulling together small pieces of information from such sources as the above and local newspapers, sales particulars, etc. and attempting to create a fuller understanding of the situation prevailing at the time. The lack of an examination of successor industries is perhaps surprising as some of them were of considerable size and local importance. In this respect, the significance of various local sources (such as newspapers) cannot be overemphasised as often, these and chance finds are the only sources of data readily available.

The problems of finding new commercial and industrial uses for redundant woollen cloth mills came much earlier in the Stroud valleys than for their counterparts in Yorkshire. Often, it was not until a century later that many of the Yorkshire mills went out of use. The additional problems associated with the latter include their often considerable size (compared with the West of England) and changes in the economic climate and industrial patterns of working. Although there were undoubtedly problems in finding new uses for the modest sized mills around Stroud during the latter part of the 19th century and beyond, the difficulties being faced in Yorkshire are clearly greater. Indeed, it was
the high rate of destruction and proposed demolition that prompted the RCHME survey of Yorkshire textile mills. Useful material on the adaptive reuse of former mills in the region is included in two publications by Marcus Binney. In *Bright Future. The Reuse of Industrial Buildings* (nd) and *Satanic Mills - The Industrial Archaeology of the Pennines* (1990), Binney examines aspects relating to the decimation of former mills but also presents cases where former industrial buildings have successfully made the transition to new uses. Thus, the problems and opportunities of the adaptive reuse of redundant mills in Gloucestershire can be put into a greater context. Overall, the redundant mills of the Stroud region appear to have experienced a high degree of reuse. The reasons behind this have not been examined.
CHAPTER 2

METHODOLOGY ADOPTED FOR EXAMINATION OF GLOUCESTERSHIRE MILLS

Clearly, some form of logical approach was necessary for examination of Stroud mill sites in order to provide data for the present thesis. Although the number of individual sites was relatively small compared to, for instance, Yorkshire, ordered standardised procedures were necessary to ensure that time was used as effectively as possible. Such mill surveys have not been widely carried out although those compiled by the RCHME were clearly of the most relevance where large numbers of structures, over a wide geographical area, were to be accommodated. Thus, the methodology adopted for the RCHME’s Yorkshire survey was used as the basis for the present work. The RCHME was faced with a considerable problem surveying the numerous textile mill sites of Yorkshire (Giles & Goodall, 1986). In this case, from practical considerations, it was considered appropriate to carry out a 6 month pilot survey, concentrating on a study of selected mills in a localised area. This allowed the investigators to become familiar with the buildings associated with the industry. This study was followed by further work to identify mill sites in the West Riding area. For this, the RCHME made extensive use of maps of different periods in its initial search for mills, identifying potential sites from a series of Ordnance Survey maps of 1920-35 (1:2500), used in conjunction with other maps and some documentary material. This work progressed to site visits in order to produce an initial survey of mills and their associated buildings. A survey form was compiled and used to record, in a standardised way, the main features of the site.

In a similar manner, as part of the present thesis, a survey of surviving mills in and around the Stroud region was carried out. Here, the practical problems were not as acute as in the West Riding, the overall number of mills being more manageable. The locations of these were identified initially by careful examination of a number of maps. Of particular use were the Ordnance Survey maps of the area published during the 1880s (1:2500). By tracing the various watercourses, a series of buildings were noted: some were clearly identified as mill sites whilst others, possibly mills that had gone out of use, were identified for further examination by means of a site visit. Even where a mill had been demolished, maps often gave considerable indications of water courses and/or mill ponds, many of which survived. This technique did not necessarily identify mills that had been solely steam powered, although the vast majority of mills in the region were, at least initially, dependent on water power, hence were linked to water courses.

During the course of the present work, it was not possible to make use of the textile mill files or historic collections housed in the National Monuments Record at Swindon; these would have undoubtedly have provided further useful data.
The 1880s OS maps provided a picture of the industry during a period of contraction to fewer but larger mills. Thus, some smaller mills that had gone out of use in earlier years were not necessarily marked as such. In order to provide a fuller picture, several earlier maps were examined in detail and used to cross reference the OS maps. Although not highly detailed, Isaac Taylor’s map of Gloucestershire in 1777 proved useful in locating sites that had gone out of use prior to the compilation of the OS maps. This was used in conjunction with Bryant’s map of 1824 (Stroud section reproduced in Anderson, 1977); this was much more detailed and helped to confirm a number of structures as formerly having been mills. In a similar way, where appropriate (and available), Tithe maps of various parts of the region were consulted, as were a number of estate maps, and sketches forming parts of deeds and sales literature, etc. The data from these various sources were combined and used to determine the site locations on modern OS maps. This was then used as the basis for subsequent site visit/surveys.

In order to carry out the survey of the main mills/sites, a survey form was produced, modelled on that devised by the RCHME. An extra section was added to the basic form which noted the mill’s access to a suitable transport system(s). Where structures were known to have existed but had been demolished, they were noted as such by the addition of "D" in the appropriate box. The Stroud mill survey included assessment of water, and other power resources at each site. It was felt that where possible, all forms of power adopted during the course of the mill’s working life should be noted in order to give a fuller picture of the development and transition from one form to another. Because of the smaller number of individual mill sites involved, this was considered a practical proposition. As in the case of the RCHME’s survey of Yorkshire, the form proved useful in gathering at least basic data for subsequent analysis. It also aided the selection of particular mill sites for further more detailed study.
Once the majority of the region's mills had received an initial visit, consideration was given to selecting suitable examples to assess further. Care was taken to ensure that the selection properly reflected the true nature of the mills in the region and that mills that could be considered atypical were noted as such. Thus, sites selected included small fulling mills and clothiers houses, medium sized sites that had grown through the addition of further structures, mills that had been built essentially at a single date, and the large, often jumbled, mill sites that characterised much of the industry's final era.

In each of the categories noted above, wherever possible, site examination was backed up with data from documentary and other printed sources; these were many and varied and are considered elsewhere in the present thesis. There are few books that deal specifically with the industry of the Stroud region, although Tann's book (1967) does contain a gazetteer section. However, this could not be relied on to list all structures associated with the industry; subsequent investigations have unearthed numerous other buildings not listed in Tann's work. Despite this, it proved useful in cross referencing
her data with maps, although some references proved to be inaccurate. Of the other published works, several gave useful references to mill sites (for instance, Buchanan CA & RA, 1980. Also Falconer, 1980). Similarly, occasional articles published in the annual journal of the GSIA provided pointers to specific mills or parts of the region (eg. Haine, 1984).

**STROUD WOOLLEN MILLS: INITIAL SURVEY**

**Parish:** Ebley  
**Name:** 0 0  M Ol  
**Address:** Ebley Cora  
Westward Road, Ebley  
**Occupiers:** Vacant  
**Listed:** Yes  
**Present Condition:** Mainly in good condition  
**Date range:** 18-20th centuries  
**Multi phase:** Yes

**Number of principal buildings:** One L-shaped block  
**Number of principal phases:** 2

**Power:**

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<tr>
<td>D</td>
<td>Chimney</td>
<td>Yes</td>
<td>D</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Auxiliary Buildings**

<table>
<thead>
<tr>
<th>Stables, Counting house. Large wing demolished c1954</th>
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</thead>
</table>

**Earthworks and water courses**

<table>
<thead>
<tr>
<th>Head race</th>
<th>Mill pond</th>
<th>Dam</th>
<th>Sluices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tail race</th>
<th>Reservoir</th>
<th>Weir</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
<td>Weir</td>
<td>No</td>
</tr>
</tbody>
</table>

**Manufacturers House:** No

<table>
<thead>
<tr>
<th>Workers Cottages</th>
<th>No</th>
</tr>
</thead>
</table>

**Other associated features:** Very small windows in main block. Had two internal wheels and two steam engines. Remains of turbine/HEP scheme of c1908. Also, iron bridge for rail link to MR.

<table>
<thead>
<tr>
<th>Communication</th>
<th>Road</th>
<th>Yes</th>
<th>Canal</th>
<th>Yes</th>
<th>Railway</th>
<th>Yes</th>
<th>Other</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
<td></td>
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</tbody>
</table>


|---------------------------------------------------------------------------------------------------------------------------------|

**Example of Initial Survey Form adopted for survey of Stroud Mills**

As noted by Giles and Goodall, the maps used did not necessarily identify small, urban-based workshops that may have been remote from a confirmed mill site. The semi-rural nature of the Stroud region meant that town-based structures were few in number, although similar problems occurred in
identifying loom shops and weavers cottages in some of the larger villages. Here, site examination proved to be the most appropriate way of identifying smaller structures, often part-domestic, part-industrial. For example, a number of such buildings were noted in the former weaving villages of Eastcombe and Chalford Hill. Although such examinations could not be considered to be comprehensive, in many cases it proved possible to glean details of location, scatter, scale and configuration, as well as the ratio of domestic:industrial space. Although such buildings were generally shown on the maps consulted, they either remained anonymous or were referred to by their later uses; these were often purely domestic. Location and identification of these buildings was dependent largely on local knowledge.

As well as providing answers, almost inevitably, investigation of mill sites raised further questions. For instance, discovery of the name or an individual associated with a particular site often prompted further examination of documentary sources in order to provide additional data. Vice versa, documentary sources sometimes gave information on, perhaps, the siting of a mill that had been demolished, this resulting in a further site visit. Overall, it was a two way process, useful leads to further study being generated by both fieldwork and documentary/published sources.

The information gathered from the site visits, coupled with that gleaned from documentary sources was used for consideration of the woollen industry in Gloucestershire. It was hoped that, once analysed, the information could be used to answer a number of important questions relating to the local industry. The answers would be used to assess how Gloucestershire mills compared with those in other parts of the country in terms of a number of issues such as the linkages between siting and power sources adopted; what was the split between mills that were built originally to utilise water power and those built to use steam power? Other issues of importance to be considered included an assessment of how Gloucestershire mill sites developed in line with the changing methods of organisation adopted by the industry - was this development different from that encountered elsewhere? The uptake of new machinery by the woollen industry had a significant effect on how mill buildings were both constructed and enlarged - what would the evidence from the Stroud mill sites show? Similarly, how were the clothiers and their workers housed, and did the type and location of their dwellings change with time? These were some of the issues to be addressed in comparing and contrasting the development of the mills in Gloucestershire with those in other woollen areas. During this study, these issues were addressed using a combination of fieldwork in conjunction with various documentary sources and used to provide a clearer picture of how sites developed and declined with time. This was the very successful approach adopted by the RCHME and proved to be equally suitable as the basis for the Stroud mill survey.
LIMITATIONS OF DOCUMENTARY SOURCES AND THE USE OF ARCHAEOLOGY

Documentary sources can take a variety of forms, some more useful and/or reliable than others. On the one hand are various official reports encountered under the general heading of Parliamentary Papers, and on the other, a myriad of sources that include material found in newspapers, trade press, sales particulars, etc.

The present thesis has drawn heavily on local manuscripts and documents, primarily from three sources. Considerable use has been made of material located in Gloucestershire Record Office. This has yielded collections of deeds and other material related to a number of important clothier families (eg. Clutterbucks, Webbs, Hicks, etc) and others indirectly associated with the industry (eg. Dangerfield). Useful data have also been gleaned from various tithe and estate plans, maps and related manuscripts. In addition, several collections of Gloucester council and borough records have been examined. The second major source of information are the large collections of both manuscripts and printed material held in "The Gloucestershire Collection" which forms an important part of the City’s library. This has provided much useful data gleaned from its collections of newspapers and news sheets gathered from around the county. In addition, transactions of various societies have proved useful: these included those of the Gloucestershire Society for Industrial Archaeology, Bristol & Gloucester Archaeological Society, and Gloucestershire Notes & Queries. Manuscripts and other documents held in private hands have formed the third major source of data. This category has included such items as trade literature, invoice and order books, and issues of local village magazines such as that published in Eastington during the latter part of the 19th century. Additional material has also come to light from unexpected sources such as the Family History Society, which kindly provided several letters related to the Clutterbuck clothier family.

Of particular importance are Parliamentary Papers from the 18th and 19th centuries; some of the most relevant ones are held locally in Gloucestershire Record Office and others in the library of the University of Bristol. Fortunately, many are now available in the form of reprints from the Irish University Press, these encompassing a number of reports of Commissioners on the Employment of Children in Factories, Reports on the Condition of Hand Loom Weavers, Reports by the Factory Inspectors, plus reports to Select Committees relating to issues such as the Factory & Workshops Act. These contain much useful data on a variety of topics, often allowing useful comparisons to be made between competing woollen areas. Such data is particularly useful when combined with published sources (on the West of England) such as those of Ramsay, Mann, Rogers, Tann and Ponting.

Thus, official papers are particularly helpful in making comparisons between different woollen regions,
although clearly, finer detail may need locating from other written sources. In general, data from official sources may be viewed as reliable. However, in some instances, it is important to differentiate between fact and opinion. For instance, the report compiled on the condition of the hand loom weavers in Gloucestershire (Miles, 1839) contains a variety of responses made by parties and individuals whose aims and opinions were often at odds with one another. Thus, the overall picture is best created through input from a variety of documentary sources, both official and "local" in nature. The latter can take many forms and will vary from location to location. These can include news reports, trade publications, tax assessments, particulars produced at the time of sale of a mill and/or land, personal diaries, biographies, etc. Once again, care needs to be exercised when using such sources as, inevitably their content may not reflect a true or representative picture. Overall, the best result can often be obtained through the use of a combination of written sources, hopefully allowing for a degree of cross referencing and checking to be carried out. In this respect, the writers of the RCHME surveys of textile mills are to be commended.

Although an "RCHME-type" survey of the Gloucestershire mills remains lacking, the development and histories of several individual Stroud mills have appeared in various local studies. However, a factor that tends to influence the usefulness of these has been the heavy concentration on documentary and archival sources at the expense of site examination. Undoubtedly, much useful data has been generated from such sources although its usefulness is limited as it generally only paints a limited "localised" picture. Where significant structural remains survive, there is no substitute for at least a preliminary site survey and this, used in conjunction with documentary evidence, can help to create a much fuller picture. For instance, the RCHME survey of Longfords Mill near Stroud, concentrated on an examination of extant structures and this, coupled with documentary evidence, has enabled a fairly comprehensive history of the site to be compiled. It has thus been possible to cross-reference chronological changes with changes in the buildings themselves. Unfortunately, in the West of England at large, this is one of but a handful of isolated examples treated in such a manner and may not necessarily reflect developments in the Gloucestershire industry at large.

Thus, the tendency of some studies relating to the West of England to rely predominantly on documentary sources has meant that these may not necessarily give a balanced view of the industry. For instance, part of Tann's studies examined papers located in the Boulton & Watt collection and although many of these are of considerable significance, they sometimes fail to give a full picture of the industry as a whole (Tann, 1970). Enquiries and orders for steam engines inevitably tended to be associated with the larger, wealthier clothiers in the West, the costs involved excluding all but the bigger manufacturers. Taken in isolation it could be construed that this scale and mode of operation was the norm and this was clearly not always the case. Thus, the Boulton & Watt papers contain no
reference to a large number of Gloucestershire mills, many of which were too small to contemplate a switch to steam power. Orders are associated predominantly with the larger clothiers, although for a time at least, a considerable volume of business was still carried on by clothiers of much more modest means. Hence, over-reliance on written source material can result in an unbalanced overview of the industry. It can also lead to a geographical imbalance, as certain areas, such as the Painswick and Slad Valleys, through their lack of steam power, would fail to register.

A further comment regarding the Boulton & Watt papers concerns the apparent distribution of early engines. From consideration of the overall number of engines listed, it can appear that a significant number of clothiers adopted steam power, although this can be misleading. For instance, the Hicks family of Eastington were responsible for no less than five early individual engines, located in various mills along the lower Frome, whereas other clothiers never made use of steam. However, adoption of steam power cannot be taken as an indication of the magnitude of the business as, for example, even the extensive New Mills at Kingswood (Wotton-under-Edge) still relied entirely on water power probably as late as the 1840s. Hence, fewer businesses may be apparent from consideration of this source if data alone and in this respect, the Hicks were atypical of the industry and the relatively large number of engines bought by them helps to inflate the overall situation. Steam power was not as dominant as might be suggested, and water power often remained the prime source of power for many years. Only by taking such "isolated" sources of information within the context of the broader picture, combined with site examination, is it possible to assess the industry at large. The Stroud region and indeed much of the West of England, is characterised by occasional highly detailed reports of individual (sometimes atypical) sites, but little in the way of an assessment of the overall trends in the industry.

**The Significance of Archaeology**

Clearly, despite their limitations, documentary sources, both published and unpublished, have a significant role to play in any examination such as the present one. Published works may help to provide an overview of a particular subject area and suggest additional routes to further fruitful topics for investigation. On the other hand, total reliance on written sources can impose serious limitations. In the present study, a considerable amount of useful data has been sourced from both published works and archival sources, although its usefulness would have sometimes been limited had it not been used in conjunction with archaeological inspection of remains on the ground. Even the most relevant documentary sources can only address certain issues, indeed, many were specifically created with this in mind. Thus, deeds may give information on names and dates of ownership although reveal little of the uses, magnitude and layout of a particular mill. Conversely, for instance, sales particulars may
provide a useful listing of structures, machines and their relationship, but may make little or no mention of the background and previous ownership of the site. Clearly, combining the data from such sources helps to create a fuller picture of a particular mill, site, individual or company, although the usefulness of even the most informative documentary sources is enhanced by even a cursory examination of a site; this will always reveal facets that have not been covered by written sources. Such examinations often reveal a wealth of additional information. Frequently, it becomes apparent that surviving buildings are of differing ages, scale and function and may have been built of different materials. In turn, careful examination of the latter may give a clue as to date. For instance, locally produced bricks may have only been made during a specific period. Likewise, examination of mortar types may also give an indication of age.

Frequently, a mill structure will have evolved around an earlier building or have been built/extended on the footings of an earlier mill. Many Gloucestershire mills developed in this manner although there may be little evidence to support this in documentary sources. Only on a few occasions has consideration been given to the fabric and construction of Gloucestershire mills, and where this has occurred, there has always been the tendency to concentrate on the unusual and the grand (eg. Stratton & Trinder, 1988); lesser mills have received scant coverage, yet it was these that formed the bulk of the local industry. Once again, only examination of the mill sites and their attendant water courses reveals the true picture and magnitude of a "typical" Gloucestershire mill. Combining such data with written sources greatly enhances the usefulness of both.

Even in situations where all buildings associated with a mill site have been swept away, it is still often possible to trace water courses and foundations, thus allowing at least some of the site’s layout to be reconstructed. The water courses may shed light on the type of water control system used (eg. leats, millponds, sluices and bypass channels) and this in turn may allow the type of wheel and its relationship to the main mill to be determined. Although some of this information may be obtainable from maps, these may fail to give an indication of the fall of water available at that particular point, which can help in determining the type of wheel adopted.

As well as sometimes failing to provide a clear picture of a particular mill site, over-reliance on documentary sources may also fail to make reference to the site’s relationship to its geographical and/or topographical surroundings or adjacent mills. Their presence, or lack of, could have a significant effect on a mill’s operation and as many Stroud valley mill owners discovered to their costs, their hours and mode of operation were sometimes dictated by mills upstream impounding water. Although documentary sources sometimes refer to these riparian disputes, examination on the ground often makes it clear as to why such problems so frequently arose.
In recent years, the importance of combining documentary sources with archaeological evidence has been noted by some investigators. Giles & Goodall described how the RCHME went about producing firstly an initial, and secondly, a more selective survey of surviving textile mills in Yorkshire (Giles & Goodall, 1986). Whilst acknowledging the obvious importance of documentary sources, they noted that:

"For some mills, few facts could be gleaned from readily available sources" (Giles & Goodall, 1986: 73).

In situations such as these, the only evidence surviving may be that actually found on the site in question; this may not even include buildings although remains such as water courses can at least suggest the presence of some form of mill structure and perhaps the site layout. Conversely, in the case of the Yorkshire survey, written sources of information for some mills were readily available in a variety of forms. The above writers noted that the final element in their survey was the documentary research which was so essential to the understanding of sites. Whilst much was readily available, it was often found to be "scattered, inconsistent, and diverse, and in some cases almost as threatened as the mills themselves" (ibid. 79). Problems associated with incomplete documentary sources were by no means limited to Yorkshire. In Gloucestershire, as far back as the 1960s, this was being noted as a cause for concern:

"In some parts of the county, local history is strongly influenced by the presence of local industries and specialised trade, such as the cloth industry in the Stroud area...older records relating to such commercial enterprises are scanty and widely scattered...in many cases, they have been lost or destroyed" (Jamieson & Smith, 1968: 29).

The present writer can confirm that this remains a problem, despite significant improvements that have been made during the last decade regarding the collection, preservation and availability of documentary records stored in Gloucestershire. Although some records relating to a small number of companies active in the woollen trade survive, many more have been destroyed. Even where a company still survives, records may not. Enquiries to former engine manufacturing concerns of Fielding & Platt and Tangye, revealed that much had been disposed of in earlier years.

Documentary sources, both official and "local" in nature can clearly be of great significance. However, in both cases, they may only give data on a short, specific period. Thus, when a mill was bought or sold, documents may have listed buildings, machinery, land and water supply arrangements. Data of this type may help to give a "snapshot in time" although clearly, there might be no further
information available following this date. Under some circumstances, this situation may be rectified
by combining a series of chronologically-ordered records, although as already acknowledged, further
sources might be incomplete or non-existent.

Although such data from documentary sources might cease at a particular point, developments will
undoubtedly have continued in some form at the site - this could take the form of expansion, reuse or
even demolition. Inevitably, the site will have continued to evolve and change with both time and use.
From examination of physical remains it is often possible to determine how the buildings changed and
to what uses they may have been put in the post-woollen phase. Even where evidence of machinery
etc. is lacking, it is sometimes possible to deduce the building’s function by analogy with other local
examples of known provenance. Internally, evidence of power transmission systems may give
additional clues to former uses.

One of the other problems associated with written sources, such as newspapers and trade journals of
the period, is their understandable preoccupation with the latest developments or the novel and
innovative concept. Over-reliance on such sources can seriously distort the overall picture. In the
case of Gloucestershire, even now, the iron-framed Stanley Mill holds a special fascination but often,
this has been at the expense of consideration of the local industry at large. Stanley Mill has always
been the exception of the Gloucestershire woollen industry and has received considerable attention
whereas the large number of mills that comprised the remainder of the trade have been largely
ignored. Such has always been the impact of the novel, a factor that always needs to be borne in mind
when using documentary sources, unsupported by archaeological examination.

In the case of Giles and Goodall’s comprehensive examination of the Yorkshire textile industries, the
final result was based on a “fusion of two types of evidence - architectural and documentary, acting
to complement each other”. There is little doubt that wherever possible, this is the most appropriate
route to follow. In this equation, local knowledge must also play an important part; familiarity with
a particular region and/or industry certainly assists a researcher to, perhaps, locate sites unrecorded
in surviving documentary sources.

Many of the foregoing points were addressed by Dr Marilyn Palmer as part of her 1993 Rolt
Memorial Lecture (1994). She noted the importance of combining data from both documentary
sources and physical examination, commenting that there is a need to use both and to recognise the
limitations of each. She cites the case of the hand loom weaver, where easily available documentary
sources can be misinterpreted, creating the impression that this aspect of the industry was one of
"unremitting decline in the face of mechanisation". However, fieldwork has confirmed that in fact,
a huge expansion of hand loom weaving took place during the first quarter of the 19th century, an important conclusion that would have remained lacking were it not for the use of fieldwork, combined with the use of documentary data.

Thus, as Palmer, Giles and Goodall (and others) have stated, and the present writer can confirm, the most appropriate way forward with any such investigation is through a combination of documentary sources and site examination. Although individually, each can be of great importance, combined, their usefulness can be heightened immeasurably. This approach was adopted for the present examination of the development of woollen mills in Gloucestershire.

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Summary of Overall Research Designs

Overall, the uniqueness of many factors that influenced the organisation and development of the Gloucestershire woollen (and post-woollen) industry have not yet been addressed. The importance of the industry in the Stroud valleys has been largely missed by published material to date, or else has been simply lumped in with examination of the West of England as a whole. It has been too easy to ignore the individual nature of the Stroud valleys’ industries, a nature that has been glossed over in most published works.

Although there were times of hardship and change, the Stroud valleys’ relative success (compared to other West of England clothing districts) especially during the latter part of the 19th century, could be viewed as surprising, given its former relative geographical isolation. Similarly, its continuing existence at a time when the remainder of the West of England industry was in steep decline or dead deserves further consideration. For instance, some Stroud manufacturers continued to survive in the face of hostile market forces, still dependent largely on water power, despite their traditional competitor’s heavy reliance on steam power.

Likewise, various organisational aspects of the Stroud trade made it different from other regions. For instance, the majority of the Stroud clothiers and later, manufacturers, lived either in part of their mill or at least in close proximity. In this and several other respects, the way in which they organised the industry was different from that of Yorkshire or even of neighbouring Wiltshire. In the latter, the clothiers preferred to inhabit towns and villages some distance from their respective mills. As such, this may have had a significant effect on their commitment to their businesses and how they were run.
on a day to day basis. This aspect has not been addressed in any depth and such factors set the Stroud valleys trade apart from that of other woollen areas.

The major areas requiring further examination, based on existing knowledge of the Stroud valleys may be summarised as follows:

- The origins of the Stroud trade and its gradual relocation from the county’s traditional centres of clothmaking.

- The effect of immigrant communities on the subsequent development of the trade and their significance on its success.

- The differences in organisation of the industry between Stroud and competing woollen areas.

- The attitude and tolerance of the workforce with regard to changes in organisation and mechanisation of the local industry.

- The influence of Stroud’s relative isolation on the degree of self-sufficiency and how local needs were met by local resources.

- Local manufacturers’ long-running dependence on water power, only adopting steam as a seasonal backup system. The fact that many continued to operate using either water alone or a water/steam combination, when some competing steam-powered areas were in decline.

- No overall examination of surviving mills in the valleys has been carried out, hence there is little data on trends on the construction and evolution of local mills. The change in design with new requirements imposed by new machinery has not been well explored.

- Adaptive reuse of redundant cloth mills - a high degree of reuse was in order. Some successor industries achieved national importance. There has been no survey or examination of this important aspect.
CHAPTER 3

URBAN-RURAL RELOCATION

Gloucester and The Decline of Clothmaking

Throughout the Middle Ages and beyond, it was considered normal practice for industrial activities to be limited to towns and urban conurbations and for agriculture to be the dominant force in the countryside. With the exception of such crafts as charcoal burning which clearly had to be carried out in wooded areas, and corn milling, whose location was dictated by the availability of water-powered sites, little of an industrial nature was carried on. In Gloucestershire, the City of Gloucester remained the centre of industrial and commercial life, whilst at this time, the site of what was to become Stroud existed only as a muddy hamlet in a region dominated by agriculture.

For centuries, successive authorities had encouraged this arrangement and supported the town-based craft guilds who were responsible for the organisation of urban-based workers, supervised their standards of workmanship and largely contained their activities within urban areas. The reaction of the guilds to rural-based competition was entirely predictable. As early as 1298 the fullers of London were trying to prevent cloth woven in the city from being fulled elsewhere, in this case, in the fulling mills of the River Lea (Pelham, 1958: 3). A similar situation was described by Ponting, who examined both the advantages bestowed by the Bristol woollen guilds in earlier centuries and the growing disadvantages as the industry gravitated to new rural locations (Ponting, 1971). During the 14th century, much of the cloth woven in Wiltshire was finished by guild-controlled fullers in the City of Bristol. Their rules and restrictions were numerous and amongst others things covered duties, wages and working hours; as with town-based weavers, no night working was permitted. Of note was the fact that the Bristol fullers were warned repeatedly against any dealings with the rural fulling mills. As their London peers had done earlier, regulations attempting to prohibit cloth being fulled in the country mills were invoked (Cunningham, 1922: 426). Certainly, by the 14th century, competition from such sources was becoming significant and doubtless the exhortations to the Bristol fullers increased in line with this. In the 1340s, it was noted that:

"certain merchants had their cloths fulled in villages round about the City of Bristol to the disadvantage and discredit of the Bristol fullers". (Cunningham, 1922: 436-7).

In the City of Gloucester, the growth of the guild system was no different from that in many other English towns of comparable size, most guilds evolving out of various private organisations of townsmen. During the medieval period, every major cloth-producing town had its associations of
weavers, fullers, dyers, etc. (Calladine, & Fricker, 1993: 7). In Gloucester, where woollen clothmaking was an important occupation and weavers in particular were numerous, some form of rudimentary organisation appears to have been in place at least from the 1260s. At this time, the organisation was paying 20 shillings to the city bailiffs (GBR. F3/1). Although not yet described as such, this was clearly the precursor of the city-based weavers guild.

By the 12th century, the guild system was becoming widely established throughout the majority of English manufacturing towns. Guilds became responsible for teaching their respective skills to apprentices, regulating working hours and wages, and ensuring that minimum standards were maintained by the membership. Once full apprenticeship had been attained, the apprentice then became a journeyman working for wages, or practised his craft as a master, possibly with his own journeymen and apprentices. The urban guilds maintained a firm hold on its members, but many guilds, having become powerful and obtained certain privileges and exclusive rights, began to abuse their position. Apprentices having served their time were hampered in becoming masters and in doing so, the guilds effectively sowed the first seeds of discontent amongst their ranks. The restrictions imposed on those wishing to join their ranks was to be a major factor in the gradual relocation of the trade to other localities (Calladine & Fricker, 1993: 7).

Despite the problems associated with guild control, clothmaking remained an important activity in the city, the trade being well established at least from the latter part of the 12th century (VCH. iv. 23). Amongst the city residents active in the trade were Wulward the fuller (in 1173), also a wealthy burgess (Pipe rolls. 1173: 154) as well as another fuller and a number of weavers. As water played such an important role in several stages of cloth manufacture, not unnaturally, many cloth workers tended to gravitate towards the River Severn and both fullers and dyers became concentrated in several areas bordering the river. As a consequence, a street near the quay became known as Fullers Street (VCH. iv. 26). Likewise, on the northern edge of the city, both dyers and fullers were active, apparently using the waters of the diminutive River Twyver (GCR. 98). In addition, an enclave of fullers in the city was operating at least from the 1180s and inhabited another street known as the Vicus Fullorium, Walkers Lane (Holt, 1986: 7-8).

It appears that in later years, the quality of Gloucester-made cloth was variable and a Statute of the latter part of the 15th century refers to "abuses in manufacture in Somerset, Dorset, Bristol and Gloucester" and notes that merchants who unwittingly took such faulty cloth abroad to sell ran the risk of imprisonment or even death (Cunningham, 1905: 435). As well as a location for manufacture, Gloucester also served as an important trading centre, cloth being amongst the array of goods imported and exported. In 1303, Adam Honsum was recorded as importing both silver and cloth from Antwerp (Cal. close 1302-7, 110). In addition, wool continued to be bought and sold in the town throughout
the 14th century (GBR.C9/6) with traders coming from the Midlands and Wiltshire (VCH. iv. 45). However, by the 14th century, cloth-making in the city was declining as a direct result of the industry beginning to grow in the Stroud valleys.

A Lingering Death

Like a number of other woollen districts, in Gloucestershire, there began a gradual shift in the organisation of the industry and manufacture moved progressively to rural locations within the county. As the new rural cloth-making industry began to blossom, various cloth workers abandoned the City and took their skills to the new locations around Stroud and the southern part of the county. Thus, several important aspects began to come together in the valleys, namely plentiful mill sites plus skilled labour escaping the restrictions and difficulties imposed by the guilds and municipal authorities. As the guild system at large began to weaken, further legislation was created in order to bolster its decaying position, this leading ultimately to the Statute of Artificers (1563) in which amongst other items, a seven year apprenticeship was imposed. However, this Act proved to be largely ineffective and was never uniformly enforced and the guilds continued to lose their power and influence (Enc. Brit. 1970. v2. 144c).

In the face of the gradual shift of cloth making to the Stroud valleys, the Gloucester-based guilds continued to decline further. This trend was still carrying on up to the 18th century and was now accelerated by the increasing adoption of machinery in the cloth trade, aspects that were not covered by existing apprenticeship law. This, coupled with the rise of capitalism and the emergence of the wealthy independent clothier of the Stroud region, helped to ensure that the Gloucester cloth-making guilds never regained their control over the industry. The final coffin nail arrived in 1814 when the Statute of Artificers was finally repealed, ending compulsory apprenticeship, one of many aspects that had already been effectively dead for a long time (ibid). In their early days, the guilds had fulfilled a useful role however, in their dying years they had become increasingly restrictive and had helped to stifle innovation and hamper production, with the result that market opportunities were lost, much to the dismay of the merchant class. As the market for cloth changed from the local to the national and international level, the usefulness of the guilds diminished further.

It is interesting to note that even during the undeniable decline of clothmaking in Gloucester, the number of weavers remained higher than might have been expected. A listing of "freemen admitted Michaelmas" 1535, lists two dyers, two clothiers, one tucker and no less than 22 weavers (GBR.C9/6). Given the situation prevailing, this prompts the question as to whether they were surviving commercially through links with the Stroud fulling mills, which would seem contrary to all of the edicts issued by the guilds. If so, this may have been prompted through sheer necessity, as the
city itself had few possibilities for the erection of fulling mills, even if the authorities had sanctioned their use. The Severn itself was unsuitable which only left a number of minor streams as possibilities. Of these, only the River Twyver was utilised to any degree, powering a handful of small corn mills en route to its outfall in the Severn. There is no evidence to suggest that these, with one isolated exception, were ever turned over to fulling (Mills & Riemer, 1989: 82-3).

New Arrangements

The lack of sites for fulling mills was a significant drawback and there is little evidence of any sizable band of fullers in the city during the 13th century. Holt suggests that they had all gone by c1200 (Holt, 1986: 7) however it is likely that some lingered on after this date. There is no doubt that their activities declined greatly during this period and indications that Gloucester-woven cloth was probably being fullled increasingly elsewhere begin to occur. There is evidence to suggest that links were being forged with some of the Stroud valley mills and from the 14th century onwards, Stroud cloth workers began to crop up in rolls of traders within the city; in 1380, Robert Brymour, a Woodchester fuller was mentioned (GBR C9/1) as was a dyer of Kings Stanley during the 1390s (ibid). In 1481, another Stroud fuller was mentioned. Contrary to what might be expected, it appears that some form of trading or co-operation was taking place between some guild-regulated city workers and industry in the Stroud valleys and it seems likely that some of the cloth woven in the city was being fullled and finished in the Stroud mills (VCH. iv. 52).

Certainly by the 1520s there were firm connections between the two areas as in 1524, John Cooke, merchant of Gloucester, bought land and a fulling mill at Ebley (Hawker, 1945: 66; also GBR. 427). By the 1540s, John Sandford, a resident of Gloucester, was also recorded as operating a fulling mill in Stonehouse. He is likely to have been the same man who was operating the fulling mill at Millend in the village of Eastington in 1549, possibly a second mill under his control (Cal.Pat. 1548-9. 6). Sandford was a wealthy and influential figure in the city and was one of the leading burgesses at the time. His position and influence may have given him the opportunity to circumvent the albeit dwindling powers of the guilds and engage in commercial activities in Stroud.

Trading connections between urban and rural regions are perhaps not as unusual as is sometimes perceived. Throughout history, interchange between cities and surrounding countryside had been a fact of life. In the case of Gloucester, this took the form of the exchange of manufactured goods for foodstuffs and raw materials. As Power notes:

"not even the smallest towns, exchanging goods with their hinterland, could properly be called a closed economy. Still less the great industrial and commercial centres whose area of exchange was a country,
Textiles, woollen cloth manufacture in particular, was the earliest and most important of these trades, in the light of which, the trading connections between the City of Gloucester and the Stroud valleys may not seem so surprising and gradually, the industry in the latter expanded at the expense of the former. The trade in Gloucester began to dwindle and in 1528, a resident lamented that "the trade ofappers and clothiers [is] much decayed in Gloucester within 20 or 30 years past" (GBR. B2/1, f, 103v). However, by the middle of the 16th century, the making of woollen cloth in the city still retained some importance, possibly as a result of the trading arrangements alluded to. Throughout this period, clothiers and a few dyers maintained sufficient status to become aldermen of the city. The VCH* lists the professions of aldermen throughout the 16th century and beyond. Clothiers crop up on a fairly regular basis:

Table 1
Some Aldermen of the City of Gloucester

<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Profession</th>
</tr>
</thead>
<tbody>
<tr>
<td>1503</td>
<td>Thomas Tayloe</td>
<td>Clothier</td>
</tr>
<tr>
<td>1519</td>
<td>William Hazard</td>
<td>Dyer</td>
</tr>
<tr>
<td>1545</td>
<td>John Sandford</td>
<td>Clothier</td>
</tr>
<tr>
<td>1560</td>
<td>Thomas Semys</td>
<td>Clothier</td>
</tr>
<tr>
<td>1565</td>
<td>John Kirkby</td>
<td>Clothier</td>
</tr>
<tr>
<td>1569</td>
<td>William Sandford</td>
<td>Clothier</td>
</tr>
<tr>
<td>1570</td>
<td>Peter Romney</td>
<td>Clothier</td>
</tr>
<tr>
<td>1578</td>
<td>John Webley</td>
<td>Dyer</td>
</tr>
<tr>
<td>1605</td>
<td>Lawrence Wilshire</td>
<td>Clothier</td>
</tr>
<tr>
<td>1612</td>
<td>Thomas Adams</td>
<td>Clothier</td>
</tr>
</tbody>
</table>

(* Entries abstracted from the VCH. iv. 375-381.
These were collated from a variety of sources)

Throughout this period, John Sandford remained active, having an agency at Frankfurt am Main for the import of cloth into Germany (Perry, 1947: 112). Towards the close of the century there is little
doubt that cloth-making was now in terminal decline (VCH. iv. 75) as verified by the dwindling number of cloth workers recorded. The pressures and dissent within the ranks of the weavers company were becoming apparent and c1602, the journeymen weavers set up their own rival company although it appears that it was short-lived (GBR B1/6).

In 1608, the muster rolls list only 4 clothiers, 29 weavers, plus a handful of dyers and shearmen but no fullers (Perry, 1947: 96). This suggests that whatever cloth was still being woven in the city was being fulled elsewhere, no doubt in the Stroud mills. By 1620, there were only 2 or 3 clothiers left and by 1634, there were no more than 6 or 7 looms left at work, compared with more than 400 at the industry's peak (GBR. H2/2, 67). No clothiers have been found recorded as Aldermen after 1612 (see above). The weavers company was said to be in disarray and shortly afterwards, the last clothier had left the city (VCH. iv. 58) but despite this, they still continued to make a brave show of their vanishing status. They met annually amidst fading splendour and on St Anne’s Day, elected their officials (ibid. 80). There is no doubt however, that by the 1630s their influence and status was following a downward path alongside that of the urban cloth trade generally (PRO E l34/11). By this time, weavers were rapidly becoming the only cloth workers left in the city, the preceding decades having witnessed the virtual obliteration of dyers, shearmen and cappers; the diminishing number of weavers were the sole survivors of this once flourishing trade. By the 1640s, the city’s trading institutions, along with the urban economy in general, appears to have been locked into a state of decline and uncertainty. By the early part of the 18th century, cloth-making had virtually come to an end (Ripley, 1954: 65). In the intervening period, when at least some weavers remained at work in the city, the cloth produced was almost certainly fulled in the mills of the Stroud valleys, doubtless through the trading connections earlier alluded to.

There was to be one last flicker of hope for cloth-making in the city, but it proved to be short-lived. Around 1740, what later became known as Browns (corn) Mill, situated on the little River Twyver in the parish of Barton St Michael, was taken over and rebuilt by the clothier Benjamin Gegg from Woodchester (GJ. 20 January 1741). Presumably he perceived some advantage in providing a monopoly fulling situation for those weavers still active in the city. It appears that by now, either trading arrangements with the Stroud fullers were too firmly entrenched or that the dwindling number of weavers had reached an uneconomic level. Whatever the reason, Gegg's initiative appears to have been both short-lived and isolated.

In 1779, Rudder commented on the decline of cloth making in the City:

"Many centuries ago, the city of Gloucester [was] famous for its cloth manufacture, where Brook St, situated upon the Fullbrook was the place of habitation for clothiers, dyers and shearmen; and even
as late as 1629 there was a company of clothiers in the city”.

The fact that there remained at least the vestiges of cloth-making in the city at this late date adds weight to the notion that the relocation of manufacture to the Stroud valleys was a gradual one. Rudder goes on to mention that the trade:

"has long since seated itself principally on the borders of the little rivers and brooks in the parishes of Bisley, Hampton, Stroud...Tis there the master clothiers live and the most curious operations of the manufacture are performed under their immediate inspection; but the women and children all over the county are chiefly employed in the carding of wool and spinning of yarn”.

As had also happened in other clothing districts around England, the pattern of the relocation of cloth manufacture from the urban to the rural setting was essentially complete, although Gloucester still maintained some importance as a centre for the marketing and export of cloth. However, in terms of cloth manufacture, Gloucester, Bristol and a number of smaller towns around the county were now essentially dead. Despite the increasingly desperate attempts of the urban organisations, cloth-making was now firmly centred in and around the valleys around Stroud and the southern half of the county. The latter comprised important centres that had grown up in places such as Wotton-under-Edge, Cam and Dursley, powered mainly by the Rivers Cam and Little Avon, plus their tributaries.

Overall, there were three main reasons for Gloucester’s decline and a number of additional factors that worked in Stroud’s favour. The Gloucester trade was predominantly killed, albeit over several centuries, by the competition of the burgeoning industry in the Stroud valleys. Strangled by restrictive practices and hampered by a lack of fulling mills, the urban workers were slowly driven out of business. That many lasted as long as they did may have been due to some form of grudging cooperation between the two areas; if this was the case, this was an uncommon arrangement, one which in other regions was steadfastly opposed by the urban guilds. It may have occurred through the realisation of individual clothiers such as John Sandford that the industry was changing fundamentally and that the future lay with water-powered rural locations. The fact that the authorities had created legislation to reduce the effectiveness of the rural industry was of little use to Gloucester as the Act of 1557 against rural textiles specifically exempted the Stroud valleys. In 1557, the importance of the Stroud district for woollen cloth manufacture was officially recognised as an "Act touching the making of woollen cloth" was brought in, whereby an effort was made to confine the manufacture to the towns. There were a very limited number of favourable districts that were exempted from the Act’s powers, which included;

"any town or villages near the River Stroud [Frome] in the County of Gloucester, where cloths have
been made for the twenty years past”.

In an Act of 1565-6, this grace was again extended to the “parts of Gloucestershire about Frome Water, Kingswood Water [Avon] and Stroud Water” (Woollen Cloths Act, 4 & 5, Philip and Mary. C5).

Further Acts of 1585 protected the Gloucestershire industries of card-making and card wire drawing, both specialities of a few areas such as Dursley.

Another factor that worked against the City of Gloucester’s cloth makers was their heavy dependence on the London and North European markets; in the case of the latter, this was fine when a degree of stability existed within the region. However, there were frequent periods of disruption caused by wars and civil conflict. In addition, the Gloucester workers were very conservative and failed to adapt to changing fashions and markets, steadfastly sticking with traditional broadcloth targeted at traditional markets (VCH. iv. 76). Certainly, by 1640 new requirements were being imposed by the markets, and Gloucester’s decline can be at least in part be attributed to the failure to “move with the times”.

As noted above, a further fact that acted against the survival of the woollen trade was the lack of sites suitable for the construction of water-powered fulling mills.

The only reliable source of power for mills around the city was the River Twyver. During the 12th century, the Abbott of St Peters improved its course and constructed or rebuilt seven monastic water mills along its length towards Upton St Leonards. Throughout their working lives, all remained corn mills with the exception of Browns Mill which saw a brief period as a fulling mill. The other streams were too marginal to reliably power mills. The Sudbrook (not shown) had none and the Horsebere Brook, a single one (Pitts Corn Mill); even this was seasonal. The Severn itself was unsuited to mill construction.

Thus, gradually, for the reasons discussed above, some local and some fundamental, many workers abandoned their traditional urban locations and moved to rural areas. In a significant number of parts of Britain, cloth manufacture spread to an increasing number of rural locations and as “new” workers became more skilled, so an increased variety of articles came to be produced (Cunningham, 1905: 435). Especially in the West of England cloth-making counties, industrial populations spread from the towns into the countryside. For instance, in Wiltshire, cloth-making gravitated to Salisbury, Devizes, Chippenham, Calne, Bradford and Trowbridge (Ramsay, 1943: 3). Particularly between the 15th and early 18th centuries, expansion of rural industries took place (Thirsk, 1970: 816-826). In some instances, the movement began earlier; such was the case with the woollen cloth trade of the
West of England. Here, the trend in relocation accelerated from the 13th century onwards, gathering momentum throughout the 14th and 15th centuries. Gradually, the rural woollen cloth industry began to overshadow the older town-based centres of production (Ponting, 1971: 13). In each localised case, the reasons for this relocation may have differed, although perhaps the most important factor was the availability of suitable mill sites.

Thus, the older cloth-making centres declined as the uptake of the rural-based fulling mill increased. The appearance of the latter is traditionally credited with being directly responsible for urban decline. As a consequence of the lower costs and increased throughput obtainable through the use of mechanised fulling, urban-based merchants were drawn increasingly to what was clearly an attractive option. Consequently, it was only a matter of time before associated groups of workers such as dyers, weavers, etc, moved en masse to the new rural locations (Carus-Wilson, 1954: 51-59). This view of
the sequence of events has rarely been challenged although some writers have asserted that the rural fulling mills appeared as a consequence of the move to the country, as opposed to the reason for it (e.g. Miller, 1965: 73). It may have been that at least in some areas, the main incentive for the industry to relocate was the restrictive nature of the guild system and that encouragement was given by merchants, anxious to reduce costs and increase the availability of English cloth in the face of increasing competition from overseas. Hence, there may have been strong incentives for the move, more directly associated with flexibility of working and cost cutting than pure technical innovation. As Holt comments, it may be that the rise of the rural fulling mill merely reflected attempts by the rural lords to acquire a share of the profits being generated by the cloth industry which at the time, was expanding in many rural districts. As a consequence, some manors in the West had up to six individual fulling mills at the same time (Holt, 1986: 8). There was an incentive for land owners, both lay and ecclesiastical, to invest in new fulling mills, sensing that here was a second manorial monopoly with which to supplement their incomes. It seems likely that initially, at least in some areas, the proliferation of new fulling mills may have outstripped local demand. This excess capacity may have stimulated cloth production hence the presence of the mills would have acted to stimulate demand, rather than merely meeting it (Pelham, 1958: 3). In some areas, mills multiplied more rapidly than the local cloth production warranted. The result was that in some instances, for a time, such mills only attracted a low rent (ibid).

In the Stroud region, the rural industry was in the ascendancy from the early years of the 13th century, at which time the number of fulling mills was relatively low. This would seem to add weight to the suggestion that mills were a result of, rather than the prime cause of, the move to the country. A further point worthy of consideration was the assumption that considerable cost benefits to merchants would inevitably accompany the move. As fulling mills were almost entirely in the hands of the rural lords intent on increasing their incomes (Carus-Wilson, 1954: 52) merchants may not have actually benefited from the reduced costs of manufacture, rather the increased output of cloth may have been their main advantage.

In the case of the industry blooming in the Stroud valleys, there was a steady increase in the number of fulling mills. Geographically, the distance between Gloucester and Stroud was not great, hence the fact that plentiful water power and existing infrastructure was available would have been well known in the city. It is thus conceivable that a certain percentage of the urban industry moved to the valleys during the earlier part of the 13th century and that its consequent success prompted others to follow over ensuing years, with the result that fulling mill numbers increased further. These factors doubtless influenced the industry’s relocation hence in this particular case, it could be surmised that the Stroud valley fulling mills were both a causative factor and a reflection of the exodus from the urban centres.
The timing of the movement of industrial activities to rural locations depended upon the particular area and circumstances. In the West of England, cloth-making generally gravitated away from urban locations over a period of several centuries, the process accelerating from the 12/13th centuries onwards. At some point in the 12th or possibly 13th century, the fulling mill made its initial appearance in the Stroud valleys; tradition locates this in the Toadsmoor valley although does not suggest a date. Alternatively, this may have appeared at Dudbridge between 1271-1276 (Watson, 1932: 374); a fulling mill probably existed here in the 1300s, if not earlier (ibid. 761). By the 14th century, fulling mills had begun to proliferate in the area although they remained something of a rarity in the West of England in the latter part of the 13th century. At this time, there were only 26 mills that were definitely operating as fulling mills in the entire South West clothing counties of Gloucestershire, Wiltshire and Somerset.

In Gloucestershire, the main evidence for the geographical shift in production is provided in the form of the increasing number of fulling mills appearing around the Stroud valleys. For instance, in 1465, Edward IV bestowed lands and mills comprising the Chalford estate upon Thomas Herbert, one of his esquires. The estate included a water mill and two fulling mills, later referred to as a "tokying mill and grist mill", just several of many set up during the same period (Rudd, 1937: 308).

Throughout the West of England clothing counties of Gloucestershire, Somerset and Wiltshire, new fulling mills were initially set up in well watered rural locations, much to the chagrin of the urban guilds. In fact, this trend was not limited to the West, as the other important centres of woollen cloth production, the West Riding of Yorkshire and East Anglia, also began this pattern of regional relocation. However, nowhere was this trend greater than in the West of England clothing areas. This movement has been described as an early industrial revolution and in truth, this is perhaps how it could be viewed. In the West, the extent and success of this mass industrial relocation was to usher in what became subsequently known as the "golden age of Tudor broadcloth" (Ponting, 1971: 13). The multiplication of the rural fulling mill was especially pronounced and significant in the West and although similar translocations were occurring in the West Riding, the overall effect on the industry of the region was less (ibid). Before c1500, there were around 30 fulling mills known in Wiltshire (Rogers, 1986: 5).

Such relocations were still taking place centuries later. Thus, it was not until the 18th century that an upsurge appeared in textile production in the south west Pennine region, causing a dramatic upturn in the local economy; like Stroud had centuries earlier, this switched from agricultural subsistence to industrial prosperity as a result (Calladine & Fricker, 1993: 6-7). This particular textile relocation had been triggered by similar reasons to those that attracted other urban industries to the countryside, centuries earlier. Apart from abundant water supplies, the Pennine region offered water of suitable
quality, an appropriate climate, plus availability of a workforce, similar reasons to those behind the move to the Stroud valleys.

Hence, in Britain, the relocation of cloth-making from urban to rural locations occurred over a period of half a millennium or more, the actual period involved depending on the particular region. In the West, the movement started early and was generally a gradual process, whereas in others, substantial relocation did not occur until much later.

**Background and Advantages Offered by the Stroud Valleys**

As established (eg. Awdry, 1973), the Stroud valleys already had some 28 mills in operation at the time of the Domesday survey, almost certainly operating as corn mills. Precisely why so many existed in areas of limited cereal growing is an interesting question. That their use was not yet connected with the woollen cloth industry is confirmed by the lack of evidence for fulling mills in the locality until the 12th or 13th centuries. Although the valleys themselves only had limited possibilities in terms of cereal growing, it seems likely that they may have been used to grind grain from areas further afield. There is a general misconception that medieval mills ground grain exclusively grown in their immediate vicinity, only for local consumption. Although this was undoubtedly true in many circumstances, it was not necessarily always the case. Holt refers to similar clusters of early mills in other parts of England and makes the point that such a high density of mills was not always associated with a large local population. By the 11th century, it has been established that at least some mills drew a large percentage of their overall business from outside their own localities, perhaps some considerable distance (Holt, 1988: 13). In some areas, inhabitants had become accustomed to carrying their corn to be ground in mills outside their lordships; such was the case where mills were lacking, usually through a dearth of suitable sites for their construction. Hence, at least some of the Stroud valley mills may have been engaged in milling grain grown a few miles downstream in the Vale of Gloucester as well as from the land surmounting the valleys. In addition, Stroud was well placed to handle cereals grown on parts of the Cotswold uplands. Here, once again, with a few exceptions, streams of sufficient fall and volume were relatively scarce. Although some areas of both the Vale and the Cotswold uplands were not ideal for large-scale cereal growing, a certain amount did take place, as evidenced by the existence of corn mills at for instance, Fromebridge and Wheatenhurst in the former region. Much of the uplands was fairly bleak and exposed during parts of the year and the clay soil of the Vale resulted in the preponderance of dairy farming but despite this, cereals were grown in both areas. In addition, parts of the area bordering the lower Frome valley were similarly utilised. Although physical evidence is lacking, many of the 28 Stroud mills were doubtless very small affairs, only capable of grinding relatively small quantities of grain. In addition, some may only have been operable during particular times of the year.
Although transport in the valleys remained notoriously difficult even up to the 18th century, individual mills were small and the volumes of grain to be transported and processed remained relatively low. The Stroud mills may have been the only option open to cereal growers in locations mentioned, areas with few exceptions, largely bereft of streams suitable for powering mills. Therefore, the presence of so many Domesday mills in the valleys could be explained simply as a case of mills being built in a region where water resources outstripped the requirements of the local population (Holt, 1988: 11) but were being capitalised on by others from outside the immediate area. Although transport to the Stroud valley mills must have frequently been troublesome, some rudimentary transport links were already in place, a number of ancient tracks connecting the various areas. Individual loads of grain at this time were not large and thus easily transported by pack horse or man power.

The fact that in the period immediately following the Domesday survey, the rate of mill building levelled off could be taken as an indication that the majority of premium sites had now been fully exploited (ibid. 13). It is generally accepted that at this time, corn milling could generally provide a sizable income for the owner (usually the lord of the manor) hence there was a clear incentive to exploit this further. The lack of further mill building would seem to add weight to the supposition that the first tranche of suitable mill sites had now been fully occupied. Although these small corn mills were clearly of some importance to the economy of the region, within a century or so, an industry of much greater significance began to develop in the area. The upsurge of rural cloth manufacture was destined to overshadow all other occupations and was to assume the role as the greatest employer for several centuries.

Why did the cloth industry arise in the Stroud valleys? Some of the answers may be obvious but others, less so. As noted, there were clear pressures on cloth workers in the City of Gloucester and perhaps some of the county’s smaller towns to migrate to the countryside in order to escape the restrictive regulations and working practices of the urban guilds. This, coupled with the wealth of existing mills and as yet, unused water-powered sites, was a great incentive for the industry to settle here. However, although these may have been the primary reasons, there are other points that require consideration. Matters may have been complicated by other factors and Thirsk explores a number of situations where industries relocated to rural locations and confirms the supposition that the reasons behind this may be both complex and site-specific (Thirsk, 1984: 223). One case cited concerns a society of stocking knitters settled in Dent, in the Yorkshire Dales. Here, stocking knitting was adopted widely as a necessary means of generating additional income. Formerly, fully sustained by agriculture, the populous had suffered as a result of a particular form of inheritance (partible inheritance) whereby if a land owner died without making a will, the paternal lands were split equally between his sons. This had the effect of breaking up larger units of land to the extent that each became too small to support the various family offshoots, hence extra income was required (Thirsk,
1984: 217. Also PRO. E134. 10-11. Chas I, Hil. 22). This serves as an illustration of some of the underlying and often overlooked complexities that may influence a particular set of circumstances. As Thirsk comments, there is no certainty or finality in any explanation for the growth of a rural industry in one district rather than another. However, in the case of the rise of the Stroud woollen industry, several factors probably predominated.

The development of a successful cloth-making enterprise has traditionally been attributed to the use of local raw materials, although there are cases where rural cloth-making areas have risen to national importance without fulfilling what are perceived to be the necessary criteria, namely:

- Plentiful supplies of water for processing and power generation
- Adequate supplies of locally grown wool
- Availability of local seams of fullers earth
- Good communications with markets and ideally, a port

How did the Stroud valleys fare in meeting these apparent requisites? Certainly, water power was available in profusion and there can be little doubt that this was a major factor in luring the industry to the region. That mill sites were available and water supplies adequate for fulling was confirmed by the number of existing corn mill sites already in operation.

Local wool is cited as a requirement, however even availability of locally grown wool was not a guarantee of a successful cloth industry. As has been pointed out by a number of writers, counties such as Leicestershire, Cambridgeshire and Lincolnshire had the most wool but the least cloth manufacture. Thomas Fuller noted that in the mid 17th century, the aforementioned counties:

"[had] most of wool, but least of clothing therein". (Quoted by Thirsk, 1984: 218).

Cloth-makers frequently obtained their supplies of wool from elsewhere and there are references to buyers travelling considerable distances in search of suitable supplies. For instance, buyers from Herefordshire came to Gloucester and it was common practice for Wiltshire buyers to obtain supplies from the Cotswolds flocks and from Salisbury Plain (Thirsk, 1984: 223). Hence, a good local supply of wool was not necessarily a good reason for the development of a cloth-making industry, although during its early formative period, the industry in the Stroud valleys was supplied by locally grown wool. The surrounding Cotswolds were renowned for both the quality and quantity of its wool and
this has been explored at length by other writers (For example, Ponting, 1961 and Bischoff, 1842).
At a time when large-scale, long distance transportation was something of a rarity, there was little
incentive or opportunity for the cloth-maker but to source his wool predominantly from his own
locality. Bischoff, when referring to the early industry’s dependence on the pack horse states:

"With this tedious mode of conveyance, as well for the raw materials as for the manufactured articles,
it must be obvious that the manufacturer would fix as near as possible to these districts where wool
was grown, and where he could find a sale for his goods at no great distance from his dwelling".  
(Bischoff, 1842: 429).

Bischoff oversimplifies the case; as mentioned, counties producing the most wool did not necessarily
host large indigenous cloth-making industries. However, his assertion is probably largely correct in
the case of Stroud. In addition to the clothiers and others who made their living solely through the
manufacture of cloth, were other groups of workers who combined cloth-making with alternative
occupations. Hence, the group of farmer-clothiers active in the region no doubt raised much of their
wool from their own flocks (Tann, 1967: 19). Apart from the farmer-clothiers, it was not unusual for
the wealthier weavers to grow their own wool, both in Gloucestershire and Wiltshire (Ramsay, 1943:
16).

The easy availability and high quality of Cotswold wool undoubtedly gave a boost to the fledgling
industry in the valleys, the high reputation enjoyed by the wool being well known at the time.
Woodman quotes a popular saying of the 12th century:

"In Europe the best wool is English
In England the best wool is Cotswold". (Woodman, nd: 3).

Cotswold wool was renowned for its whiteness, which was important for dyeing, and better felting
properties than many of its competitors; this ensured that it was held in great esteem up to and during
the Middle Ages (Mann, 1987: 256). According to clothiers of the period, the wools of Leominster,
Cotswold, Hampshire and parts of Wiltshire stood in a class apart as capable of making finest cloth
(ibid).

The great bulk of fine wool exported in the Middle Ages came from two long-woollen breeds,
Cotswolds and Lincoln’s, although the largest and most important source was the Cotswolds (Power,
1941: 21-22). Throughout this period, local wool growers fell into two clearly defined categories; the
big ecclesiastical and lay landowners, and the ranks of small owners and peasant farmers (ibid. 42).
The supplies for the Stroud valleys industry thus came predominantly from the surrounding area and
local cloth-makers either bought their own wool directly from the growers or in some instances, grew it themselves. Others relied on the services of wool broggars or woolmen such as William Midwinter and John Busshe of Northleach. Like many others in their profession, they bought up wool from surrounding farms then sorted and stored it ready for resale. Apart from selling considerable quantities to overseas buyers, they also supplied local clothiers (Woodman, nd: 9).

A number of these woolmen grew to be both wealthy and powerful, some of the most notable being those of the Cotswolds (particularly of the 15th century); their chief meeting place with export merchants was Northleach. Initially, the Stroud market remained relatively small compared to the export side of their business and as early as the 12th century, foreign buyers from as far away as Italy were coming to the area to buy clips directly from the growers or through intermediaries such as broggars (Woodman, 3-4). Great wool markets grew up in Tetbury and Cirencester and by the 14th century, both were well established as centres for the sale of wool from the surrounding area. Tetbury fair was a recognised mart for the sale of wool by 1306 (Ross, 1964: 359) and was to play an important role for the next four centuries or so.

As the Stroud valleys' industry developed and evolved over the ensuing centuries, it became commonplace for farmers to sell their wool directly to the clothiers (Hadfield, 1973: 183) and this gradually reduced the importance of the wool markets of Cirencester and Tetbury. By the 17th century, the Stroud clothiers were obtaining their wool from a variety of sources partly through economic pressures but mainly because between the 16th and 18th centuries the nature of the wool produced on the Cotswolds changed dramatically and gradually its position as one of the best feedstocks for the manufacture of fine broadcloth diminished, its use becoming limited to coarser cloth. As the 17th century progressed, the Stroud industry was characterised increasingly by the use of imported Spanish Merino wool, destined for the manufacture of fine broadcloth (Herrick, 1980: 14). The use of Cotswold wool by the Gloucestershire clothiers thus became limited to lower grades of cloth sent to the Levant and India (Mann, 1987: 257).

Hence, in overall terms of supplies of wool, the Stroud industry was initially well placed to make use of locally grown supplies of high quality Cotswold wool and later, when the latter's quality declined, had little trouble in switching to imported wool from Spain and latterly, Australia and Germany. In this case, initial easy access to locally grown wool was clearly a significant advantage to the
developing Stroud industry although it may not have been as important as is often perceived. Even with the limitations imposed by the restricted communication and transport systems that characterised much of the country at this time, it was not uncommon for clothiers to obtain their wool from distant counties. For instance, some Shepton Mallett (Somerset) clothiers obtained wool from Dorset and Hampshire (M Westley. PRO. C110/119. Pt II. Wool Accounts. Quoted by Mann, 1987: 259). Other Wiltshire clothiers sourced their wool from such markets as Cirencester, Tetbury and Castle Combe (Ramsay, 1943: 12). Hence, successful woollen cloth-making districts were not entirely dependent on local wool supplies and were able to develop successfully even where such a crucial commodity had to be brought for considerable distances. In this respect, the Stroud valleys were fortunate that such high quality wool was readily available during its early development and this was undoubtedly an important factor in its rise to eminence in the region.

With regard to local supplies of Fullers Earth, parts of the area fared better than others. The major deposit within the county is sandwiched between the inferior and great oolites and is found only in a narrow outcrop lying usually between the 500 and 700 ft contours (Payne, 1946: 33: Also Herrick, 1980: 14). Supplies to the local industry have been obtained from this outcrop at various points around the Stroud valleys including the aptly named Clayspit (somewhat lower and at the most northerly limit), Nupend, Avening, Minchinhampton, Bournes Green, France Lynche, Chalford Hill, Brownshill and Bisley. Hence, some locations were more easily supplied than others; the Eastington clothiers were supplied from deposits in both Nupend and Clayspit, where they were blamed for causing the flooding of the Bristol road. Minchinhampton and Chalford were both important woollen centres and deposits were dug in locations around both. These tended to be at fairly elevated sites whereas most of the mills were in the valley bottoms. For instance, Fullers Earth was dug around Theescombe and St Chloe in Minchinhampton, some distance from the mills themselves. It was not uncommon for mills to obtain their supplies of Fullers Earth from some considerable distance and in the case of the clothing districts of East Anglia, this was transported from Kent. (Thirsk, 1984: 218).

It appears therefore, that many of the Gloucestershire mills had to obtain their supplies from some distance away and in some instances, this would have entailed transport via pack horse descending steep tracks down the valley sides. Nearer the Vale, such problems were minimised as a result of the flatter terrain but even here, transport could be notoriously bad due to the poor state of the roads at different times of the year. Thus, it appears that many of the Gloucestershire mills were within reasonable distance of supplies of Fullers Earth and even those that were not, managed to cope by carrying in supplies as necessary, despite the poor state of local roads. Hence, the existence of locally available supplies within the region was certainly of benefit to the developing industry although it seems likely that the surfeit of water-powered sites was a more dominant reason for its development.
In addition to the reasons cited above, there was also the need for a suitably skilled workforce to be resident in the area. In the Stroud valleys, small settlements of workers grew up around the fulling mills, these forming the focal points of the growing industry. Thus, groups of weavers cottages developed at many places in and around the valley mill sites, although some came to inhabit squatter settlements on higher ground.

The industry grew, but not necessarily at a linear rate. Following the relatively slow increase in numbers of fulling mills up to c1400 throughout England, there was an increase in the rate of construction of new mills during the 15th century. This may have been given extra impetus not merely through the increasing amounts of cloth being produced, but because the demand for corn was falling at this time (Holt, 1986: 8). During the 16th century, throughout much of England, there was a further upsurge in cloth production and also in the rate of fulling mill construction. Much of this impetus came from the new gentry who had acquired lands or estates formerly in monastic hands. By the beginning of the 17th century, differences in the organisation between the clothing districts were emerging. For instance, in Wiltshire, virtually all of the fulling mills were owned by wealthy clothiers (Ponting, 1971: 19. Also Mann, 1987: 92). In Gloucestershire, although a high proportion were also in similar ownership, there was a higher incidence of independent fullers operating. In the Stroudwater region, for a time there were 2½ fullers to every clothier (Rudd, 1937: 288. Also Mann, 1987: 92). Whatever the ownership, fulling mills remained the focal points of the Gloucestershire industry.

The increased availability of fulling mills required a corresponding increase in the other stages of production, in some cases the additional labour being sourced from the large potential labour force set free by the enclosure movement and the demobilisation of armed retinues (Pelham, 1958: 5). Significant increases in the scale of the industry were noted in parts of the Stroud valleys from the 15th century on. For instance, it appears that the ascendancy of Painswick into an important cloth-making centre began in earnest during this period. Certainly, by the 15th century, evidence begins to suggest that the trade was becoming firmly established in the area. Hyett cites an early manuscript (dated 1440) that mentions items such as "tesills" [teazles?] as well as:


Architectural evidence suggests that many of the substantial stone-built houses of the area date from the beginning of the 16th century, continuing into the 17th century, suggesting a population that had risen above subsistence levels. In 1495, the lord of the manor's rent roll mentions eight mills, the likelihood being that most of them were fulling mills. In addition, between 1495-c1700, large increases in population were noted, all confirming the presence of a thriving cloth industry in the area.
In all parts of the valleys, there was an on-going theme of reuse of mill sites, and although buildings might be replaced, the importance of good water-powered sites ensured that the locations were used time and time again. In other locations, where a glut of water-powered sites was available, this did not necessarily happen. For instance, the South Wales area is peppered with the remains of small fulling mills although here, the industry evolved in a different manner to the Stroud valleys. The number of mill sites in the South Wales region was high, although they were not all working at the same time (Parkinson, 1985: 42-47). The industry was one of booms and busts hence many of the mill sites are in reality, of different periods. In Gloucestershire, over several centuries, mill sites were constantly reused.

Influence of Transport and Communications

Initially, both of these aspects were poor, however because of the limited nature of the business at the time, the pack horse proved adequate. In this respect, the Stroud industry was no worse off than competing rural-based clothing districts. For instance, certain rural areas of Wiltshire were in a similar situation. As the majority of clothing areas located in the countryside were heavily dependent on the pack horse as the main means of transport, the playing field effectively remained level.

Bischoff comments that before the middle of the 18th century:

"...the roads throughout the kingdom were extremely bad and almost impassable, so that it was very difficult to convey from place to place either bulky or heavy articles. Wheel carriages could be little used and pack horses were the general means of conveyance." (Bischoff, 1842: 428-9).

Figure 9. Pack horses carrying packs of wool passing Avening church. Late 18th century.
In the locality of Stroud itself, communications between the town and many outlying mills was both difficult and slow. Fisher comments on the difficulties of reaching Chalford, a mere four miles from Stroud:

"This highway was through its whole length very inconvenient both to the clothiers who lived near their mills on the stream...it required a whole day for a team of horses to draw a loaded waggon from Stroud to Chalford and return". (Fisher, 1975: 156).

In the industry’s infancy, manufacture was aimed predominantly at meeting local needs however this situation changed. Clothiers capitalised on the relative freedom that existed in such rural locations, free from the urban guilds’ restrictive practices. Gradually, they began to look further afield to markets beyond their locale. The widespread adoption of the fulling mill acted as an impetus in general and ensured that greater quantities of cloth could now be processed. For the first time, this gave many clothiers the opportunity to look beyond their own region to markets further afield and this increased the pressure to improve both communications and transport links with the outside world. However, little in the way of improvement was to ensue for a long time. Even during the 16th century, transport still relied heavily on the pack horse. Lengths of cloth were done up in packs of ten and taken by pack horse or waggon along the road across the hills from Bisley...thence to Cirencester and London (Tann, 1967: 25). By 1550, most of the cloth produced around Stroud was sent to the capital for sale (ibid).

The poor state of the roads in the district was well known. For instance, one of the most important main through routes in this part of the county was the road to Bristol that ran through the Vale. By the 1750s, this had been turnpiked (Gregory, 1983: 40, 55). This formed the most direct route to the nearest port of importance through which passed a whole range of commodities and raw materials, both as imports and exports. Despite its turnpike status, it was often remarked that at times of the year it was almost impassable.

Despite the greater geographical distance, generally speaking, the Northern clothing districts had better communications with London than the West. By the 1750s, the West Riding had enjoyed improved communications with the capital for some years (Gregory, 1983: 55) however, the West still lagged lamentably behind. An observer noted in 1754 that it would be beneficial:

"...to see all England accessible to travellers and open to commerce. The North is already and the West, 'tis to be hoped, will take its turn and come into play soon" (Gentlemans Magazine. 1754. 347-9).
Although the limitations imposed by the poor roads was a major handicap at times, it did not stop the industry from expanding. Despite the problems, business was being carried on through Gloucester, Bristol and London (Gregory, 1983: 56). Gloucestershire cloth was being exported through Bristol from at least the early 14th century (Herrick, 1980: 16). Cloth was sold to the Bristol merchants and in return, clothiers bought such commodities as oil from Spain and woad from Toulouse (Carus-Wilson, 1969: 183, 246). In addition, the presence of fulling mills in the Stroud valleys attracted business from considerable distances. For instance, cloth woven in Worcester was being sent to Stroud for fulling in the 1630s (PRO.SP 16/221/28). Carriage was presumably limited to the pack horse for at least part of the journey.

By the 18th century, however, it was becoming a significant problem as the valleys' industries found themselves in a more competitive and nationally-based marketplace. From now on, there were repeated complaints from clothiers in the district about the deleterious effect this was having on their business. Not only was this affecting the ease by which bulk supplies of wool could be imported from Bristol and London, and finished cloth out of the district to various destinations within Britain and beyond, the adoption of steam power was now playing a part in the changing equation. As explored later, the difficulty in obtaining reasonably priced, regular supplies of coal was to have a significant effect on the development of the industry in the valleys. The high cost and difficulties in obtaining regular coal supplies undoubtedly tempered the clothiers' enthusiasm for steam power although perhaps surprisingly, their long-running dependence on water power did not appear to hamper their overall commercial activities to a large degree.

The extent of the difficulties associated with long distance travel, let alone transport of goods, can be gauged from a letter written by the clothier Giles Clutterbuck to his cousin Richard. The latter intended to visit Giles' home and fulling mill at Millend and wrote enquiring of the best route to take to Stroud from his lodgings in London. Giles replied:

"...as also your intention for Gloucestershire, as a favour I must confess I could not expect, but as you desire to see the place of your Family helps you to surmount all the Difficulties of Distance and the fatigue of so long a journey...there is a stage coach sets out from the Bolt and Ton in Fleet Street (if I mistake not) which brings you in two days (through Oxford) then Glou[ester], seven miles distance from me...Millend, 21 March 1749" [I am indebted to Mrs G Leighton of the Family History Society for bringing this letter to my attention].

Giles may have been overly optimistic in assuming that the journey would only take two days. In 1750, the time from London to Gloucester was reckoned to be at least 39 hours travelling time, not allowing for stops (Gregory, 1983: 57).
So, even travel by coach over some of the best highways in the region to the capital city took two days or more. Clearly, slow moving heavily laden wagons took much longer. When the weather intervened, times inevitably increased considerably.

Overall, the Stroud region therefore fulfilled most of the perceived requirements for the establishment of a successful woollen manufacturing area. On the plus side, there were no guilds to contend with, water power was plentiful in the valleys, high quality wool was available from a variety of sources and Fullers Earth could be obtained without too much trouble. On the minus side of the equation was the long-running bugbear of the region, that of poor communication and transport. Yet even here, until the eventual appearance of improved roads, canals and rail links in the 18th and 19th centuries, local clothiers managed, albeit sometimes with difficulty, to overcome the handicap caused by their relative isolation. Hence in overall terms, the Stroud industry had significant advantages over some competing regions. In all probability the most important factor working in its favour was the surfeit of water powered sites available. As commented earlier, other clothing districts managed successfully even when totally dependent on supplies of wool brought from elsewhere and similarly, where necessary, Fullers Earth was imported from farther afield. Clearly Stroud's isolation diminished gradually as transport links were improved over the centuries although in its infancy, when heavily dependent on the pack horse, it was in a position that was no different from most of its competitors situated in rural areas.

Like the Stroud region, the clothing districts of Wiltshire had essentially the same requirements. The manufacturing areas were almost exclusively in the western part of the county, predominantly in the hundreds of Chippenham and Melksham. In their favour were adequate supplies of water for processing and the provision of power, plus supplies of Fullers Earth. Unlike Stroud, although some was found from local sources, wool supplies tended to be sourced from further afield and it was not uncommon for this to come from as far as the Cotswolds, Worcestershire and parts of Wales. Despite the obvious transport problems, this apparent drawback was constantly overcome, allowing the industry to develop and flourish (Ramsay, 1943: 3-4).

Therefore, it appears that most woollen clothing districts could meet some of the criteria but often, not all. The overwhelming prerequisite was for water supplies, crucial in the adoption of the fulling mill, a technology that without which expansion was effectively impossible. Such was the case with some of the earlier clothing centres such as Gloucester and Tetbury. In the case of both, the lack of suitable sites for fulling mills essentially sounded the death knell for the industry in these areas. Other difficulties might be overcome, but access to water power was critical. Gloucester, despite all the obvious advantages offered by an established commercial and industrial centre, at the heart of a road network and river crossing point, was doomed as a result of the lack of mill sites.
A further requirement sometimes overlooked was for access to suitable foodstuffs to feed the growing population involved with the industry. Being essentially an agricultural region, food was on hand for the growing band of workers around Stroud. Similarly, land was available for housing, as evidenced by the squatter settlements that sprang up at various locations such as Chalford Hill, Eastcombe and France Lynch. These advantages greatly outweighed the region's relative isolation, hence the industry grew in importance with the passing years and continued to thrive even when competing regions, some of which were apparently more advantageously situated, were in steep decline. As a direct consequence of the Stroud region's suitability, the woollen trade began its gradual relocation to the area from its traditional locations in Gloucester and some of the smaller county towns.
CHAPTER 4

ORGANISATION AND EVOLUTION OF THE GLOUCESTERSHIRE INDUSTRY

Background

The cloth-making business in the West of England differed significantly from that in the North; these issues have been identified and examined by several writers including Gregory and Ponting. These alternative arrangements came about from a combination of circumstances, some national and others more local in nature, but whatever the reasons, once the various systems had been established, although evolving, they continued largely in their respective forms up to the 19th century. In some respects, the operations of the Stroud clothiers were very much in line with what was happening in the western region as a whole. However, some aspects of the organisation of the industry in Gloucestershire developed in different ways to the rest of the region.

The West of England clothier was a different animal from his counterpart in the North, and from an early date, was responsible for organising the working patterns of a significantly greater number of individual workers than his Yorkshire peers. Capitalism had come early to the West and there had been exponents of this system of organisation in the region from at least the 14th century; for instance, the wealthy Thomas Blanket of Bristol who, as early as 1339, was setting up looms and hiring journeymen to manufacture cloth for him (Cunningham, 1905: 436-7). Others similarly active included William Stumpe of Malmesbury and Thomas Bell of Gloucester (see later, pp239-240).

Precisely when this system became the prime means of organisation of the Gloucestershire industry is unclear, although certainly from the 16th century onwards, organisation of the trade in the Stroud valleys was predominantly in the hands of a select band of clothiers, directly responsible for the employment of a great number of local workers. That some of these early capitalists managed to rise to great wealth and influence can be gauged from the fact that by the latter part of the 17th century, some were being referred to as "gentlemen clothiers". These men were essentially capitalists who financed the whole business from fleece to finished cloth, retaining ownership of the raw materials as they were passed from one group of outworkers to the next, each performing a specific task in the chain of manufacture. Individual reasons for entering the trade probably varied, although many doubtless realised that the growing Stroud industry presented the opportunity to invest capital with a good chance of generating substantial income. By the mid 18th century, some Gloucestershire clothiers were controlling huge numbers of individual workers, some scattered throughout surrounding villages and parishes and others grouped around the base of operation, the clothier's fulling mill. As the Dean of Gloucester commented when describing the clothiers' role in the industry:
"One person, with a great stock and large credit, buys wool, pays for the spinning, weaving, milling, dying [sic], shearing, dressing, etc. That is, he is master of the whole manufacture from first to last, and probably employs a thousand persons under him". (Tucker, 1757: 37).

These comments referred to a relatively small number of clothiers who were operating on this scale at the time (Moir, 1957: 226) and there were others who spanned the entire spectrum in terms of the size and nature of their business. The major clothiers who dominated the Gloucestershire industry were men of considerable wealth and standing and a "respectable man" was reckoned to provide work for 30-40 hand loom weavers. A few clothiers had up to 150 or more weavers on his books (ibid. 239). What is clear is that many of the larger clothiers came from the necessarily wealthy background. In the Stroud region, at least some of them came from the ranks of the landed gentry or aristocracy and the lord of the manor was often in a strong position to take up the business. Not only did he often own the local mill(s), he also had sufficient capital to plough into, perhaps, the conversion of his corn mill to fulling or a dual function. Equally, he often controlled much of the local workforce hence could direct their efforts in the appropriate direction. The Stephens family, lords of the manor of Eastington, were just one example of what must have been many.

Not all businesses operated on the scale of the gentlemen clothiers and at the lower end, some were only modest in size. However, it was the wealthy capitalist clothiers that were increasingly driving forward the Stroud industry. Thus, many of the major clothiers’ roots were firmly in the privileged class or landed gentry. Their efforts and experiences with the organisation of large numbers of workers set them in good stead for what later developed into the factory system, with its attendant patterns of work.

Capital was needed to invest in the growing cloth trade, not only to pay wages and purchase raw materials at various points in the manufacturing chain, but perhaps more importantly, to gain access to a fulling mill. The latter was crucial and involved either the purchase or lease of an existing mill, or the construction of a new one. The fulling mill acted as the centre of the Stroud clothier’s business and from here, he organised the purchase of wool, sorted, cleaned and oiled it, then distributed it amongst his outdoor carders and spinners. It was then passed to the weavers and thence back to the mill for fulling and increasingly, raising on the gig mill; the majority of the Stroud mills appeared to have performed both functions. Following shearing, where appropriate, the cloth was dyed and dyehouses crop up regularly at many fulling mills; for example, in 1660, Giles (Stanley) Mills consisted of "three fulling mills, one grist mill and a gigg (sic) mill, and a dyehouse" (Tann, 1967: 149). Likewise, in 1749, Arundels Mill was described as a fulling mill with three stocks and a gig, with a dyehouse (GRO. D1347). Where the individual clothier developed particular skills in this field, he could prosper and some of the smaller clothiers opted to send their cloths for dyeing at his mill,
as opposed to attempting it themselves. Just such a specialist (Clutterbuck) occupied a site at Bridgend, near Stonehouse. In 1773, a visitor reported:

"Thursday July 15 - My cousin being gone this morning down to Bridgend to attend the colouring of the Scarlets " (Journey into Gloucestershire. 1773. Reported in Eastington Magazine. June 1889).

The Clutterbucks were like many of the major Stroud clothiers in that they lived at their mill and took a great interest in the day-to-day running of their business. In the Stroud region, it was not unusual for clothiers to supervise workers located in the vicinity of their fulling mill, and to oversee especially fulling and dyeing operations. Clearly, they were less able to supervise out-workers in cottages at any appreciable distance. However, the core of his business remained the mill, around which it was not unusual to find spinners, weavers, dyers, etc, grouped, an arrangement that was undoubtedly beneficial to the clothier. In such groupings, where the clothier took care to maintain and develop his business, there was a tendency for the neighbourhood as a whole to benefit (Moir, 1957: 240).

Thus, smaller clothiers who lacked the capability to carry our certain operations such as dyeing, looked to their larger brethren to perform the task for them. In a similar way, where a minor clothier lacked his own fulling mill, he sent his cloths to be fulled and gigged at the mill of a larger peer; this presumably constituted something of a major disadvantage as at least part of the control of manufacture lay in the hands of a potential rival. In a number of cases around Stroud, a consortium of smaller clothiers leased a fulling mill. Such was the case at Bonds Mill, where a consortium of four minor clothiers worked the mill (GRO. D2193). In Yorkshire, the situation sometimes differed although as a result of the relatively small scale of operation of many individual clothiers, it was not unknown for them to do likewise.
Among the lesser clothiers who aspired to join the ranks of their wealthier brethren, were those who were already connected in some way with the wool or cloth trade. Thus, the lesser clothiers’ roots were varied and included some who had been associated with the trade as wool buyers or as members of the various artisan classes such as shearmen, etc. Others were formerly drapers who dealt wholesale in cloth, or tailors, who manufactured goods from cloth (EM. May 1869. 11). For instance, the master weaver Thomas King of Rodborough, Stroud, became a clothier (PP 1802-3. vii. 4). Hence, it was not unusual for individuals from many walks of life to invest capital and employ workers, their role now changing from that of employee to capitalist clothier (Cunningham, 1905: 437). Clearly, the scale of their operations and capital invested was far removed from that of the gentlemen clothiers.

It appears that the larger Stroud clothiers of the 17th and 18th centuries were progressive in their outlook and although the county’s reputation was based largely on the production of traditional high quality fine cloth, they were careful to ensure that they kept abreast of changes in fashions and adapted their products as necessary. In later years, this attitude was to give way to one of conservatism and opposition to change. However, during this period, it ensured that Gloucestershire-made cloth was in a good position to meet market demands.
Scale of Business

Up to the 18th century, apart from the substantial gentlemen clothiers, it is difficult to assess the scale of individual operations of many Gloucestershire clothiers. However, from the beginning of the 19th century, it is possible to obtain a clearer picture of how the local industry was structured. In 1802, the clothiers lobbied parliament for the repeal of outdated legislation governing various aspects of the trade. A committee of 21 clothiers local was formed to pursue this and in order to defray the expenses associated with their lobbying, they imposed a subscription on each of their members. The amount levied reflected the size of the particular clothier’s business, and each paid either £20, £12 or £6 (GCL. JF 13.6, 13.27). In the first category, were 11 major clothiers, in the second, 21, and in the third, 46. Of the first category, the members were associated with some of the most wealthy and influential families in the county, these including Sheppard, Hicks, Wathen and Austin (Table 2).

<table>
<thead>
<tr>
<th>Clothier/partnership</th>
<th>Location</th>
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<tbody>
<tr>
<td>Sheppard &amp; Hicks</td>
<td>Uley and Eastington</td>
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<tr>
<td>Wallington &amp; Co</td>
<td>Dursley</td>
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<tr>
<td>Tippetts &amp; Co</td>
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<td>Lloyd</td>
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<td>Austin</td>
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<td>P Wathen</td>
<td>Kings Stanley</td>
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<td>Cooper</td>
<td>Woodchester</td>
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<tr>
<td>Smith Tate &amp; Co</td>
<td>Stroud</td>
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<tr>
<td>Day, Smith &amp; Alder</td>
<td>Nailsworth</td>
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<td>S &amp; N Wathen</td>
<td>Brimscombe</td>
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The second "£12" category also contained some fairly substantial businesses, their number including Phelps of Dursley, Dauncey of Uley, Playnes of Minchinhampton, and Hawker of Dudbridge. Although operating in a smaller way to their peers in Category 1, these clothiers were also men of some wealth and standing; examination of their houses and mills confirms this. In the £6 group were many of the region’s smaller clothiers although even here, some were of considerable local influence. For instance, T Beard of Beards Mill in Leonard Stanley was a member of the wealthy clothier family.
resident in the area. Doubtless many of the other members of the group were operating in a relatively small way although once again, surviving houses and mills suggest that they were often far from poor.

What is interesting is that of the 11 major concerns, most were located some distance from Stroud itself, some occupying relatively remote locations such as Uley and Alderley. The group comprising the smaller clothiers was made up of businesses primarily in and around Stroud and Chalford and in mills along the Painswick Stream.

**Development of Markets**

Parts of the West of England clothing districts supplied predominantly (sometimes) highly lucrative, overseas markets. By the beginning of the 18th century, several types, notably fine "Spanish clothes" formed important exports from Britain, with annual figures being in the range of 50-60,000 pieces. Much of this quantity came from the West Country as Yorkshire was concentrating on the production of different types of cloth such as Kersies. At the time, Yorkshire was less focused on overseas markets although during the 17th century, a few clothiers had dabbled unsuccessfully in the export trade to the Levant (Mann, 1987: 25; PRO. SP110/20). Some Western clothiers were very active in the Levant trade and it was noted that by the later part of the 17th century, Gloucestershire had taken much of the markets formerly supplied by centres such as Coventry (ibid. 27). By the close of the century, exports had attained greater importance than domestic markets for many clothiers of Wiltshire, Somerset and later, Gloucestershire. Despite the inevitable fluctuations, exports were to remain an important source of income for the next few centuries, with organisations such as the East India and Levant Companies supplying markets in Persia, Northern Europe, Portugal and the Mediterranean region.

In particular, the East India Company was important for Gloucestershire clothiers and several regions relied heavily on sales to India via the company. A number of clothiers, such as the Phelps of Dursley and others in Uley, Painswick and Nailsworth sometimes made cloth for the company although the main base of operations within the county remained the Chalford area (GJ. 7 September. 1807). For three or four decades, Chalford relied heavily on this outlet for their products although clothiers in other parts of the county were also busily exporting; both Edward Sheppard of Uley and the Austen family of Wotton were active in this sphere, sending cloth to supply both the Russian and Chinese markets.

In 1779, Rudder noted that the Gloucestershire clothiers were exporting around half of their entire production and were thus heavily dependent on overseas markets. Through such operations, considerable fortunes were built up by some of the larger clothiers (Moir, 198: 239). In contrast, the
clothier in the North operated on a much smaller scale, his workforce often comprising himself and his immediate family. As a result, the cost of labour was effectively low, enabling him to specialise in the production of cheaper goods. With a greater dependence on home markets and a much more modest business, few of the northern clothiers were in a position even to consider competing in the international market, as some of their Western peers were. In the West, the powerful clothier was able to encourage the development of overseas markets, invest in materials and buildings and organise labour on a scale far less frequently encountered in the North. The West of England clothier's business now comprised a water-powered fulling (and in Gloucestershire, gig) mill, with a network of out-workers, predominantly in their own homes. In the North, many clothiers worked in their own homes and fulled their cloth at public fulling mills. It was usual for the northern clothier to sell his cloth (to a merchant) in an undyed and unfinished state. The merchant then sent out the cloth for dyeing and dressing, usually in specialist workshops, mostly urban-based. Alternatively, he carried out the work in his own workshop, similarly located. (Giles & Goodall, 1992: 77). This mode of operation was significantly different to that of the West of England clothiers, where virtually all stages of manufacture remained under the clothier's direct control.

Thus, some West of England clothiers grew rich on the export trade with the Levant, etc. As a consequence, they were in a position to invest heavily in order to construct/enlarge their mills and build up their business even further. Later, when some export markets decayed in the face of competition from Yorkshire and overseas producers, they were in a strong position to take on the expanding home market, created by the general increase in population. As a result of these earlier forays into the export markets, some of the West's clothiers grew rich; this was especially so for Gloucestershire. (Mann, 1987: 50). The wealth created through exporting in earlier years allowed many to capitalise on the greater demand at home, often increasing individual wealth even further (GJ. 8 November 1784). In 1802, Gloucestershire clothiers noted that:

"It is pretty well understood that we have the market of the world in our hands since the French Revolution" (PP 1802-3. vii. 141)

Thus, the considerable fortunes generated by some Western clothiers allowed them to plough money into expanding their businesses at appropriate times. This became clearly reflected in the way they organised their business activities and in the type and scale of buildings they erected. Through a combination of circumstances, Gloucestershire clothiers of varying sizes were able to develop businesses that serviced both home and perhaps more importantly, overseas markets, in a way that their northern peers rarely did.

But what were the origins of the Stroud clothiers? As noted, although many important clothiers in the
region were of local origin, some of the most influential did not have their roots in the locality, but had originated from different parts of Europe.

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The Impact of Immigrants on Gloucestershire

Some immigrants were early arrivals appearing in Gloucestershire much earlier than the large scale immigrant influxes of the Middle Ages. Around Temple Guiting, the site of the county's first fulling mill (originally belonging to the Templars), the name "Fleming" occurs several times; its first mention is at Little Utryngton in Guiting in 1328 (VCH. ii. 157). The VCH speculates that the Templars themselves may have introduced skilled foreign workers to operate their fulling mill. Although this cannot be substantiated, it is nevertheless, an interesting possibility.

Encouraged by Edward III, many skilled workers were lured to Britain. Amongst their number were members of the Cloterbooke, Webb and de la Playne families, some of whom settled in Gloucestershire. Although the good treatment meted out to such workers once settled probably ensured that they were unlikely to return to their homeland at least in the short term, he nonetheless took precautions:

"The king having gotten this treasury of foreigners, thought not fit to continue them in one place, lest on discontent they might embrace a general resolution to return, and bestowed them through all parts of the land, that clothing thereby might be better dispersed. The new generation of Dutch was now sprinkled everywhere". (Bischoff, 1842: 425-6; quoting Fullers Church History: 110-112).

A tradition recorded in the early 18th century states that some of the Flemish weavers brought over to England by Edward III were settled in Stroud (Bodl.MS.Top.Glouc.c.3,F 169; quoted in VCH. xi. 120) and that the later development of the cloth trade in the area was connected with an influx of Huguenots. Indeed, there were a number of highly successful immigrant clothier families that came to operate in the Stroud region.

There was an understandable initial tendency for immigrant families, settling in a new land, to stay close together, living and establishing their businesses in the same locality. Such was the case with Flemish immigrants settling in London who huddled together for mutual support and protection. Flemish silk weavers set up a colony at Spitalfields where they long remained (Gibbins, 1890: 308). Similarly, there was a tendency for immigrant families in the Stroud region to stay close together in discrete areas. For instance, the Webbs appear to have made Painswick their initial home whereas the Clutterbucks remained mainly along the reaches of the lower Frome. Following this initial period, the perceived threats receded and through various commercial and social contacts, over the course of
a few generations, the families began disperse into society at large, a trend that was also discernable in other parts of the country (Pettegree, 1990: 297).

Several immigrant families had a significant effect on the cloth industry in the Stroud region. By way of example, the impact of four such notable clothier families on the Stroud trade is examined briefly:

■ The Clutterbucks

This came to be one of the most significant families, of Dutch descent, who settled predominantly in areas along the course of the Lower Frome in parishes around Eastington, Kings Stanley and Leonard Stanley. It has been suggested that their first arrival may have been 1574 when they are mentioned as being resident in Kings Stanley (VCH. ii: 158). However, at least some of them were earlier arrivals as by 1498, the family had been resident long enough in Eastington for one of their number to become church wardens (EM. May 1895). Clearly they had already been assimilated into the local community. This is somewhat earlier than another source which asserts that they had fled Holland in the 16th century. (Witchell & Heddlestone, 1924: 77).

Figure 12. Bridgend House, Stonehouse. Built by the Clutterbucks. Their original name was "Cloterbooke" - said to have been derived from "cloter", the Dutch word for cloth.

A succession of family members were active in the cloth trade throughout the 16th century, most located around the lower Frome area, their original point of settlement. Some members of the family grew wealthy through their efforts in the cloth trade, much of their money being invested in land; the latter was a common trait with immigrant families. By c1550, various members owned much of the parish of Eastington. Throughout the 17th century, family members continued to play an important role in the local trade, with some operating as clothiers and others as weavers and fullers. Throughout
the 17th century, family members continued to play an important role in the local trade, with some operating as clothiers and others as weavers and fullers. Throughout this period, the family maintained significant influence in local circles. For instance, a steady succession were recorded as church wardens of Eastington.

The Clutterbucks continued to intermarry with the local population, further consolidating their position in the community, although the impression that the respective partners were carefully selected cannot be ignored. Many were from the aristocracy or landed gentry and others were also engaged in the cloth trade. For instance, c1680, Thomas Clutterbuck married Elizabeth Freame, who had a part share of the Manor of Nether Lypiatt. (Bigland, 1889: 261). Apart from owning property, the Freames were themselves active in the cloth trade, hence such intermarriages helped to strengthen business as well as social ties.

From their original base in the villages along the lower Frome, from the 18th century, the family had spread out along the valleys, owning or leasing a variety of mills over the next century or so. During their period of influence, the Clutterbucks owned or operated at least 14 different cloth mills in the region, some for lengthy periods. The extent of the success of at least some of the family members can be gauged by the fact that they owned much of the parish of Eastington for several centuries, as well as estates at Avening in 1781 (GRO. S1265. Deeds 1716-1842) and Thrupp (GRO. D1157. Clutterbuck family. Thrupp leases. Also VCH. xi. 109).

After several centuries of importance in the trade, the Clutterbuck’s influence began to wane and eventually, their position was effectively usurped by the appearance of a new breed of clothier such as Henry Hicks. It was the latter whose:

"...kettles of steam shut down the cottage looms that had made wealthy many of the Clutterbucks". (Keys, 1953: 74).

Eventually, their independence had gone forever, and Clutterbucks, like many others, found themselves paid employees, working in the region’s enlarged factory mills; during the 19th century, many were recorded as workers in various mills, especially along the lower Frome.

- The Webbs

Another important clothier family with its roots firmly in Europe was the Webbs and records note their widespread presence in the cloth trade from c1300 onwards. (Hawker, 1945: 145). The Webbs were of Dutch origin although their original family name is obscure. At least some of the family arrived during the reign of Edward III:
"I am informed that a prime Dutch cloth maker in Gloucestershire had the name of Web (sic) given to him by King Edward. There is a family still famous for their manufacture" (Bischoff, 1842: 426; quoting Fullers Church History: 110-112. Also Marling, 1913: 315-333). Marling further noted that the surname of Webb was still frequently found around Stroud as were others such as Clutterbuck, that could be traceable to foreign immigration.

Thomas Webb the Elder, long an established clothier of Painswick, stated that his:

"forefathers beyond the memory of men had followed the trade of making red cloth, but only coarse cloth the colour of blood". (Mackintosh, 1984: 13-18).

Hyett notes that a small colony of Flemish weavers was said to have settled in Painswick towards the end of the 16th century (Hyett, 1928: 99) although clearly, at least some of their kinsmen in the shape of the Webbs had been settled here by this time. By now, Webbs were numerous in the cloth trade and amongst those settled in Painswick were Thomas (noted in 1634 and known as Webb de Hill), Edmund in 1686, Thomas (d1713), John (d1712), John (d1736), and Samuel in 1784. (Hyett, 1928: 185, 186, 234). The family subsequently turned its attention to the manufacture of finer cloth (both white and coloured), characterised by improved dressing. The Webbs were an important clothier dynasty who were credited with improving the quality of cloth and revitalising the white cloth trade. In 1608, Webbs were recorded as clothiers, weavers, tuckers and fullers. Their influence spread partially through intermarriage with the local aristocracy, a relatively frequent way for second generation immigrants to integrate into the local community. For instance, in 1675, Samuel Webb married Elizabeth Smart of the Manor of Througham (GRO. D1842.H.3), one of a number of marriages that helped to further establish the family in the region.

Like the Clutterbucks, some at least, had been early arrivals in the Stroud area for Thomas Webb was operating Churchend Mill in 1449 (SRO. D641/1/4K/2). However, the family's main centre of activity during the 15/16th centuries appears to have been Painswick where they became established as one of the important clothier families of the town (VCH. xi. 72). However, the Webbs appear to have spread geographically at a faster rate than other immigrant families and over four centuries, owned or worked at least 22 different mills throughout the valleys. Like many of their kinsmen, they were also prodigious buyers of land and owned the Manors of Culkerton, Rodmarton, in 1567 (CP 25(2)/141/1793. no. 11. Also VCH. xi. 239) and Archards, Rodborough, in 1561 (VCH. xi. 222) as well as estates at Brimscombe, bought by William in 1648 (GRO. D873. T102) and Newhouse in the 1630s (GRO. D873. T86). In addition, they owned an estate at Ebworth in 1781 (VCH. xi. 67); Rodborough (ibid. 222) and Bartons End, Horsely in the mid 18th century (Bigland, ii: 100-1).
The Playne Family

Of the immigrant Stroud clothier families, although not the first to arrive, the Playnes were the ones destined to remain actively involved in the cloth trade up to more recent times. Their greatest creation, Longfords Mill and Lake, stand as a monument to their innovation and success, plus their long involvement in the trade. The mill complex, although latterly forming part of a combine of companies, closed in 1990 and currently stands empty and decaying, a sad end for a family that was active in the Stroud trade from at least the 17th century.

It is not clear whether the original Playnes were refugees or voluntary immigrants, coming from the Netherlands in the mid 16th century. (Playne, 1952: 13). At this time, they settled in Kent and over the course of the next generation or so, became linked with some of the leading gentry of the county. Apart from business connections, as with many wealthy clothier families, intermarriage played an important part in their successful assimilation into English society. In addition, the family name now became "Playne" or "Plaine" as opposed to its earlier forms of "de la Playne/Plaine".

The family remained resident in Kent, where they were recorded as holding land from at least 1590 and continued to intermarry with the indigenous gentry, especially the Idens, an "ancient and well known Kentish family" (ibid. 14); several of the next generation of sons were named Iden Playne. The family remained at the hub of industrial life, centred around Great Chart, in the Weald of Kent, although c1650 signalled a move to the Stroud valleys where they continued their instrumental role in the cloth trade. What prompted the move is unclear - possibly the importance of Stroud as a rapidly expanding centre for cloth manufacture had spread even as far as Kent.

There are few records of their activities for the next century although it appears that much of their
efforts centred around cloth-making in the Woodchester area, probably involving Frogmarsh Mill. However, in 1759, the family’s long association with the Longfords Mill site in the Avening Valley began. Unlike the Webbs, most of their activities were focused on mills in and around the same area, particularly from the late 18th century onwards. During their reign, their main bases of operation included Frogmarsh, Longfords, Stanley, Iron, Dunkirk, Egypt and Avening Mills.

The Playnes’ played an important role in the development of the local industry and were directly responsible for the importation of German wool and its subsequent widespread uptake in the early 19th century (Ponting, 1978: 166).

The Paul Family

The Paul family, although less in number than some of their fellow countrymen, first came to England as Huguenot immigrants and were established in Gloucestershire from the 17th century. They settled predominantly in the clothing villages of Kings Stanley and Woodchester; the former was already a stronghold of Huguenot cloth makers. They were described as small but moderately prosperous clothiers. (Moir, 1957: 195). The family’s main base of operation appears to have been Southfields Mill in Woodchester, from whence, a number of significant improvements in dyeing and finishing emerged. In addition, the Pauls were responsible for the invention of the "Knapping engine", a machine which raised the nap of the cloth at regular intervals giving an attractive finish. Of the family, the most notable to emerge was George Onesiphorus, who in 1750, entertained the Prince of Wales on his visit to the Stroud valleys. In 1760 he became High Sheriff of the county and on the accession of George III, he presented a loyal address which brought him a knighthood (ibid. 196). Within a few years he was a baronet and on the death of his father, inherited large areas of land, by now, a Huguenot trademark, at Rodborough and Kings Stanley, plus various properties in other parts of the county, a colliery in Durham, and an assortment of estates in Somerset. At this point, he relinquished his interest in cloth manufacture and like a number of major clothiers at the time, took up the role of landed proprietor. He subsequently became a magistrate and an active and effective prison reformer.

In many respects, the Paul family exhibited the same traits as other Huguenot immigrant families in that they initially operated from a single locale, upon amassing sufficient capital, they ploughed it into the purchase of land, and through a combination of careful husbanding of resources and business acumen, ultimately achieved the status of the landed gentry.
Although there were many successful clothiers in the Stroud valleys who were from indigenous stock, there is no doubting the overall effect that some immigrants had on the profitability of the trade in general. Over a period of more than three centuries, cloth workers of European descent were active around Stroud, although in the West of England at large, their importance may have been somewhat less. In this respect, the Stroud valleys stand out as something of an anomaly and although their impact on the clothing districts of Somerset and Wiltshire was less pronounced, it seems that in the parishes around Stroud, they helped to create a solid foundation that was to allow the town to prosper at a time when many of the competing districts were in decline.

Thus, a number of immigrant families were resident in the Stroud valleys from an early date and through successive generations, remained a constant feature of the industry in the region. Although of importance locally, what impact did immigrant workers have on the West of England trade as a whole?

**The Effect of Immigrants on other parts of the West of England**

There seems little doubt that immigrants had a significant influence on English cloth-making practices, at least in some areas of the country. As a result of various political and religious upheavals in their homelands, foreign workers ("aliens") had arrived in England over a period of some five centuries. Although, compared to their English counterparts, some were highly skilled in the arts of cloth-making, their influence was limited geographically and it was not until the time of Edward III that the renaissance of the English woollen industry in general really began to take off. Under Edward’s protection, weavers, dyers, fullers and other craftsmen came en masse to England, bringing with them the technical and entrepreneurial skills necessary to revitalise the trade, which had in some regions, virtually stagnated.

Bischoff quotes at length from 'Fullers Church History' regarding Edward’s desire to improve the quality and output of English woollen cloth; this lagged far behind that of the continent in terms of quality and consistency. Edward had become increasingly aware of the success particularly of the French and Flemish cloth trades during his various sorties into these regions and resolved to bring the English trade up to a similarly profitable standard. This he did by secretly sending emissaries into these countries to persuade skilled artisans and merchants to settle in England. The difference in the degree of skills of the European and English workers was substantial if Fuller is to be believed:

"Our Edward III, therefore resolved, if possible, to revive the trade of his own county, who, as yet, were ignorant of the art, as knowing no more what to do with their wool as the sheep that weare
...such their coarseness for want of skills in their making. (Bischoff, 1842: 425).

Further immigrants continued to arrive, a large body of Flemish workers arriving in 1561, with others coming in 1585, following the sack of Antwerp. With them came additional skills to improve the quality of English cloth and broaden the range of products that had hitherto been possible. They brought additional skills to the industry in a number of areas. For instance, the skills in the dyeing of cloth were greatly lauded:

"One Brewer and around fifty Wallons, who wrought and dyed fine woollen cloths came into England, and the king, after the example of two of his wisest and most renowned predecessors, entertained them; by whom the English were instructed to make and dye fine woollen cloths, cheaper by 40 percent, than they could do before, not only to the benefit of the English here, but in foreign vent abroad, which before the Dutch had". (Bischoff, 1842: 75. Quoting from Smith's *Memoirs of Wool*).

In 1685, Louis XIV revoked the Edict of Nantes, resulting in thousands of Huguenots, who comprised the elite of the industrial population, to leave their homeland. Many subsequently settled in England, bringing skills not only in cloth making but also in the manufacture of glass, paper, silk and domestic manufactures in general (Gibbins, 1897: 308-9). It is stated that around 50,000 immigrants arrived in England bringing with them not only skills, but also capital of some £3,000,000.

The benefits of immigrant workers is not accepted by all writers and Ponting asserts that the woollen cloth trade in the West of England was essentially a native one and that the influence of immigrants has been overstated. Despite his assertion that there were few immigrants in the West of England and that their presence was of little consequence, there are various references to the presence of Dutch artisans in the West. The Dutch in particular were said to be skilled in the art of producing cloth entirely of Spanish wool. This was very soft and short in the staple which made its spinning very difficult. Despite this, the art had been successfully mastered by the "Hollanders" and references to their presence begin around the period of the Commonwealth and immediately after the Restoration. Not only were the Dutch skilled spinners, they also had great skills in dressing, dyeing and pressing of cloth (ibid). There are occasional references to immigrants, such as the Dutch spinner in Bradford-on-Avon in 1657 (ibid) although it was not until c1672 that appreciable numbers appear in the West, this time in Trowbridge and Bradford. Here, some 29 Dutch "clothiers" and their dependents settled in the area (VCH. Wilts. iv. 157). Although they could not claim to have originated the making of fine cloth in the region, they apparently did much to improve its quality. (Mann, 1987: 13). To some of the more progressive Wiltshire clothiers, it made good business sense to import skills from the continent and this is precisely what at least two major clothiers did. One was Paul Methuen, who had built up a substantial business in Bradford-on-Avon and his contemporary, William Brewer of
Trowbridge. (Anon. Beauties of Wiltshire. ii. 1801: 293). Both clothiers brought in foreign workers specifically for their skills; Methuen imported skilled weavers from Amsterdam and Brewer, a number of Germans or Poles (Jones & Jackson, 1907: 54-55). It was considered that such innovations not only benefitted the individual clothiers but led ultimately to the progressive improvement of cloth-making in general, as their skills were passed on to indigenous workers. (Ramsay, 1943: 116).

Apart from improvements in spinning and weaving, immigrants were responsible for improving the mode of, and reducing the cost of dressing and also made much better cards than their English peers. It is likely that they had much to teach the latter, especially in terms of cloth finishing (VCH. Wilts. iv. 157). Although there are relatively few definite references elsewhere to the presence of immigrant workers and Mann states that there were no Dutchmen in Gloucestershire (Mann, 1987: 13), in the light of the background of a number of important clothier families of European descent in the Stroud area, this does not ring entirely true as around Stroud, several areas formed the host communities for important immigrant families. Thus, in the overall scheme of things in the West, immigrant workers may not have figured very highly, although in the Stroud region, there is little doubt that their influence was of significant local importance, with families such as the Clutterbucks, Webbs, Pauls and Playnes building up large businesses. Although these immigrants families were also active in other spheres, their main influence remained centred around the cloth trade. The fact that many subsequently prospered in the trade can probably be attributed to the skills and capital that they brought with them, mutual assistance, and a good dose of business acumen. Their wider experience of Europe and its attendant cloth markets and manufacturing techniques doubtless assisted them on the road to their success.
Mechanisation of the Woollen industry

From the 1730s, advances in the mechanisation of the woollen industry began to be made with a series of developments that changed long-established procedures and practices. The first of a series of innovations came in the form of Kay's flying shuttle of 1733. Kay's invention allowed the shuttle to be projected back and forth mechanically, thus allowing wider cloths to be produced as well as increasing output. Whereas the average weaver had previously consumed the output of four spinners, he now required the services of ten. This imbalance clearly required addressing and further technological developments were pursued in order to meet the new requirements. Although he appears to be in a minority, Ponting disputes this sequence of events and suggests that the phenomenal success of the spinning inventions of the second half of the 18th century were as a result of the fact that several "mechanical geniuses" were all active in the cotton industry at the time. (Ponting, 1971: 60). Stimulus to their work may have been a result of the prevailing general prosperity of the cotton trade. Weavers had always been short of yarn, and Ponting suggests that the introduction of the flying shuttle merely aggravated this; he questions the ability of one part of the woollen industry to stimulate another into bringing the system back into equilibrium. However, Ponting's view does not appear to be shared by others and it is widely accepted that both the cotton and woollen industries were characterised by a classic engineering chain of events: needs - invention - more efficient processes - new needs. (Thompson, 1976: 38).

What is not in dispute is that over the next half century or so, increasingly efficient spinning machinery was introduced, commencing with Wyatt and Paul's roller spinner of 1738, followed by Hargreaves' jenny of 1764 and Arkwright's water frame of 1769. Eventually, the spinning mule, developed initially by Crompton c1779, was to join the fray.

Although the woollen industry had a long history in Britain, not all technical innovations were rooted in it, and many of the first developments in the realm of textile machinery development were centred on the newer cotton industry. Under the conditions prevailing in the country, cotton flourished. This was at least attributable partially to the absence of the constraints and conservatism that marked the long-established woollen industry. Thus, the cotton industry was more amenable to rapid development by the application of investment, business enterprise and newly developed machinery. (Buchanan, 1976: 92). Although not universal, there was a tendency for newly developed machinery to be adopted by cotton and only later, to be taken up by the woollen industry. Sometimes delays were caused through the attitude of woollen manufacturer and at others, through the requirement of further development in order to adapt the new machines to wool. However, wool did not always lag behind cotton and innovation sometimes came first to the former. As will be shown in the following section, apart from mechanised fulling, long-established throughout the country's woollen districts, at least in
Gloucestershire, powered gig mills were to be found from an early date.

The development of new machinery intended to improve quality and/or increase output was to be of crucial importance to the woollen industry and over a period of half a century or so, its gradual adoption was at least partially responsible for the shift of the industry from the cottage to the factory. In terms of the rate of this transition, significant differences were to found between competing regions. In Gloucestershire, there was little consistency in the rate at which the industry took up new processing machinery. During some periods, manufacturers appear to have seized rapidly upon a particular advance in technology, whilst at others, lagged lamentably behind their competitors in others regions. Opinions differ on the overall rate of uptake of machinery; Tann asserts that the West was quick to adopt new machinery (Tann, 1967: 69) and while this was undoubtedly true for some areas and at certain times, there is little evidence to indicate that Gloucestershire was always at the forefront.

Some indication of the attitude of Gloucestershire clothiers towards new machinery during the initial period of its introduction, can perhaps be gained from the following. Twelve Somerset (Shepton Mallet) clothiers attempted to set up experimental machinery in the town’s workhouse c1776. (Crump & Ghorbal, 1935: 64). However, this venture, like so many in the county, was doomed from the start. Despite agreements with the local weavers, the mob destroyed the machinery. (BC. 18 July 1776). Part of the outcome of this action was the gathering in the same year (in Bristol) of clothiers from Gloucestershire, Wiltshire and Somerset. (Mann, 1987: 123-4). As a result of their deliberations several statements were issued, one of which recommended that experimental machinery should be constructed and evaluated in various places of manufacture (GJ. 9 September 1776). In a further statement, the Shepton Mallet clothiers were thanked for their efforts. This latter statement was signed 101 clothiers from the three counties, however of this total, a mere eight were from Gloucestershire. This perhaps gives an indication of their attitude and Mann makes the salient observation that the Gloucestershire clothiers may not have been so enthusiastic about machinery as their neighbours in Wiltshire and Somerset. Meanwhile, many Yorkshire clothiers had pursued technical advances with vigour; by the 1770s, both the carding engine and spinning jenny were in widespread use. (PP 1806. iii. 113).

In order to obtain a clearer picture of the advance of new machinery in the Gloucestershire woollen districts, it is useful to follow the introduction of, and examine briefly the attitudes adopted to, some of the more significant technological advances on their introduction into the county, namely the gig mill, flying shuttle, carding and spinning machinery, and the power loom.
Gig Mills

Although details of the earliest gig mills are obscure, in all probability, these as well as the later variants, consisted of a rotating cylinder covered with teazle heads. The cloth was traversed against the revolving cylinder, the teazle's hooked barbs raising the nap of the cloth in the process. This technique eventually ousted the long-established hand-based process of using (teazle) hand cards.

Apart from the fulling stocks, the gig mill was the first piece of powered equipment adopted by the clothier although its rate of uptake was heavily dependent on the area in question. Their initial date of introduction into the country's woollen areas is unclear although it was in at least limited use by the first part of the 16th century. In 1552, a Statute was introduced banning the use of the gig mill. How effective this was is a matter for conjecture and their use in some areas, Gloucestershire in particular, seems to have carried on unabated.

In other parts of the West, the Act was more forcibly adhered to and in Wiltshire, following a few prosecutions they appear to have fallen out of general use. (Rogers, 1986: 28). Surprisingly, a few gigs were in use in Wiltshire as early as c1554 (Ramsay, 1943: 13) although their use was later suppressed throughout the county.

Despite the hostility of the workforce, there was a great incentive for Wiltshire and Somerset clothiers to adopt the gig mill as it had proved itself capable of producing results equal or superior to hand raising. Clothiers attempting to make use of the gig in these areas ran both the risk of worker unrest and the attention of the law. For instance, several clothiers at Warminster faced worker opposition and were also indicted for owning gig mills (ibid. 24). The worker response was symptomatic of the Wiltshire industry and in later years, wholesale opposition inevitably accompanied virtually all attempts to introduce new machinery; by 1756, the only type of powered machinery in use was limited to fulling stocks and possibly a very small number of gigs in the more remote corners of the county (ibid. 67). In some cases, the clothier was obliged to transport his cloth out of the county for gigging.

In the North, the gig also met with great resistance in many areas. As in parts of the West, clothiers were sometimes forced to go to great lengths to make use of it and it was not uncommon for cloth to
be transported great distances in order to be gigged. For instance, at least one Leeds merchant found it worth his while to send his cloths some 16 miles by road to Halifax and Huddersfield to have them raised and dressed by the gig mill (PP. 1806. iii. Evidence of W Cookson).

Figure 15. 19th Century Gig Mill

There is disagreement on the date of the gig's introduction into Gloucestershire; Tann asserts that water-powered gigs were in common use in Gloucestershire by the mid 16th century (Tann, 1967: 23) although Moir puts this somewhat later, commenting that gigs were used in the Cotswolds from the 1770s (Moir, 1957: 260). Anthony Wither, inspector for the Cloth Commission set up in 1631, implied that not only were water-powered gigs common in Gloucestershire but that at the time, their use was almost exclusive to the county (CSP. 1633: 164). What is clear is that the gig mill was probably in use in Gloucestershire from at least the first quarter of the 16th century onwards, its use initially, limited to coarser types of cloth. Despite the question over its legality, its use in Gloucestershire appears to have been unbroken. Gigs continued in use and were mentioned in documents of 1652 and 1678 (GRO. D822. T53, T58). In 1707, coarse cloth destined for export markets via London was certainly being gigged (Mann, 1987: 142). Thereafter, throughout the 18th century, there is greater evidence of its use and it became increasingly uncommon to find a Gloucestershire fulling mill offered for sale without a gig mill on the premises; numerous examples existed around Stroud. For instance, Bonds Mill was offered for sale as follows:

"That well known CLOTH or FULLING and gig mill...with the several dwelling houses and buildings and about ten acres of exceeding good land..."(GJ. 21 November 1754).
Despite its obvious advantages, in the West, the gig mill was confined largely to Gloucestershire and the northern part of Wiltshire, with only isolated examples existing in the latter (GJ. 7 July 1752).

Although the gig’s major use during this early period had been restricted largely to the coarser cloths, even when, c1793, it began to make headway in the area of fine cloths, little or no opposition was encountered in Gloucestershire. Developments of the gig continued and it was not long before it was also being used on the finest white cloth and subsequently, fine medleys, the latter being particularly sensitive to rough handling. (Mann, 1987: 141). Clearly, over a long period, the gig mill had given the Gloucestershire clothiers a distinct advantage over their counterparts in other West of England clothing areas.

Despite its undisputed usefulness, the question of the gig mill’s legality was not finally settled until the early 19th century. In 1806, a Commission of Enquiry, when reporting on the use of machinery, commented that:

"...the gig mill, the use of which has been longer and more generally established...finish the cloth in the most perfect manner". (Moir, 1957: 259).

The clothier, William Sheppard of Frome, was like many of his peers, obliged to adopt the gig to treat his cloths; he asserted that:

"the old mode of dress was so found fault with compared with the Gloucestershire that our customers would suspend any further orders, were not our cloths like the Gloucestershire". (PP 1802-3. vii. 368).

The major Gloucestershire clothier Edward Sheppard commented that if he was not allowed to use the gig mill, he could "not carry on his business" and that:

"the cloth trade had increased in those districts where the gig mill is used to a very great extent indeed...and that the trade of Gloucestershire has increased to the prejudice of Wiltshire and Somerset" (PP 1802-3. vii. 360).

The Committee, having listened to the overwhelmingly positive comments of the manufacturers concerning the use of the gig, concluded that gogs:

"...when properly regulated and carefully employed, finish the cloth in the most perfect manner".
The status of the gig mill was confirmed in a Bill ordered on 9th July 1806. Within a few years, much of the legislation that the various groups of clothworkers had lobbied for had been repealed (PP 1806. iii. Report). There seems little reason to doubt Sheppard's assertion that the early and continued use of the gig mill had given the county a distinct advantage over its competitors.

Figure 16. Gig Mill in Longfords Mill.

- The Flying Shuttle

Prior to Kay's invention, the single weaver was limited to producing cloth of limited width. If he wished to weave broadcloth, it required the services of an assistant stationed at one side of the loom in order to catch the shuttle and return it to him. The flying shuttle obviated the need for two people and also improved matters, even when a narrow loom was being used.

Kay's flying shuttle had been introduced during the 1730s although the point of its first appearance in Gloucestershire is not entirely clear. Ponting asserts that the West in general was notably slow in making use of the invention (Ponting, 1983: 61). This may be attributable to the general opposition, particularly in Wiltshire, to the introduction of any form of machinery. Here, worker co-operation was lacking, possibly through the loss of business (such as superfine) to Gloucestershire (PP 1803. vii. 55). The first evidence of the flying shuttle in Wiltshire came in Trowbridge in 1792, the result being a riot (VCH. Wilts. iv. 167), just one of many to mark the area.

Attempts by clothiers to introduce the flying shuttle in the Stroud district did not go unopposed. When a Stonehouse clothier tried to introduce the shuttle c1793, he was dissuaded from its use by fellow clothiers, anxious that unrest should occur (PP 1803. vii. 15). In the region, widespread uptake of the flying shuttle did not occur until c1798, when a general shortage of weavers resulted in its acceptance by most of the workforce (ibid. 299-300). By 1803, the shuttle was in widespread use in Gloucestershire, although at this time, it remained a rarity in Wiltshire (Mann, 1987: 141). Even in the 1820s, its use was not universal in this county. By now, it had been long accepted by Stroud weavers and was in use in both cottage and mill-based weaving shops. Some years later, the notable
Stroud clothier William Playne, confirmed the widespread use of the flying shuttle in the district:

"[that] fifty years ago, broadlooms were all worked by two persons but for the last 25 to 30 years the fly shuttle has been generally used" (Miles, 1839: 373).

The combination of the flying shuttle, coupled with the adoption of improved spinning machinery had a significant effect on output and Playne commented that "the yarn being much better spun since it had been done by machinery, one man can now certainly weave more than two did fifty years ago in the same time". (Longfords Wool Invoice Book. GRO D4644 2/101).

Thus, in the Stroud region, the flying shuttle had become well established by the end of the first decade of the 19th century if not before, probably some way behind Yorkshire. Although the adoption by Stroud clothiers of the flying shuttle, at least in centralised loomshops, seems to have been fairly slow, its use had spread throughout the valleys. As with many subsequent technological developments, once taken up by a particular manufacturer, in reality it was imperative for the competition to do likewise.

■ Carding and Spinning Machinery

Initial designs of the rotary carding engine had been developed and patented by the middle of the 18th century, separate designs being proposed by both Lewis Paul and Daniel Bourne in 1748 (in a somewhat analogous situation to the later appearance of the rotary cutter, developed and patented in Stroud by both Price and Lewis). At this stage, the main problem was the lack of a system to remove the carded fibres produced; periodically, the operator needed manually to remove the fibres, clearly a serious drawback. It was not until 1775 that this problem was overcome by the appearance of the continuous rotary carding machine. (Benson, 1983: 10).

As with other forms of mechanisation, carding and spinning machinery was not universally welcomed and in Wiltshire, the first attempt to introduce the spinning jenny in 1776 met with what was to become the regular response, and was destroyed by the mob. Despite such worker hostility, some forms of machinery eventually managed to make limited headway in the West. There were economic advantages to be gained through the use of new machinery and it was estimated that overall savings of ~ 10% could be made through the use of the spinning jenny (Mann, 1987: 130). The carding engine and the jenny began to crop up throughout the West of England woollen districts, and several were recorded in Wiltshire (VCH Wilts. iv. 167). Jennies had certainly been introduced into at least two Wiltshire locations (Salisbury and Sturminster Newton) by 1777 (ibid. 125)
The first spinning and carding machines began to appear in the Stroud region in 1770s (Smith & Lewis, 1976: 18) and jennies crop up in sales of belongings. For instance, the Gloucester Journal carried an advertisement for the sale of the belongings of a bankrupt, Thomas Tippetts of New Mills, Dursley, which included a spinning machine of unspecified provenance (GCL. R115.118). Nearer to Stroud itself, under similar circumstances, the effects of a Mr Turner of Ebley also included several spinning machines (GJ. 8 September 1788). Such machines could have been produced locally or come from further afield, such as Yorkshire (Mann, 1987: 128). At this stage, machine making in Stroud was still largely in its infancy, although at least one manufacturing family was now starting out on its long and varied career. Certainly, machine makers such as Guppy & Armstrong, were active in Bristol by 1792 (Rogers, 1986: 71) and others were working in a few places in Wiltshire. Machine makers were recorded in Westbury, Melksham and Frome at this time (SJ. 4 October 1790). Possibly the spinning machines originated from one of these more local sources. There was some incentive for machine makers operating in Wiltshire to find markets for their spinning machinery at some distance, as a result of local opposition to their introduction.

Jennies were adopted widely and, being fairly compact machines, could be accommodated in a variety of situations, ranging from converted dwellings or other buildings, to specially built jenny shops. Certainly in Gloucestershire, some were housed in domestic buildings or small workshops, operated by independent workers. For instance, S & S Sparrow of Stonehouse were recorded as working as independent operators using a small workshop housing only jennies, a fairly common situation (GCL. RR 289.1). In other instances, additional machines, such as carding engines, were to be found alongside jennies (Mann, 1987: 131). Other jennies were mill-based and under the direct control of the clothier although this arrangement came later, and certainly in the West, they were not common in mill-based shops until the 1790s (Ponting, 1983: 37).

The water frame, invented and patented by Richard Arkwright in 1769, was an important addition to the range of powered machinery being introduced into textile mills. Here, rovings were stretched by draughting rollers and twisted by the action of winding it onto spindles. It required power hence was only suitable for use on a large-scale in powered mill (Williams & Farnie, 1992: 9). However, its initial use was limited almost solely to cotton as its action was found to be too severe for weaker, short stapled woollen fibres (Giles & Goodall, 1992: 9-10). Instead, the jenny was used widely in the woollen branch although a single water frame was recorded at a mill in Twerton, near Bath, producing serge (Mann, 1987: 134).

In 1779, Samuel Crompton introduced the spinning mule although this remained hand-operated until it became partially-powered during the 1790s. This was followed in the 1820s by Richard Roberts' fully automatic version. The precise date of the mule's first introduction into the West in not known.
Although it appears to be c.1828 (PP 1840. v. 370). However, the mule did not immediately displace the jenny which, in much of the West, continued to be used widely alongside it. Jennies were still in use in Trowbridge in the 1840s (VCH. Wilts. iv. 72). The life of the jenny had probably been extended through the introduction of powered versions by the 1840s; eg. one was advertised for sale in 1856 (TA. 5 July 1856).

Although mules were used in large numbers in the late 18th century in the cotton mills of the North (Williams & Farnie, 1992: 9) it was not until the 1820s, with the introduction of the automatic mule, that spinning in the woollen industry was fully mechanised (Giles & Goodall, 1992: 9-10). The adoption of water-powered spinning machinery by mills around Stroud was a factor that contributed to a period of mill rebuilding and enlargement; many of the surviving Stroud mills were built during the first quarter of the 19th century (Smith & Lewis, 1976: 20). The appearance of the dedicated water-powered spinning mill opened up opportunities for the application of power to other stages of manufacture. For instance, prior to the mechanisation of spinning, the shearing frame had been in use (during the 1770s) although had remained relatively uncommon around Stroud up to the 1790s. At this point, it became a viable option to utilise the power now available in the new spinning mills and as a consequence, the number increased (ibid. 20).
Power Looms

In general, the Gloucestershire clothier was relatively slow in adopting the new power loom and for a long time, both hand and power loom weaving existed side by side. Traditionally a cautious group, many local clothiers, unconvinced of the power loom’s advantages, played a watching game, waiting for the results obtained by the few of their number who had taken it up. Thus, at the time of the Assistant Commissioners Report on the Condition of the Handloom Weavers (1839), hand looms still greatly outnumbered power looms (Table 3).

The total number of both hand and power looms amounted to 1154, owned by 31 manufacturers. Of this number, 103 were power looms and 1051 hand looms. At the time of the report, the majority of weaving in the district was still being carried out using hand looms, both cottage and mill-based. Only two major manufacturers had installed power looms in appreciable numbers (T & S Marling and Stanton & Sons), with smaller groups in use by Hunt and N S Marling. Both the Marlings and Stantons were accomplished businessmen who were in a better position than most to have access to the investment capital required for such installations and this was undoubtedly a major factor in limiting the uptake of the power loom at the time. Many smaller businesses simply lacked sufficient resources to enable them to even consider such an investment. Others may have had the capital but were still unsure of the power loom’s potential, hence the number of manufacturers who had installed perhaps one or two looms as an experiment. Even a number of the larger, more progressive companies such as Stephens of Stanley Mill was still entirely reliant on hand looms. Clearly, opinions of Gloucestershire manufacturers on the potential of the power loom were polarised, some treading warily whilst others embraced the new technology with open arms.

Thus, the wholesale adoption of power looms in Gloucestershire did not occur overnight, although as the loom itself became further developed and began to unlock its potential, their numbers began to rise. In a few cases, manufacturers quickly replaced their hand looms with power looms en masse. The few Stroud manufacturers who did switch were well satisfied with the results in terms of reliability and overall performance. In 1836, Thomas and Samuel Stephen Marling installed 45 power looms in Ham Mills, with good results (Tann, 1967: 171). Similarly, Charles Stanton of Staffords Mill also took up the option in the same year. It was reported thus:

"that he put up four power looms in July 1836, by way of experiment; they answered fully, were made in Rochdale and cost when brought home £25 each for the broad, and £21 for the narrow; he employs at the narrow looms one man, and at the two broad looms a man and a woman; there is no subsequent improvement in the loom; the man who looks after the looms can earn from 20s to 21s per week, and the women employed in them 8s to 9s; found them to succeed, and in consequence, put up a further
quantity. Is now putting up eighteen narrow looms on the premises, making in all thirty four power
looms. Considers that there has been no diminution in labour, except that females are employed
instead of males ... Mr Charles Stanton further states that he now has twenty six power looms at work
at present, and that he introduced them about three years ago. As yet their introduction has not been
the means of putting any weavers out of employ; it has displaced eight or ten male weavers, but as
many women have been substituted. Considers that the cloth made by power is better made than the
average; there is certainty, regularity, and quick return in favour of power looms" (Miles, 1839: 462).

Stanton had been induced to investigate the use of power looms as a result of "their prevalence in the
North". He also emphasised that "women were never put to the broad looms, except that they had
been previously employed by master weavers on the same sort of work". To every six cassimere
looms (he had 18) he placed one man and four women. About half of his female loom operatives were
recruited from the quilling section. Most women were considered to be unsuitable for operating broad
looms "as it requires a certain stature to enable them to reach over the loom to tie on; under sixteen
years of age they could not work them". (ibid).

Certainly in terms of quality, Stanton was well satisfied, stating that the quality of cloth produced on
the power loom was as good as the best made by the hand loom. Output was also increased; the
power looms consistently made 42 shoots a minute and although a skilled hand loom weaver could
make up to 40, he was obviously unable to sustain this pace for long. His large scale (for the Stroud
valleys) adoption of the power loom was to be one of the first of a number of such schemes in the area
as other manufacturers began to realise that in order to remain in a competitive position, they too,
would have to invest in power looms. Some clothiers realised that the adoption of the power loom
was inevitable:

"The improvements in mechanical weaving will go on, and will ultimately and altogether supersede
hand loom weaving; we possess not the means of arresting their progress and ought not to attempt to;
a machine is a good to society, which loses nothing, but gains in the end by every discovery in, and
by every new application of, mechanical power" (PP 1834-35. vii. 90. Ev. of Mr Davison).

The scene was set and from the 1830s, the power loom began to make an increasing impression on
the Gloucestershire industry. But how did the Stroud region compare with its competitors in the
adoption of the power loom? It was inevitable that the power loom would eventually usurp the hand
loom although the latter lingered on in the West in a few places until the 1870s (Ponting, 1971: 125).
However, the period 1850-70 really saw their gradual elimination from large scale manufacture.

By the 1870s, there was apparently little to suggest that the West of England in general, lagged
particularly behind Yorkshire in the adoption of powered machinery. By this time, all of the major stages of production were mechanised and the second half of the 19th century was really a period of consolidation and gradual refinement, as opposed to significant technological advances. However, with regards to the widespread adoption of the power loom, Wiltshire and Somerset clothiers were some way behind Stroud. In the case of the latter, there were at least two large scale collections of power looms in operation from 1836 or earlier, some three crucial years before the first tentative steps were taken towards their installation in Wiltshire. In this county, the long-running opposition of the workers to the adoption of virtually any form of mechanisation had cost many clothiers dear, and it was perhaps this above all else that kept the power loom out of Wiltshire until 1839, when the first few were installed at Staverton and Heytesbury. It was to be much later before significant numbers were set up in the county (Rogers, 1986: 102-3).

In the West Riding, although successful power loom weaving had been achieved with cotton, linen, silk and worsted by the 1820s, it was not until the 1830s that it was applied successfully to the woollen branch. Even in the case of worsted, the initial takeup of the power loom was not particularly rapid. By 1830 there were less than 3000 looms in the entire region however, by 1841, this had risen to more than 11,000 and by 1850, it was over 30,000 (Giles & Goodall, 1992: 15). In the woollen branch, the earliest recorded use of power looms came in 1830 although the rate of takeup was slow. By the 1850s, there were still less than 4000 in use. However, the repercussions of their use had spread beyond Yorkshire and it was early experience in the North that influenced Stanton of Stroud to switch from hand looms to power units made in Rochdale. In Yorkshire, post-1850, there was a rapid uptake of the power loom and by the 1870s, over 30,000 were in operation in the woollen branch alone.
<table>
<thead>
<tr>
<th>Name of Manufacturer</th>
<th>Name/location of Mill</th>
<th>No. power looms</th>
<th>No. hand looms</th>
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The advance of technology throughout the woollen industry was clearly marked by a series of innovative developments - the flying shuttle, rotary carding engine, spinning mule, power loom, rotary cutter and so on. In terms of mechanisation, at times, some segments of manufacture were well ahead of the others although each innovation eventually improved and speeded up the chain of manufacture. Although the changes that inevitably accompanied each innovation were not universally welcomed, it was inevitable that the relentless advance of technology would proceed, whatever the ultimate consequences. The pace at which technological adoption progressed depended to some extent on the particular region and the conditions prevailing there, but of equal importance were differences within each region. Thus, for example, the gig mill was generally in use much earlier in the West of England than in Yorkshire, but its use within the former region was by no means evenly spread.

One of the most crucial factors in the adoption of new machinery was access to capital. As well as the initial outlay, machinery also required care and maintenance, and as manufacturers switched increasingly to powered machinery, this aspect took on an increasingly important role. Hence, capital and running costs could be considerable and these had to be balanced against the increase in profits generated directly by new machinery. This balance was specific to individual sites and manufacturers and was generally a reflection of the circumstances pertaining to each. Smaller manufacturers were not always in a position to avail themselves of the advances in technology. Thus, in many woollen districts, at least for a time, small clothiers, still dependent on outworkers, hand-working and small fulling mills, co-existed alongside increasingly large and complex manufactories. During this transitional phase in the Stroud region, there was little overall pattern as to the uptake of new machinery, factors remaining site-specific. However, overall, by the start of the 19th century, machinery was having a substantial impact on the Stroud woollen industry. The extent of mechanisation taking place can be gauged from the comments of James Tait, a visitor from the North of England. In 1806, he visited Gloucestershire in order to study the current situation in the industry and declared that "machinery was more general than in any other county" (PP. 1806. iii. 353).

During the period c1800-25, many of the Stroud mills were rebuilt/enlarged in order to accommodate new machinery and manufacturing techniques. A number underwent total transformation or at least considerable expansion. For example, the fire-proof Stanley Mill was started in 1813, Dunkirk was extended in 1818 and Ham Mills added to in 1814, 1825 and 1832 (Loosley, 1993: 4-5). Similarly, in the Wotton area, a series of expansions and rebuildings was also under way (eg. Charfield 1812, Nind 1817, Langford 1822). Increasingly, large scale manufacture was being drawn into fewer and fewer sites, with cloth produced by sophisticated powered machinery. Over the course of a decade or so, the smaller mills began to suffer and from Miles' report it becomes clear that they were finding
it increasingly difficult to compete with their larger brethren. The impact of centralised large-scale production on the industry is indicated from the rateable value of local mills; over the period 1822-1839, the rateable value of some of the larger mills such as Vatch Mill in the Slad Valley had more than doubled, whereas for smaller mills such as Bourne Mill, it had fallen or remained virtually unaltered. Similarly, Dark Mill, valued at £59 in 1822 was still only worth £60 in 1838 (Tann, 1967: 186). In other cases, the changing nature of the market had driven some cloth manufacturers out of business, with mills either turned over to other uses or standing idle. Those who were either unable or unwilling to keep up with the pace of change in the industry soon found themselves left behind and by c1840, increasing numbers were beginning to fall by the wayside.

Clearly, the situation for manufacturers was becoming polarised, and those with the foresight and financial capability continued to mechanise and expand, while the smaller makers struggled to keep up. Times were changing apace, and as the factory system relentlessly took hold of the industry, the scale of domestic manufacture diminished accordingly throughout all clothing districts. As factory-based production began to account for an increasing market share, it was inevitable that the old methods of organisation and manufacture would be squeezed. The days of the clothier whose business had been based on the long-established putting-out system were numbered and in 1830, Richard Oastler observed that:

"...there are scarcely any of the old fashioned domestic clothiers left"

(PP 1831-2. xv. Evidence of Richard Oastler)

However, Oastler was clearly wrong as factory-based manufacture had not yet eliminated completely the domestic-based production in some spheres (Palmer, 1994: 151). Thus, in the case of hand loom weaving, both organisational structures coexisted for lengthy periods and in parts of the North, at least some of the small-scale independent clothiers were still managing to make a living. In the West, some small clothiers continued to operate although their numbers were declining. Some survived as independent workers, perhaps specialising in a particular aspect of manufacture such as burling or dyeing. There were also many cottage-based weavers still active in the West, but many now enjoyed little independence; although they remained in their own homes, most were now effectively paid employees of a particular manufacturer.

Effectively, in all major woollen areas, pre-1825, the uptake of new machinery was dependent on a variety of factors, some general and others highly specific. It is difficult to establish precisely which woollen region was winning the race towards full mechanisation at a particular period, as there were such gross differences within each region, especially during the latter 18th/early 19th centuries. Even by the close of the 18th century, the influence of better organisational methods and the increasing use
of machinery was having a significant effect on some clothing districts. The changes within the industry affected different regions in a variety of ways; Gloucestershire was faring better than the other Western districts:

"By the end of the 18th century, the clothing districts in the West of England had contracted and the remnants of prosperity were more common among clothiers in Gloucestershire than their hard-pressed counterparts in Somerset and Wiltshire. In the West Riding, business was booming". (Gregory, 1983: 47).

Even within the Stroud district itself, there were marked differences, with the more far-sighted and progressive clothiers continuing to prosper as their smaller and more technologically backward counterparts continued to struggle. As the clothier Lewis of Oil Mill, like many others, was to discover to his cost, it was becoming impossible to rely totally on outworkers at a time when his immediate neighbours were operating in almost fully mechanised mode (Mills, 1995). The latter was confirmed by a report of 1861 which noted that the larger of the Stroud manufacturers:

"had made great additions to their mills and laid out capital freely to secure the newest and best machinery." (Mann, 1987: 203).

For the smaller clothiers such as Lewis, it was merely a case of time before they succumbed in the face of competition from their increasingly automated neighbours although the region was fortunate that it rarely suffered the orchestrated worker opposition experienced in other parts of the West. As a consequence of the latter, the progress of automation had been greatly impeded through the intransigence of the workforce and it was largely as a result of this that Gloucestershire prospered at the expense of Wiltshire and Somerset (explored further in section devoted to Workers).

What does become clear is that at times, Gloucestershire was well ahead of its immediate neighbours in its adoption of many forms of machinery. However, as the 19th century wore on, Yorkshire assumed a dominant role in the country's woollen cloth production, predominantly through the sheer scale of the industry coupled with a high degree of automation.

In the North, after c1825, the process of centralisation to integrated mill complexes increased and although not immediate, this led to a corresponding decline in the smaller/specialist manufacturer. It led eventually to their extinction (Giles & Goodall, 1992: 84) although up to c1830, as in the West, substantial numbers of domestic-based weavers and other outworkers continued to operate. The next two decades were effectively to see the end of this way of life.
Thus, the rate of uptake of new machinery varied not only with site and individual manufacturer, but also period. Prior to the first quarter of the 19th century, the introduction of new machinery had generally been beneficial to the smaller northern manufacturer. However, the emergence of the large capitalist manufacturer, intent on the development of the integrated mill, ultimately spelt their end:

"The smaller manufacturers in Yorkshire were at first benefited by the introduction of machinery, but in a little time large capitalists began to emerge in the woollen trade, and performing all the processes with their own machinery, they were enabled to work cheaper and undersell the smaller makers…soon after 1850, the number of small manufacturers began rapidly to decrease". (Cossons, 1972: 468).

Overall, the rate of uptake of machinery in all woollen areas was very site-specific and great differences were found at different times between and within the various manufacturing districts. Needless to say, such dramatic developments within the industry had inevitable consequences for the workforces.
Machine Makers, Millwrights and Engineers

The mechanisation of the industry progressed through the efforts of a number of individuals, with significant developments occurring in different woollen areas at different times. Stroud played its part in this on-going development.

Perhaps surprisingly, many of the most important advances made in the design and construction of textile making machinery, particularly during the 18th century, did not spring from established engineers or 'mechanics' or even necessarily from individuals with a background strongly steeped in textile manufacture. Some of the most important innovations came from men who were either not directly connected with textiles or were perhaps skilled in only one particular area of it.

The flying shuttle was the brainchild of John Kay, a clockmaker by profession, and the spinning jenny came from James Hargreaves, who appropriately enough doubled as both carpenter and weaver. Similarly, innovations came from Richard Arkwright, formerly a barber, in the form of the water frame, and Samuel Crompton, a fustian weaver responsible for the development of the spinning mule. Even ecclesiastical gentlemen were not adverse to turning their hands to such development, namely the Reverend Edmund Cartwright, responsible for the first power loom.

On a more parochial basis, the Stroud region was also home to a number of innovative individuals who with the passage of time, were to continue along the same lines as the aforementioned, in some cases refining and improving on existing concepts and in others, developing novel machines that improved the overall quality or throughput of woollen cloth produced at the time. The majority of these developments fell into the former category and a steady stream of patents was granted particularly throughout the first half of the 19th century, relating to the design and improvement of textile-related machinery.

The Appearance of the Machine Maker

The gestation period for many initial developments centred on essentially taking hand-powered processes and applying some form of mechanical power to replace the hand of man. For instance, initial efforts to mechanise cropping of woollen cloth continued to use what were in essence, bulky hand-operated shears, but mounted in a frame and driven mechanically. In this case, true innovation was only to come later with the eventual development by Lewis of the helical cutter, even though this was not a new idea. The fact that most early machines were relatively unsophisticated ensured that their actual construction could be carried out largely by established craftsmen. The main framing timbers of the typical hand loom would present no problem to a carpenter and although looms might
differ in details and overall dimensions, the majority of the parts could be easily produced by a carpenter of even modest capabilities. Generally, with the exception of the lathe and the healds, all of the necessary parts would be well within his range of skills. The lack of references to the specific manufacture of looms in the Stroud valleys confirms that such work was simply carried out alongside the regular activities of the carpenter, just another piece of work.

Gradually, the advances being systematically made ensured that further stages of cloth manufacture became mechanised and the machinery involved became increasingly complex. In addition, as the various processes were gathered together in the expanding factory mills of the area, processing machinery increased not merely in complexity but also in scale. By For example, in 1811, an inventory of the machinery in Lightpill Mill was carried out (Rose, 1970: 6; also Tann, 1967: 220-221). Amongst the wide range of powered machinery listed was one 80 spindle billy, one 80 spindle jack, one 60 spindle jack, three 80 spindle jennies, and four 70 spindle jennies. Clearly, the complexity of such mill-based systems had increased enormously over a decade or so.

Throughout the region, mechanisation continued to increase and by 1850, there were a total of 61,896 spindles in use in Gloucestershire cloth mills, the vast majority in and around the Stroud area (PP 1863. xviii). By 1856, this had increased to 63,256 (Mann, 1987: 220). Inventories of individual mills or manufacturers help to gauge the scale of operations taking place there; for instance, in 1889, the combination of Stonehouse Lower and Upper Mills (both in the same hands) housed a total of 5500 spindles and in the same year, Strachan & Co. of Fromehall and Lodgemoor Mills reportedly had 8300 spindles in 27 frames in use (Kellys Dir. Glos. 1889). By 1891, Lodgemoor alone had 5660 spindles and on the other side of Stroud, Ham Mills was operating 4530 (Tann, 1967: 172). The advances made in spinning over a single generation were clearly substantial.

Especially from the beginning of the 19th century, the steady stream of advances being made in the development and application of powered machinery inevitably led to areas of specialisation and from the assorted ranks of millwrights, carpenters, blacksmiths and clock and instrument makers evolved a select band, whose expertise lay specifically in the area of machine making, aimed directly at the woollen cloth industry. By the 1820s, the "professional purveyor of machines, made with other machines" was a firmly accepted figure in most woollen cloth areas (Rose, 1970: 6), this being the case on a national basis, not merely with the Stroud area.

Although there was a fair amount of activity in the sphere of machine making in Gloucestershire, in other areas the craft had been pursued with vigour at an earlier date. Many of the developments in the Stroud area essentially started from the beginning of the 19th century whereas in Bristol, at least one well known machine making concern, Guppy & Armstrong, was already producing and selling
machines certainly by 1795 if not by 1792 (Rogers, 1986: 71). Here, machinery was solely directed
towards carding and scribbling, the two areas that were to receive the greatest attention for a decade
or more. Guppy & Armstrong advertised their carding and scribbling machines thus:

"...warranted of the best seasoned timber, which entirely prevents the cylinder from warping, finished
in the compleatest manner, with every late improvement by the most experienced workmen...the
cylinders may be made of deal, sycamore, beech or mahogany, which makes a considerable difference
in the price". (ibid. 71)

Other concerns were also active around this period, as sales particulars of a Wiltshire machine maker
confirm. Based in Westbury Leigh, it was noted that:

"...to be sold by Auction by R Townsend. On Friday 11th December 1794 at the dwelling house and

In the West, some of the more enlightened machine makers shrewdly kept themselves informed of
what was happening particularly in Yorkshire, scene of much activity on this front. A few even
appear to have gone to the extreme of poaching skilled labour from the latter in order to further
develop their machinery. In 1795, Messrs Pobjoy, Morgan, Allwood and Harris, cardmakers of
Frome, announced that they had:

"...at great expense procured compleat machinery for manufacturing engine cards of every kind, on
the Yorkshire plan...[they had also] engaged a person who is well acquainted with the method of
making cards in the North of England". (Rogers, 1986: 71)

Such interchange of skills, experience and equipment was to carry on throughout much of the lifetime
of the Stroud woollen industry. In later years, power looms were to come from Rochdale and Lewis
cloth cutters were to be exported to Yorkshire and elsewhere.

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For several decades, the main mechanical input into the local mills continued to be provided by
machine makers who had developed their trades out of, indeed, also still operated as, carpenters and
smiths; it often becomes difficult to differentiate between the prime occupation of such individuals as
some worked predominantly as smiths and others as carpenters although there was often a degree of
overlap between the two occupations. During this transitionary phase, boundaries were sometimes
blurred and individuals took on work in whatever sphere they could accommodate. In the Stroud area,
most of the machine makers and "mill furnishers" of note developed out of earlier professions such as carpentry and smithing. For instance, Stephen Price developed his machine making expertise from a carpentry background (G.J. 23 Aug 1820. Sales particulars). By the 1820s, he was no longer alone, other machine makers active locally including Henry Hall of Lower Street, Stroud, Samuel Ogden of Minchinhampton and John Hardy of Painswick (ibid).

On occasion, the blacksmith and the carpenter combined efforts in the manufacture of machinery, such was the arrangement with Joseph Gardner and John Herbert; the former was a smith and the latter a carpenter, both of Stanley St. Leonards, near Stonehouse. They were responsible for several patents and a number of their products such as rotary cropping machines came to be relatively widely used in the locality.

During the first few decades of the 19th century, development of machines essentially mirrored what was happening to the individual processes and their transition from hand to powered working. Consequently, the majority of the major developments and patents were at this stage, concerned with carding and spinning. Even though mechanical fulling had long been established, efforts to refine the process appear to have been relatively few, although improvements in the actual construction of fulling stocks were made, primarily through the increasing use of iron components. In any event, the monopoly of fulling stocks was soon to be broken and in the Stroud area, as by the 1840s, stocks were being increasingly supplanted by milling machines produced locally by companies such as the Phoenix Iron Works. Although work on carding and spinning predominated, efforts also continued in other areas and by the 1820s, patents began to emerge from Stroud workers developing improved methods of cloth washing (No. 4721. 1 Nov 1822. A Flint) and scouring (No. 4013. 5 April 1816. W Lewis).

Throughout the life of the Gloucestershire machine makers, they retained their independence from the mill masters, producing machinery for anyone who would buy from them. In this respect, they differed from some other woollen areas in that it was not unusual for factory masters to employ blacksmiths, joiners and clock makers to develop and construct prototype machines, specifically for their own use. Apprenticed to these mill-based mechanics came a generation of specially trained textile engineers, with a sound knowledge of the requirements of textile processing (Benson, 1983: 19). Consequently, machine making developed in one of two ways: developments were either carried out directly for a single master or as in the case of Gloucestershire, largely by independent workers.

In the realm of Stroud-based machine makers, the Lewis family (working largely with Ferrabees) were acknowledged as having been behind some of the most important advances, having greatly improved the design of a number of pieces of cloth making equipment. Operating for a time from both Upper and Lower Brimscombe Mills and Brimscombe Port Mill, they initially came to general notice in 1815,
following the patenting by John Lewis of his version of the rotary cloth cutter or shearing machine (Mann, 1987: 297, 303-5). This was arguably the most important and far reaching success for locally developed machinery (Patent No. 3945. 22 September 1815). In this, Lewis outlined his improved shearing machine, stating:

"The shearing machines hitherto in common use for shearing or cropping woollen cloths operate so as to shear them in a transverse direction from list to list. My new machine is so constructed that it will shear a piece of cloth in the longitudinal direction with great accuracy and rapidity, and without any intermission of that operation being necessary before the whole piece is shorn from one end to the other."

Overall, the major claims of the Lewis patent concerned the rotating blades, the adjustable nature of the supporting beds (and their filling) and the smooth, unbroken movement of the cloth through the machine. The revolving runner blades were each 'twisted' one quarter of a revolution, such that in operation, each runner blade (against the edge of the ledger blade) proceeded regularly from one end of the blade to the other.

Figure 19. Detail of Lewis' patent No. 3945. 27 July 1815
Ironically, shortly afterwards, Stephen Price, of the machine making family of Stroud, also patented a similar design (GRO pamphlet. 1815). There may have been some antagonism between the two as a result. This was not a new area to be investigated as there had been a pressing need for a reliable shearing machine for some years. A number of other machine makers had worked on similar designs of rotary cutter although none had managed to bring it to a condition suitable for commercial exploitation. Hence, although the Lewis family were not the only workers actively working in this field, they are generally credited with producing the first shearing machine to effectively cut cloth from list to list. In the following years, as the design was further refined, John and William Lewis patented several improved variants. These found a ready market and came into widespread use, both locally and as far afield as Yorkshire. The Lewis cutter was an important step forward and is succinctly summarised in the following passage (GRO Pamphlet. c1829. Anon):

"Shearing or Cutting...formerly this operation was performed by shearmen, who passed the shears over the cloth, which was tightly stretched upon an inclined plane. The shears weighed from 30lbs to 40lbs., and consisted of two blades, one, the larger one, resting on the cloth, the other, a moveable blade, and nearly perpendicular, worked by the shearer’s hand, and at each blow it removed a certain portion of the pile...about fourteen years ago, Mr Lewis of Brimscombe, invented a new machine for shearing cloth, for which he obtained a patent which has since expired; the first cost was £100., the price is now £25. This machine is an horizontal iron cylinder, round which is a hollow spiral blade, revolving with great velocity and cutting the pile of the cloth immediately in contact beneath it, and which is stretched upon a horizontal moving frame...In former years the cloth was thinly dressed, it was not cut more than six times but now it is cut fifteen to twenty times".

The observer goes on to comment on the habits of the shearmen, noting that the greatest advantage to the mill owner adopting the Lewis cutter had been the avoidance of using men who "were notorious for their drunken and careless habits".

The Lewis cutter was an important step forward however, within a few years, further improvements to machines based largely on the same principle were being patented. The most notable local examples were those produced by Gardner & Herbert of Leonard Stanley. In 1824, a patent was granted for a rotary cropping machine featuring a number of improvements over the Lewis design of machine, utilising a fixed ledger blade and upper revolving cutter (No. 5059. 18 December 1824). The patent claimed that the new design gave:

"a new lateral or horizontal motion which we give in succession to each blade of the revolving cutter at the same time that it is revolving, thus causing it to slide or pass along the fixed ledger blade, by which its cutting power is materially improved".
The mechanism was adjustable to allow for alterations in the degree of oscillation of the blades. In addition to this claimed advantage, the "bed" supporting the cloth as it passed under the blades was improved the use of a supporting roller, eliminating any tendency for the cloth to droop in the centre section. This produced "an even and regular face upon the whole width of the cloth". The final claimed improvement concerned the powered friction drive that pulled the cloth through the machine. Overall, these improvements are surprising considering that the Lewis cutter was considered state-of-the-art only a few years earlier, an indication of how quickly developments were to progress as the 19th century wore on.

Some cloth manufacturers were quite happy make use of similar equipment from a variety of manufacturers. In 1838, the business of the Neal Brothers of the steam-powered Britannia Mill in Wotton-Under-Edge failed. The inventory included 5 cloth cutters (narrow) by Miles, 1 wide cloth cutter by Gardner & Herbert, 5 cloth cutters by Lewis, and 3 cloth cutters by Gardner & Herbert (Tann, 1967: 101). The number of cutters helps to give an indication of the scale of operations that had been taking place at the mill.

At the same time that the rotary cutters were under development, work on improving the scouring of woollen cloth was also being carried on. In 1816, William Lewis patented a machine that in essence consisted of a pair of rotating cylinders through which the cloth was pressed. This apparently obviated the requirement of using sig and avoided the partial felting which tended to occur during the scouring operation. This subsequently made burling more difficult (Patent 4013. April 5 1816). In respect of improvements in the scouring of cloth, through the efforts of the Lewis family and other workers,
Stroud was ahead of many other cloth producing areas. By the 1830s, the cloth washer had become an accepted piece of machinery, found in nearly every mill (Mann, 1987: 297). During the 1820s, several others variants of the cloth washer were patented by other local individuals including Alfred Flint of Uley (Patent 4721. 1 Nov 1822) and William Baylis, a member of the long-established clothier family of Painswick, in 1823 (GJ. 10 Feb 1823).

Although primarily cloth manufacturers, the working connections between the Lewis family and the iron-working Ferrabees were clearly strong and extended over several generations. During this time, there was no documentary evidence to suggest that the Lewises were ever directly involved in the actual construction of machinery. They were described solely as cloth makers and were never cited as an engineers, iron workers or machine makers. It seems that they may have been responsible for the design of various pieces of equipment and their subsequent development, and the Ferrabees, their actual construction. Both John Lewis and his brother William were active in cloth manufacture and between 1815 and 1838, they were granted nine patents dealing primarily with various aspects of cloth finishing. Patents encompassed improvements to gig mills as well as their existing rotary cutter (Rose, 1970: 10). Throughout this productive period, links with the Ferrabees appear to have continued and in 1838, a joint patent for a gig mill was granted to William Lewis and John Ferrabee. All was not plain sailing for the Lewis family however, and in 1843, William was in deep financial trouble. In that year, Brimscombe Port Mill was mortgaged to John Ferrabee and Upper and Lower Mills were put up for sale by his creditors. Port Mill was subsequently bought by another Ferrabee, James, who was listed as one of Lewis’s creditors (Tann, 1967: 183; Also GRO D1160). Little was subsequently heard of the Lewis family.

Although most initial attempts at mechanisation had been centred around carding and spinning processes and their subsequent transferral to mill-based working, efforts continued to improve existing machinery. In this respect, the machine maker, John Price of Stroud was responsible for a number of new developments. In 1824, he was granted a patent for “Certain Improvements in the Construction of Spinning Machines” (No 4995. 5 August 1824). His spinning machine featured an endless belt for conveying the carding to the spindles and also an adjustable rack to regulate the quantity of cardings required for the appropriate size of yarn. His system "brought in a certain portion of the said cardings every time the carriage or spindle frame [was] wound in"; this reduced the tendency for the cardings to break off so easily at the instant the carriage began to draw out. Another claimed advantage was that his machine was capable of producing longer draughts than could be made when wound in by hand.
By the middle of the century, the innovative pairing of William Apperly, cloth manufacturer, and William Clissold, engineer, associated with Dudbridge Mill, were making their presence known. Their patent No. 2874 of 1856 "Preparation of Fibrous Substances for Spinning" was one of a number in this area. The patent describes the development of a novel mode of delivering the sliver from one preparing machine to another, making the process continuous whilst at the same time, ensuring the uniformity of the sliver. The patent describes how the continuous sliver was laid in "parallel serpentine rows" on the feed apron of the preparing machine prior to feeding to the next stage. As with most of their patents, emphasis was placed on the importance of continuous working, with the minimum of human intervention; in this respect, their successes were acknowledged widely. In 1904, the importance of their earlier developments was noted:

"...the late Mr James Apperly and William Clissold invented and patented a self-acting feed for the carding machine which has since been developed and perfected. The invention is now in general use having been sold in all parts of the world where cloth is woven, and its adoption marked a decided advance in the art of carding" (Industrial Gloucester, 1904: 25-26).

Thus, improvements in textile machinery resulted from the efforts of individuals from varying backgrounds, some involved directly in cloth manufacture and others who were not. Alongside the various individuals and companies that developed into makers of textile machinery, were others who honed their skills in a different direction, namely equipping and maintaining the mills themselves. Like the machine makers, their role changed and evolved, reflecting the changes taking place within the industry at large. Some called themselves millwrights whereas others referred to themselves as
mechanics or engineers. Whatever name was adopted, from the industry’s early days they fulfilled an important role in ensuring that mills were able to function and develop in an efficient and reliable manner.

The Evolution of the Engineer

As a profession, millwrights were certainly well established in the area from at least the 17 century. Smith lists a number of millwrights in various parishes around Stroud in 1608. For instance, in Bisley parish at the time, 62 people were connected with the cloth trade, with a single millwright being mentioned (Smith, 1980: 290-2, 294). Similarly, two millwrights were mentioned in Horsley and one in Eastington. Others were dotted around the valleys, looking after the water-powered sites that were beginning to proliferate around Stroud. The trade continued to crop up increasingly as the number of mills and factories increased, with millwrights appearing in areas where previously none had been recorded. For instance, in 1737, Richard Remington of Woodchester was recorded as such (GRO.D.131/T 1/1), with a colleague also listed for Minchinhampton. Two millwrights were also located at Bowbridge Mill around this time (VCH. xi. 129). The duties of the millwright at this time extended largely to the operations of both corn and fulling mills and although the primary system providing the power for each was similar, each imposed different requirements. Competence with one type of installation did not necessarily imply a complete understanding of the other. For instance, a millwright skilled in the construction and operation of corn mills did not necessarily understand the precise requirements of the fulling mill. In the case of the latter, some millwrights, after years of practical experience, were adamant that the overshot type of waterwheel was the preferred type. This was not merely a case of greater mechanical efficiency, but that the wheel was more suited to the intermittent loads imposed by the falling and rising stocks (Parkinson, 1985: 45).

In the Stroud region, the number of millwrights increased as the need for their services rose in line with the level of industrial activity in the region. In 1820, two millwrights were recorded as operating in Nailsworth (Gell & Bradshaw Dir. Glos. 1820: 214-215) and Joseph Clutterbuck was plying his trade in Rodborough (ibid. 196). An indication of the burgeoning use of both water and steam power as well as the greater mechanisation of the local mills can be gauged from the fact that in 1821, no less than 12 millwrights, along with 8 engineers were recorded in the eastern division of Stroud parish (Kellys. Dir. Glos. 1856: 364). They were "engaged mainly in servicing the steam engines and other machinery in the mills" (VCH. xi. 121). In some instances, premises were shared; such was the case with Henry Holmes "millwright and engineer", who shared Grove Mill, Painswick, with Godsell & Sons, brewers of Salmons Springs of Stroud (Kellys Dir. Glos. 1870: 616). Precisely how this arrangement worked remains obscure.
As the years progressed and the cloth trade eventually began to diminish, millwrights, iron founders and engineers turned their collective attention to other markets. When a cloth mill closed, this did not necessarily mean the loss of business, assuming that a new trade replaced it. For instance, the making of walking sticks became a peculiar speciality of the Stroud valleys, numerous former cloth mills being turned over to this. Wesley Whitfield "millwright and engineer" (Mills et al. 1992: 26) like many of his peers, alongside his more normal duties, capitalised on the new trade. This took the form of specialised manufacturing equipment, such as bending machines, aimed at the local stick makers.

Usually, successor industries still required the services of the engineer or millwright. Many still retained the water power that came with the building and sometimes, where power requirements were only moderate, such as with silk throwing, the water wheel was sufficient. In other instances, the mill came ready equipped with steam power. In both cases, each type of power source still required the services of an engineer or millwright for repairs and improvements. As a result, even though the cloth trade was becoming confined to fewer and fewer sites, engineers and millwrights remained a necessary part of the industrial scene. In 1889, no less than nine major "mechanical engineers" were operating in and around Stroud (Kellys Dir. of Somerset, Gloucestershire and Bristol. 1889), namely T H & J Daniels of Lightpill, Samuel Gore and Waller & Co of Thrupp, H J H King of Newmarket, Charles Wade of Brimscombe, Jehu Shipway of Ebley, and Holbrow & Co; Vick, Lydeard & Co; and Wesley Whitfield of Dudbridge. There was a natural tendency for each company to service mills and factories in its own locality; there were no hard and fast rules in this sphere although it was not uncommon for them to operate further afield.

Meanwhile, local iron founders were also keeping busy, turning out general engineering components for a variety of uses, no longer reliant solely on the cloth trade. In 1889, major iron founders active in the area included Edwin Clark of the Canal Iron Works, Brimscombe; Ralph Lugg of Brimscombe; Vick, Lydeard & Co, of Dudbridge; the Phoenix Iron Works at Thrupp; H J H King at Newmarket; and John Llewellin's Nailsworth Iron Works (ibid). New markets were developed with companies such as Wallers becoming heavily involved with the increasingly important gas industry. In addition, since at least the 1870s, the industrial hamlet of Dudbridge had also encompassed Holbrow & Co. "engineers and iron founders of Dudbridge" (Kellys Dir. Glos. & Bristol. 1892), who later (in 1902) became the Dudbridge Iron Works (Mills, 1992: 8). The company developed a range of gas and oil engines, some used in local mills and factories.

Power to drive the mills in the valleys was now being provided by a variety of water wheels, a few turbines, steam engines, and various combinations of the above. In other instances, oil and gas engines were making their presence known. Whatever the source(s) in use at a particular site, systems for coupling up, for instance, water wheels and steam engines, came into use in some mills. For
instance, one of the largest mills in the district (Dunkirk Mills) was powered by a system designed by Joseph Walker, one of the proprietors, whereby the water wheels could be coupled up to the steam engine, the latter supplied by Excelsior Engineering of Stroud (GCL 17271. Scrapbook. 109). Depending on the prevailing water supply, the engine could be shut down and the factory run on water power alone. Ebley Mill also boasted such a system, whereby the steam engine could be coupled up to the mill's five waterwheels (Falconer, 1993: 76-77 + Plates 14 & 15 from the Watkins Collection). Local manufacturers supplied some of the components of the Dunkirk system, the Ferrabees having manufactured several of the water wheels and H J H King having supplied a speed governor. Similar combinations were fairly widespread in the area, especially at the larger mill sites.

**Development of the Engineering Base in the Stroud Region**

As a consequence of the long-running activities of millwrights and engineers servicing the local cloth industry, a significant degree of engineering expertise ultimately grew in the region. Engineering concerns developed from an assortment of blacksmiths, millwrights and assorted metal workers who had initially made their living from servicing the local cloth mills and workshops. During the later 19th century, although most individuals still advertised as millwrights and/or engineers, in the face of one contracting industrial base, they turned their attention firstly to servicing many of the successor industries that replaced wool in the region, and perhaps more importantly, to developing new markets for their skills and products that were not linked specifically to local markets. A number of companies that were initially formed in response to the needs of the woollen industry successfully made the transition from local millwright/engineer to engineering company of national importance. Beyond this core of concerns that had been born of the woollen trade, a second tranche of engineers developed out of the existing bank of general experience and expertise that had been built up, and numerous small firms were created with no direct link to the woollen trade. Rather, these capitalised on the availability of skilled labour and experience that had accumulated in the region, one in which the intense industrial activity now encompassed virtually all aspects of engineering. This extended to the construction of steam, oil and gas engines and here, markets were no longer limited to the immediate locale. In many ways, the local engineering base now turned its attention to broader markets as their traditional areas of activity declined.

A handful of large engineering companies eventually developed from small concerns that had originated in, and grown with the cloth trade. Typically, these were characterised by a wide range of industrial products and services. Markets no longer revolved solely around local textile machinery and mills, as new markets were developed and tapped for a diverse range of more widely utilised components. Some, such as Wallers, came to develop products to cater for a completely new market in the shape of the growing gas industry, although even here, alongside such an important sector, the
manufacture of steam engines etc. continued. Such a strategy helped to ensure that companies were no longer reliant solely on a single market and as such, diversity remained perhaps the most important characteristic of these engineering companies.

Thus, much of the engineering activity in the region came into being initially to service the woollen trade, followed by various successor industries, but later, became an important successor industry in its own right. The following brief case studies of companies that developed into the major engineering companies to grow out of the woollen trade help to illustrate how their role changed in line with market requirements.

— T H & J Daniels

Daniels was one of the local companies that made the gradual transition from family blacksmiths (c1840) to major engineering company, originating from the village of Nympsfield. They evolved from smiths to millwrights, operating in the valleys for over a century. Eventually, the company opened its own iron foundry and carried on making and repairing cloth making machinery and corn milling equipment (Hadfield, 1973: 130); amongst their textile machinery were upright gig mills.

As their traditional woollen-oriented markets declined, the company moved into other spheres, capitalising on the experience generated by their time servicing local cloth mills as well as the successor industries. By 1879, Thomas Henry and Joseph Daniels were recorded as operating as "millwrights, engineers and founders" from their premises at Lightpill (Kelly's Dir. Glos. 1879). Apart from their more general engineering activities, they also produced a variety of steam engines, used both locally and further afield. These were followed by the "Trusty" range of oil engines, produced between c1905-1914, which were built alongside a series of gas engines and gas generation plant. In addition, Daniels manufactured a wide range of general industrial plant, including boilers, pressure and suction gas plants, and high speed patent pumps. Diversification continued further into a range of general engineering services and products, ultimately the company moving into specialised areas such as the processing of plastics and rubber, via extrusion and moulding technologies.

— H J H King & Co

The company was set up by Henry James Hogg King, son of a local flour miller; he later worked at Apperley's large cloth mill at Dudbridge as part of his introduction to the cloth trade. By the mid 1860s, his first patent had been registered, for improvements to steam engine slide valves. This was the first of many and over the years, dozens of others were registered. Many were
developed into commercially successful products. From 1869 up to his death in 1895, he registered patents in virtually every year. Some were agriculturally-based and less than successful, whereas others sold steadily for many years. Initially set up in the former Nodes fulling mill, operations later moved downstream to the next (larger) mill, Lot Mill. From here, several generations of the King family designed, developed and produced a wide range of equipment for local mills and eventually, for markets farther afield.

Much of the company's business during the last three decades of the 19th century was dependent largely on the local mills, and as well as producing their own components, Kings operated as general engineers, supplying equipment and carrying out repairs. Not surprisingly, a good proportion of Kings' work centred around the provision of power and the company produced three types of water wheel/turbine governor, used to automatically adjust the flow of water. As more mills became dependent on combinations of water and steam power, the need for systems to link together the output from both water wheel and steam engine increased. Kings developed two types of clutches, one of which coupled up two power sources. If one retarded the other, the clutch slipped and avoided the loss of power; the "automatic ratchet clutch" was sold to a number of local cloth manufacturers. A friction-based device was also produced which could be inserted in line shafting and used to isolate individual machines within the mill. This avoided the necessity of removing and replacing the drive belt.

Kings were also involved in the design of textile machinery; for instance, during the 1870s and 1880s, eight patents were taken out for equipment designed to feed wool to carding machines.

Kings also maintained and repaired water wheels, and produced a range of water turbines, the majority of sales coming before the 1880s. From the mid 1880s, the company became increasingly active in the design and construction of their own horizontal steam engines. Their initial patent came in 1885 and before long, Kings were both compounding existing engines as well as producing their own. In the case of the former, this involved converting engines from simple to compound operation. The existing high pressure cylinder was fitted above a new low pressure unit, both cylinders being connected by a single triangular shaped connecting rod (Youles, 1989: 22-31). The converted engines were surprisingly compact and sales were made to a number of important local mills. Kings later developed more compact vertical engines, the first sale coming in 1892. Subsequent orders included those from Wimberley Mills, Brimscombe Mills, and Apperley Curtis at Dudbridge Mills.

By 1895, electricity was assuming greater importance and the company was responsible for equipping a number of manufactories with electric lighting. Typically, these setups used 225 volt dynamos, some driven by gas engines and others by water power. Later years saw Kings diversifying further, in order
to cater for markets further afield, producing a range of equipment for maltings, overwinders for coal mines and specialised materials handling equipment. The company later became the engineering concern of the millwrighting Terrett family and was eventually subsumed into the Redler company of Stroud.

■ The Phoenix Iron Works

This was one of the best known and longest-lived engineering and iron working sites in the area, operations being started here by the Ferrabee family c1792. Four generations of Ferrabees subsequently carried on this trade.

William Ferrabee settled in Stroud, probably during the late 1730s and later combined efforts with Mr Butt, a Stroud blacksmith. Edward Ferrabee, the result of his marriage to Butt’s daughter (Rose, 1971: 10) continued the business and may well have been active as a millwright, located at Thrupp Mills, the latter eventually becoming the Phoenix Iron Works. It is possible that the Ferrabees were becoming engaged in machine making, specifically for the mill owner, Samuel Wathen. If so, this was exceptional for the Stroud valleys as the majority of machine makers operated as independent craftsmen, although the former type of arrangement was not unknown in textile mills elsewhere (Benson, 1983: 19).

For some time, cloth making carried on alongside the foundry at the mill, however, by 1828, the whole of Thrupp Mill had been leased by John Ferrabee (1788-1853) from Elizabeth Wathen (GRO. D873/T86) in order to expand business activities. Under the terms of the lease, Ferrabee was empowered to carry out extensive alterations to the site. These included the demolition of the existing dwelling house and the removal of two of the water wheels plus their fulling stocks, which he duly did (GRO D873/T86). One wheel was apparently retained and probably used to provide power for part of the foundry. In addition, the press shop was turned into a dwelling and another foundry added. At this point, the name "Phoenix Iron Works" appears to have been adopted. The Ferrabees continued to service the cloth industry for many years but also continued to produce both corn milling equipment and water wheels.

During this early period in the Works’ operations, a mechanic by the name of Edwin Budding was employed. He is generally credited with having invented the first lawn mower, based on the design of the cloth shearing machinery in use at the time; even today, the principle of the helical cutter is still in widespread use. The patent referring to the lawn mower’s design was taken out in Budding’s name however, John Ferrabee (under an agreement of May 1830) financed this. He also met all the costs of manufacture and further development.
By the 1850s, John Ferrabbee was a well regarded "iron founder and machine maker with close associations with the cloth industry" (Mann. 1987. 179). After 1856, business continued to encompass the manufacture of water wheels, cloth making machinery, agricultural machines and steam engines. The Ferrabees produced a number of specialised cloth processing machines such as roller milling machines, a few of which survive (Pers. Comm. I Mackintosh, Stroud Textile Group).

The first Ferrabee beam engine had appeared by the 1850s, with other designs coming later. With some designs, efforts were made to minimise the floor space taken up compared with conventional engine designs; in 1862, such an engine was described thus:

"[It is] a vertical steam engine with overhead crank. It has a separate expansion piston-valve in a chamber behind the ordinary slide, controlled by the governor, which acts upon a link motion worked by two eccentrics as in a locomotive, on the principle of Allan's straight-link motion. The cylinder, 10" diameter with 18" stroke, is fitted with a steam jacket cast on it. The exhaust steam is discharged into a cistern formed at the base, to heat the feed water" (Clarke, 1862: 63).

The company continued to provide a wide range of products and services, and agriculture machinery manufacture continued alongside the steam engines and textile-related equipment. The Ferrabee’s connection with the Lewis cutter has already been mentioned, however, their range of woollen cloth equipment included machinery for forming and feeding "bats" of fleece to carding engines (ibid) based around a multiple conveyor system, as well as fulling machines and "perpetual shearing machines for finishing the cutting of cloth" (Rose, 1968: 17).

The family eventually ceased operations at the Phoenix Works and moved to Port Mill, Brimscombe ("The Waller Story", 1972: 3. Published privately) where by 1870, they were making cloth in partnership with a Mr Fox (Kellys Dir. Glos. 1870: 481). Following Ferrabee’s departure, the Phoenix Iron Works was taken over by a company from London, George Wailes & Co (Kellys Dir. Glos. 1879: 648), and latterly, by George Waller & Son. They came to produce a range of gas exhausters of their own design, alongside a variety of steam engines, boilers, and other machinery.

In 1880, George Waller invented the "Waller Three Blade Gas Exhauster"; this was to become a staple item, remaining in production for the next 55 years. Wallers continued to produce a variety of other items, among them, small beam engines. In some instances, these were coupled up to operate Waller gas exhausters, such as the unit supplied to the Brighton & Hove Gas Works c1881. These apparently gave long and useful service. In addition, the company continued to manufacture a range of decorative cast iron street furniture, aimed generally at the gas industry. Their ornate iron gas lamp columns were to be found throughout many parts of London. Over the ensuing century, the company continued to specialise in gas exhausters and compressors but also maintained a wide portfolio of more general
Apart from these major engineering companies, there were many other smaller concerns who had all been born out of the woollen cloth industry. Between them, they established a strong tradition of engineering in the Stroud area, one which helped to cushion the region in the post-woollen period.
Almost inevitably, the introduction of new machinery resulted in significant changes in working patterns. Eventually, this often translated into a reduction in the numbers employed. At best, jobs lost might be balanced by the creation of alternative ones and this was certainly the view of some Gloucestershire clothiers. When the major clothier Peter Playne was asked his opinion on the use of new power looms, he dismissed their perceived usefulness and noted:

"I do not consider power will greatly reduce the price of weaving, or throw the population out of employment. If it throws a weaver out of work, it employs mechanics, such as millwrights, carpenters, and blacksmiths". (Miles, 1839: 369).

In earlier years, when carding and spinning machinery was being introduced into the district, changes were not entirely without benefit to some workers and many cottage-based spinners took up the jenny and continued to ply their trade with increased effectiveness. Similarly, the flying shuttle does not seem to have displaced directly too many hand loom weavers, despite obviating the need for two operatives; at times, expanding markets for cloth accommodated displaced weavers and also increased the requirement for yarn, ensuring carders and spinners remained occupied. However, this happy arrangement for the latter was not permanent and later, when the spinning mule came into the district c1828, it was directly responsible for displacing jenny labour by about 60%. As a result, the labour market became overstocked with jenny spinners, wages falling by 57% as a consequence (ibid. 370, 375).

Not all displaced workers inevitably found new employment and it was noted that:

"Relative to the shearmen and scribblers, who were put out of work by the introduction of new machinery...as classes, they never found any other channels of labour; and their condition consequently continued to the end of their days below that of other classes of workingmen". (ibid. 435)

Not all of Playne's peers shared his apparently dismissive attitude to new machinery and in many cases, clothiers recognised its importance. Even though, for obvious reasons, in the short term, the workforce might be reluctant to accept its introduction, it appears that they too, recognised the significance of such developments (Moir, 1957: 260). For instance, Nathaniel Watt's attempt to
introduce spring looms into his Stroud mill was unsuccessful, although cottage-based weavers, realising their importance, were not slow to buy up the looms for their own use.

Despite Peter Playne's assertion that newly created jobs would compensate for those lost, in reality, the introduction of all types of new machinery contributed to changes in working practices which generally impacted directly or indirectly on job security. By the time of Miles' report (1839), he was able to note that in all but four worker categories in the manufacturing chain, reductions in labour had accompanied changes in organisation and perhaps more importantly, the introduction of new machinery. Miles report summarised the loss in jobs as follows (see also Table 4):

"The decrease per cent on labour in reference to the different classes, will be better shown in the following manner:

No decrease: sorters, engine men, roughers and mill-men

Table 4
Decrease in Jobs

<table>
<thead>
<tr>
<th>Job</th>
<th>Decrease in labour (%)</th>
<th>Job</th>
<th>Decrease in labour (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brusher</td>
<td>7</td>
<td>Marker</td>
<td>20</td>
</tr>
<tr>
<td>Mule spinner</td>
<td>12</td>
<td>Warper</td>
<td>30</td>
</tr>
<tr>
<td>Scourer</td>
<td>13</td>
<td>Beater</td>
<td>31</td>
</tr>
<tr>
<td>Packer</td>
<td>28</td>
<td>Burler</td>
<td>40</td>
</tr>
<tr>
<td>Weaver</td>
<td>37.5</td>
<td>Jenny spinner</td>
<td>57</td>
</tr>
<tr>
<td>Cutter</td>
<td>38</td>
<td>Carder boy</td>
<td>12.5</td>
</tr>
<tr>
<td>Dyer</td>
<td>50</td>
<td>Scribbler boy</td>
<td>25</td>
</tr>
<tr>
<td>Mule piecer</td>
<td>18</td>
<td>Roller joiner</td>
<td>34</td>
</tr>
</tbody>
</table>

This equated with a 33% drop in female labour, 25% for men, and 24% in youths. (Miles, 1839: 375).

Despite the various changes that the introduction of machinery made to working patterns, the biggest outcry in Gloucestershire came during the period that the power loom was beginning to make its presence felt, although the unrest at this time was not attributable directly to this factor alone. Primarily, it was a reaction against low wages and insecurity and the threat of the power loom was but one of a series of factors in the equation.
Even when an employer did not seriously countenance introducing power looms, he was able use this as a mechanism to keep wages down. One of the unfortunate results of the power loom (from the hand loom weavers’ point of view) was that for many products, it could produce cloth more cheaply. Therefore, the hand loom weaver was often forced to accept a reduced wage in order to compete with the power loom. The threat of a clothier introducing power looms was often enough to keep weavers in check. (Smith & Lewis, 1976: 25). It was noted that:

"The condition of the out-door weaver is depressed without any prospect of remedy; for if a demand for labour should arise from any change in the trade, wages will not be allowed to exceed in any great degree the cost at which power can perform the work". (Miles, 1839: 359).

The upheavals caused by the introduction of new machinery into woollen manufacturing were not confined to Gloucestershire, although worker response varied considerably between districts. Perhaps not surprisingly, workers in most districts tended to react with alarm and dismay and this often manifested itself in strikes, machine breaking, rioting and occasionally even murder. The extent of the reaction depended on the region and whereas Yorkshire witnessed the violent exploits of the Luddites and Wiltshire saw rioting and destruction spanning decades, the industry in Gloucestershire was markedly more quiet in terms of opposition to new machinery. Thus, the Gloucestershire clothiers carried on using gig mills when those of their counterparts in Wiltshire and parts of Yorkshire were being destroyed by the mob. In Wiltshire, even as late as 1802, a concerted campaign of opposition was still being waged and attempts to introduce gigs into mills in the Warminster and Bradford-on-Avon areas met with the usual response (Moir, 1957: 258). Similar occurrences took place in Somerset. Even after its legality had been confirmed by parliament, the trouble was not yet completely over and during the depressed Winter of 1807-8, there was a burst of rioting in Wiltshire, triggered by the attempt of a Bradford firm to introduce the gig mill (GJ. 19 October 1807). Thus, unlike Gloucestershire, technical advances were not always pursued and c1806, as a result of constant worker opposition, the gig mill and even the flying shuttle were still comparative rarities in Wiltshire.

The violent opposition that greeted each attempt to introduce technological innovations into Wiltshire was to be one of the major causes of the ultimate undoing of much of the trade in that area (Mann, 1987: 151). In 1807, the German traveller Nemnich, wrote an account of his journey through the clothing areas of the South West. He noted that he was warned not to speak of textile machinery in the presence of the work people, such was the vehemence of their opposition (Info. supplied by Trowbridge Museum).

The situation was different within Gloucestershire where the flying shuttle had reputedly been in use since the 1750s (Moir, 1957: 260) although this was presumably restricted to use by cottage-based
weavers. The first reference to its adoption by a clothier was the attempt by Stroud clothier Nathaniel Lewis. In 1793, he tried to introduce looms equipped with flying shuttles into a centralised location at his mill at Wallbridge. This was not through a shortage of journeymen weavers but through the Watts' desire to increase his profits through their use (PP 1802-3. vii. 232. Ev. of John Clayfield). Clayfield, a former employee of Watts, noted that:

"I worked with him, and it caused uneasiness in the minds of the workers, and they went to Mr Watts; there was a public meeting, at which I have heard people say twenty thousand people met [!]; and the gentlemen clothiers met and formed a committee, and sent to the weavers to know their grievances...they [the weavers] replied they were afraid themselves and their families should be ruined...the committee said that if that is your grievance, they shall be given up". (PP 1803. vii. 15-16).

Watts then sold on the looms to local weavers, two to Clayfield himself, thus defusing the situation. It seems that the weavers' main objection was not to the flying shuttle *per se*, but to the attempt by a clothier to impose them on them in a centralised loom shop. The use by cottage-based weavers remained unopposed, such was their usefulness (PP 1802-3. vii. 232. Ev. of John Clayfield). Such a situation was unthinkable only a few miles away in Wiltshire although like Stroud, the flying shuttle had met with greater acceptance in Yorkshire. In the latter, despite the hostility that greeted its appearance during the 1760s, by the 1770s, the shuttle was in general use in both domestic-based weaving and in mill-based loomshops (Gregory, 1983: 88).

In the Stroud region, spinning and carding machinery was introduced into the locality during the 1780s, although it was reputedly generally disliked by the workers (Smith & Lewis, 1976: 18). However, no clear picture of worker reaction emerges and according to some sources, jennies were immediately accepted by the workers and were:

"...hailed with delight by masters and weavers" (SdJ. 4 July 1868).

Needless to say, attempts to introduce the jenny in Wiltshire (in 1776) resulted in widespread rioting. Similarly, it was not until the late 1780s-early 1790s that carding and spinning machinery began to be introduced over the Wiltshire clothing districts as a whole. (VCH Wilts. iv. 167).

When the power loom began to be introduced into Gloucestershire mills, it apparently caused little direct unrest. As a report in the *Stroud Journal* stated:

"...the power loom was gradually introduced into the clothing trade of the Stroud district without any
opposition or particular excitement. The power loom was complete in itself and was an acceptable acquisition to the other machinery employed in the clothing trade". (SdJ. 11 July 1868).

Thus, in their response to the introduction of new machinery, workers in the Stroud valleys' mills were unusual. Although they may not have necessarily initially welcomed its introduction, they appear to have at least acquiesced and accepted machinery much more readily than some of their counterparts elsewhere. In fact, if some reports are to be believed, they welcomed it with open arms. However, worker unrest in Gloucestershire as a direct result of the introduction of new machinery is difficult to define clearly as the waters were frequently muddied by other factors. The weavers' response to the appearance of the power loom remained essentially verbal as opposed to physical, and their main concerns were addressed primarily to the lowness of wages. However, fearing that the power loom was yet another threat to their livelihoods, Miles reported that:

[the hand loom weavers urged]"... power-looms should be put down, either by "law" or by a tax amounting to prohibition; that factories should be abolished...In the North, power has outstripped the hand loom weaver in cotton, and in Gloucestershire the unequal race has just commenced in woollens" (Miles, 1839: 360).

Thus, at times during the gradual process of displacing hand labour with that of machines, workers in Gloucestershire sometimes protested against the employment of machinery, not because of any objection to machinery as such, but in order to draw attention to grievances (such as low and uneven rates of pay) primarily in times of bad trade (Minchinton, 1951: 126-142). Like the shearmen and others before them, many hand loom weavers were eventually displaced by powered machinery and found it difficult to adapt to a new way of life - (see following section on Decline of Hand Loom Weavers).

Despite their often almost token objections to new machinery, by and large, it was accepted without much of a fight and despite their occasional grumbles, Gloucestershire workers accepted technological change without the outbreaks of unrest and violence that marked its introduction into competing woollen districts. In an industry where changes were occurring at almost a logarithmic rate, the threat and impact of newly developed machinery to their livelihoods was but one of many factors that workers had to come to terms with. A combination of these factors eventually brought about the wide scale unrest amongst Gloucestershire weavers during the 1820s (see later - Unrest and Disruption).
The Decline of the Gloucestshire Hand Loom Weavers

The life of the typical Gloucestershire hand loom weaver was at best precarious, and although there were good times, equally, there were often bad ones to balance this. As in other clothing districts, it was often an uncertain existence, and although the weaver might have regular work from one or more clothiers, he was only engaged by the piece. The major clothier Edward Sheppard confirmed that the usual arrangement was as follows:

"A weaver comes and asks for work, we give him work; if he does it well we give him more; if he does not we give no more ... engagement is only for a piece" (PP 1802-3. vii. 1803. 236).

The weaver had little to bargain with except his labour and in an increasingly overstocked labour market, this often counted for little. As a consequence, in order to survive, hours of work could be long:

"We could work 14-15 hours a day; in winter we work as much as by candle as by daylight; I have worked from five [am] to seven at night in Winter and from four to nine in Summer". (PP 1802-3. vii. 87. Ev. of Cornelius Bancroft).

Even where a close relationship existed particularly between smaller clothiers and their weavers, this could prove to be a disadvantage as weavers could become involved in the collapse of the business (Moir, 1957: 247). At least some weavers were aware of the precariousness of their position and realised that their fate rested with that of their master. A letter from some Horsley weavers confirmed this:

"Most honoured sir; these with our humble thanks to you for your kindness to us poor weavers. As we do wholly rely upon you we hope kind providence will favour you to accomplish the thing which you have begun for if it should fail, we and ouers are undone for ever". (GRO. D149/B8).

Thus, working for a single master carried serious risks and this remained true even for some of the larger clothiers such as Edward Sheppard. The life of the typical hand loom weaver was set to undergo significant upheaval as the industry continued its transformation particularly during the first part of the 19th century. Almost inevitably, these changes resulted in a reduced standard of living for many workers and after numerous pleas from weavers for assistance, in 1839, an investigation was carried out by Augustus Miles to assess the problems, their causes and possible remedies. He was already aware of the situation awaiting him and noted:
"My attention has been chiefly directed to the condition of the out-door weaver in the county of Gloucestershire, because within the last few years the trade and system of manufacture has been altered, and with this alteration the condition of the weaver has been changed". (Miles, 1839: 360).

He went on to comment that:

"The weavers are not an intelligent class of persons; they have lived in their lone cottages, and are scarcely able to understand the machinery of commerce … [they] most strenuously urge that every sort of restriction should be adopted to secure a monopoly of their own calling … prohibit power looms, no man should have more than three looms, and that the apprenticeship system should be adopted". (ibid).

One of their principal complaints centred around both the lowness of wages and the variations paid by different masters. Miles was able to confirm that since the 1820s, there had been a constant tendency to reduce wages, with the result that weavers had gradually "become lower and lower in condition". (ibid). Evidence from Gloucestershire weavers confirmed this view with one noting:

"… wages had not risen in the last fifty years". (PP 1806. iii. 335. Ev. of John Mills. Uley hand loom weaver).

Miles was able to confirm that wages were unfairly low:

"…the lowness of the out-door weavers’ wages and earnings are fully attested, and show his condition to be below that of any other labouring class, where skill or knowledge of a trade is requisite". (Miles, 1839: 359).

Apart from their general lowness, a further cause for complaint was the disparities in payment made by different masters for producing similar products. When Robert Gardner, manufacturer and spinner, was asked if the wages of the weavers had often been reduced, he responded that this was very much the case and that they fluctuated greatly. Weavers making the same type of article were often paid different amounts by different masters. Gardner commented:

"…also every manufacturer will vary more or less…there are inferior and superior manufacturers…even though the same article goes by the same name …reduction in wages generally begins with the smaller manufacturers who have not sufficient capital to carry them over a flat season; and of course, it is always a flat season, and there is more labour in the market than is required, therefore they reduce wages". (PP 1840. xxiv. 127).
Compared to mill-based weavers, the relative isolation of many Gloucestershire outdoor weavers also helped to keep their wages down through their inability to form trade associations that may have helped them. When John Scott was asked if he thought there was a greater tendency to form trade unions and combinations among factory-based hand loom weavers as opposed to those still working in their homes, he responded:

"Those working in factories or confined spaces have a greater opportunity for combining for the protection of their wages than the weavers who are scattered through the very wide districts". (PP 1840. xxiv. 181).

Even though the bargaining power of factory weavers was probably not great, they were in a stronger position than their outdoor peers whose job security was less and wages significantly lower. As with many Gloucestershire outdoor weavers, many in Eastington were eventually forced to:

"...stand cap in hand at the gates of Millend, Churchend, Meadow, Bonds and Beards Mills, offering their labour at starvation rates, which would have to be supplemented by the overseers where the wage earner had dependants". (Keys, 1954: 87)

Miles' report substantiated the weavers claims of the dire situation faced by many of their number and also confirmed that the reasons for their decline were both numerous and complex. He concluded that strikes by weavers had proved to be to their detriment, reduced profits being made by manufacturers had squeezed wages downwards, and occasional payment in truck made matters worse. In addition, the Corn Laws were "almost unanimously allowed to be the cause of distress...over the period 1820-38, wages have fallen by 30% and corn has increased by 3d a quarter". (Miles, 1839: 360, 398).

Overall, the report concluded that the causes of distress amongst the hand loom weavers centred mainly around a combination of reduced wages, overproduction, severe competition in the market, taxation, and problems associated with currency. (PP 1840. xxiv. 9-26). The introduction of new machinery also featured in this list although at the time of the reports’ compilation, the power loom had only had a limited effect. The major cause of weavers’ distress was simply that there were too many of them trying to work in an industry that was changing in many ways. Miles estimated that in 1838, reductions in the size of the market threw 308 weavers out of work; this was on top of the average surplus of around 338 out of a total population of weavers of around 3000. Hence, 646 weavers were unemployed during 1837. (Miles, 1839: 367).

He noted that:
"It is the surplus of numbers that places the weaver in a different position to his fellow workers... The weavers have a great objection that any person should know in what time they can weave a chain. There is a regulation amongst the men in one factory that no weaver should take his cloth in under ten days; this feeling proves the effect of a surplus of population; for it is founded on the dread that if employers find a man can earn more in a given time than is actually required for subsistence, their wages will inevitably be lowered". (Miles, 1839: 360, 375).

The situation had been made worse by firms failing; in the previous eight years, four of the largest firms had failed, and 58 out of 137 mills had closed (ibid. 360). Times were clearly becoming increasingly difficult for the outdoor weaver and although various remedies such as emigration and relocation were tried, the results were generally of limited success.

As with other groups of textile workers before them, Gloucestershire hand loom weavers were seeing their way of living and working gradually disappear. Any worker is naturally reluctant to see his long-established working practices displaced and the hand loom weavers were no exception. However, in this respect, many were in exactly the same situation as other groups of textile-related workers who had already seen their domestic-based livelihoods either disappear or transferred from the cottage to the factory, where they now worked as paid hands as opposed to independent craftsmen; because of the overstocked labour market, others remained unemployed. The weavers were to find their long-established way of life increasingly whittled away. However, this is not to imply that the traditional figure of the cottage-based weaver disappeared overnight. In fact, especially during the first two decades of the 19th century, many continued to operate in such a manner (Palmer, 1993: 151). Others worked in centralised loomshops, often at the mill. Thus, both types of arrangement coexisted for many years, and often, the balance only shifted gradually towards mill-based loomshops. However, it was only a case of time before the cottage hand loom weaver became a thing of the past.

Relationship Between Masters and Men

On examination of the attitudes of the masters to their workforce and vice versa, it becomes apparent that little in the way of a general pattern emerges. At times, some clothiers remained aloof and dismissive of their workers, yet others treated them with a greater degree of respect and concern. In the former category, it seems that many of the Gloucestershire "gentlemen clothiers" of the 18th and 19th centuries adopted the former attitude, one which doubtless caused the workers to respond accordingly. The way of life of this select band of all-powerful clothiers ensured that there was little in common between them and their respective workforces, with many of the former aspiring to the ranks of the landed gentry. Their way of life ensured that few knew their workers personally. In some instances, clothiers became more concerned with their social life and standing, rather than in the
day-to-day operation of their businesses. As Samuel Sevill commented, when referring to the gentlemen clothiers:

"While the men of Leeds and Huddersfield were constantly in their mills...the clothiers of Gloucestershire, some of them, were indulging in the habits and mixing with the gentle blood of the land". (Miles. 1839: 455. Ev of Samuel Sevill).

As a result of such preoccupations, unlike in earlier years, it became increasingly common for some of the major clothiers to leave the running of the business in the hands of a manager or head servant. Consequently, some clothiers became distant figures of authority that the workers neither knew nor cared about. Thus, it was noted that in some cases:

"... the working man has no interest in the prosperity or well-doing of his employer, and the manufacturer scarcely knows his men". (Miles, 1839: 360).

Hence, a considerable gulf came to exist between some master clothiers and their men and as Moir notes, conflict developed on two levels; masters and men were divided not only by immediate grievances but by fundamental differences of outlook. The workers, conservative by nature, were generally fearful of change and attempted to retain job security through the retention of numerous ancient pieces of legislation regulating the industry (Moir, 1957: 255). Their attempts to uphold much of this legislation were doomed to failure, partially through the influence wielded by the major clothiers in Gloucestershire and elsewhere.

Although there was no official clothiers association, the gentlemen clothiers held regular meetings to "consider the general state of the trade" (GJ. 18 March 1793) and when they felt it appropriate, acted in unison in order to adjust wages, etc. They also kept in constant contact with similar organisations in other clothing districts and were therefore able to present a unified front of opposition to the workers when necessary (GCL. JF. 13. 25). Hardly surprisingly, the major clothiers were regarded by their workers, not merely with suspicion, but open fear and hatred (Moir, 1957: 255). Such animosity was not necessarily encountered elsewhere and when the former Dursley weaver, Richard Stiff, gave evidence to Augustus Miles, he commented on the difference between his present employers in Witney, Oxfordshire, and his former masters in Gloucestershire:

"[in Gloucestershire] when a weaver goes before a master, it is as bad as going before a judge" (PP 1840. xxiv. 550. Ev of Richard Stiff).

In contrast, the Witney employers:
"[showed] the kindest feelings towards the men, and the men to the masters" (ibid).

Miles confirmed that in many cases, considerable animosity existed between Gloucestershire clothiers and their workers:

"... I have found a cordiality at Witney among masters and men. This excellent feeling arose from the kindness of the masters towards their workpeople, and the interest in their workforce. I have heard workmen say they could be happier upon low wages if treated as men, as receive higher wages, and be treated as brutes...In Gloucestershire I found an acrid feeling existing among the workmen towards their masters". (Miles, 1839: 358).

Despite Miles' implication that this type of situation was restricted largely to Gloucestershire, this was far from the case. In Leeds, the gulf was as great as ever and in 1830, when weavers petitioned parliament for assistance in alleviating their distress, they noted:

"...yet on the day our petition was presented to the House...they also received letters from Messrs B Gott & Sons and Messrs P Nevin & Sons which said that they had been very large manufacturers in Leeds upwards of fifty years and that they never knew the labouring classes to be in better circumstances then they ever were at that time...this was proof that these large manufacturers knew nothing of the real situation of the labouring poor in the very town they had so long been residents" (PP 1835. x. Ev of Edward Sutherland and Michael Mahoney, stuff weavers).

This attitude was undoubtedly prevalent among many of the larger Gloucestershire clothiers although it was not universal, especially among the smaller clothiers where workers were known personally. A Nailsworth weaver commented that he had worked for his present employer upward of seven years and "liked them very well in respect of civility" (Miles, 1839: 423. Ev of George Risby). Similarly, when the Painswick clothier Daniel Packer found himself in difficulties during a time of depression, he noted with sadness:

"I fear I must part with my spinners, what they will do I cannot tell, I fear they will not find employ elsewhere". (Tann, 1967: 40).

Thus, although Miles suggested that feelings of animosity were rife in Gloucestershire, this was not always the case and acts of kindness and benevolence were to be found throughout the industry's history. For instance, the market hall in Stroud was also used as a school known as the Red Boys, founded by the clothier Thomas Webb. Webb left additional funds to be used by "Two honest widows to breed up four poor children". (Walmsley, 1994: 74). Even during the reign of the gentlemen
clothiers, acts of benevolence were not uncommon. Although the major clothier Henry Hicks was effectively a feudal lord over the entire parish of Eastington, and remained aloof and isolated from his workforce, he nonetheless assisted the poor, gave cloth for charitable purposes and donated monies toward the building of a village school. On the other hand, he was viewed with considerable apprehension by villagers and workers alike, such was the influence of Hicks and his clothier peers.

To some extent, the sometimes confrontational attitude between masters and men appears to have softened with the passing of the gentlemen clothiers. As they were gradually supplanted by businessmen intent on the success of their businesses, as opposed to consorting with the country gentry, so things began change. Although, in terms of life style, the gap between employer and employee remained fairly substantial, at least some manufacturers began to take a greater interest in the well-being of their workers. Thus, when the Hicks dynasty was extinguished in the 1830s, they were replaced with the likes of Charles Hooper, formerly their mill manager. A man already known and whose business skills and personal qualities were appreciated by the mill hands that he had been working closely with on a daily basis, Hooper adopted a paternalistic role to his men. Over the course of the next half century or so, successive generations of Hoopers supported and encouraged numerous local religious, educational and temperance initiatives, sometimes going to great lengths to assist individual workers who had fallen into debt or alcoholism. (Keys, 1954: 112). In many respects, the Hoopers took over the paternalistic role of the lords of the manor of earlier days. The Hoopers’ workforce showed a degree of respect and affection for their masters that would have been unthinkable only a generation earlier.

Figure 22. The Leaze, built by the clothier Henry Hicks c1815. Later occupants included the Marlings and Stantons.

The Hoopers may have been somewhat atypical although in other parts of the region, similar bonds
of loyalty began to form between some manufacturers and their workers. At Longfords Mill, a paternalistic attitude was adopted by the Playne family and with the passage of time, it became common for several generations of particular workers to be employed simultaneously. In fact, some spent their entire working lives with a single master such as the Playnes. This positive attitude may have been an important factor in the overall success of a business, as at least some which operated in this way, appear to have weathered the inevitable depressions in trade more successfully than others; both the Hoopers and the Playnes were prime examples of this.

Some of the largest and most successful cloth manufacturers in the region were the Marling family. From this family came a number of highly successful businessmen who, although there remained the inevitable gulf between them and their men, carried out many individual acts of kindness and benevolence. For instance, Sir Samuel Marling had a long-standing interest in the education of his workers and their families and from the 1840s, was actively involved in founding the British Schools (Walmsley, 1994: 81). Later in his life, he followed this with a donation of £10,000 towards the cost of a secondary school for the area. The Marlings appear to have been treated with a high degree of respect both for their business abilities and interest in their workforce (Pers. comm. Mr J P Evans).

Similarly, on the death of Walter Stanton, Justice of the Peace and member of the substantial Stroud clothier family, it was noted that:

"... he proved of great assistance to the police by whom, as indeed by every class, he was held in the highest esteem which was mutual". (SN. Obituary. 8 August 1913).

Like an increasing number of local industrialists, the Stantons were heavily involved in local affairs as magistrates, landowners, guardians of the poor, and leaders of the Temperance Movement.

Thus, over the course of several centuries, significant differences in attitude between masters and men existed, although the passing years of the 19th century saw something of a shift, as in some instances new "businessmen" took over the roles of the gentlemen clothiers. Many of this new breed of manufacturer not only concentrated on the commercial aspects of their businesses but also willingly took on the obligations and paternalistic attitudes formerly associated with the role of lord of the manor or perhaps latterly, the squire. Unlike their predecessors, they no longer lived their lives in splendid isolation, remote from workers, but became actively involved with many aspects of their daily lives. In some respects, the masters were more fortunate than their peers in many of the clothing districts of Wiltshire and Yorkshire in that in general, the workforce responded differently to changes in methods of organisation and production techniques. Thus, Gloucestershire workers were considered to be rather different animals to many of their counterparts elsewhere.
Unrest and Disruption

Despite the relative peace that generally prevailed in the Gloucestershire woollen districts, there were occasions when tensions boiled over into periods of agitation and unrest, although these were comparatively minor compared to elsewhere.

In the West of England, the pre-1720 period was generally a prosperous and consequently, peaceful time. However, the industry was now to become prey to a succession of ups and downs of varying duration and depth; both booms and slumps could be of short duration or protracted affairs. The period 1726-7 saw some minor rioting in Gloucestershire associated with reduced rates of pay, during a period of depression in the local industry. The unrest in the county seems to have been mild compared with the disturbances that had already occurred in the serge-making districts of both Devon and Somerset, followed by rioting in Wiltshire and Somerset during the 1720s (Mann, 1987: 109). The latter resulted from unrest over a combination of rates of pay, high bread prices and a shortage of cash. Disturbances over wage levels, in particular, were to become a recurring theme in the West in general, often occurring when clothiers either attempted to reduce wages in times of depression, or introduced changes in working practices which effectively required more work for the same money. Workers came to regard clothiers as exploiting them, driving them hard when orders were good, yet turning them off in times of slack trade or depression; doubtless this was often the case. A decade or so after the 1726-7 outburst, Wiltshire and Somerset experienced a further period of disturbances, once again, related to similar issues.

The troubled period that characterised much of the West at this time was replaced by a period of relative prosperity which in turn was followed by a further period of depression c1738-41. Riots were particularly serious in parts of Wiltshire, with outbreaks of mob violence culminating in three hangings (Rogers, 1986: 64). The depressed situation was exacerbated by the insistence of some clothiers to pay workers in truck. However, once again, trade and tranquillity subsequently recovered but was hit by a further slump during the period between c1753-57 (Tann, 1967). Unfortunately, this coincided with poor harvests, the combination of scarce/expensive food and depression in the trade leading to a six week strike of Gloucestershire weavers. In 1757, Stroud clothiers petitioned the House of Commons in regard to the "commotion resulting from the rising of the weavers". (Marling, 1913: 318). Major General Wolfe was eventually sent in with six companies of infantry to restore order to the region. Once again, trade picked up and the 1760s were generally a profitable and settled period although there was widespread rioting in Wiltshire and Somerset in 1766, resulting from the high price of bread, coupled with low rates of pay. The following decade was to see further slumps.

Despite the inevitable fluctuations in the industry, Gloucestershire remained largely untroubled for the
next few decades. During this period, increasing amounts of machinery was installed in many of the local mills, apparently with little opposition from the workforce. In contrast, parts of Wiltshire and Somerset were now entering a period of concerted opposition against the introduction of new machinery, with mob violence set to become a recurring theme for the next half a century of so. In 1767, an attempt to set up a gig mill in Warminster led to its swift destruction by the mob, and in 1776, machinery in Shepton Mallet suffered the same fate. A few years later, in 1781, workers destroyed a jenny and carding engine set up in Frome. (BC. 13 June 1781).

It was not only technological advances that were resisted in Wiltshire and Somerset, as organisational changes were similarly treated. In 1787, serious riots occurred in Trowbridge in protest at the creation of a mill-based loom shop (Mann, 1987: 115, and Rogers, 1986: 65). Events took an even more serious turn a few years later with machinery smashed and three mills being burnt down in Trowbridge and Littleton in disputes over levels of payment and the introduction of machinery. Three rioters were shot in the ensuing struggles.

1792 saw further riots, this time directed against the introduction of the flying shuttle in Trowbridge. At this time, only one site in Wiltshire is known to have been using these, 50-60 being in use in a factory in Malmesbury (Rogers, 1986: 76). Elsewhere in the county, worker opposition had stifled attempts to introduce them.

Meanwhile, the Gloucestershire districts remained generally quiet apart from minor bouts of unrest such as occurred in Woodchester in 1792. Here, rioting broke out in response to the introduction of scribbling machinery but unlike their peers in Wiltshire and Somerset, the Stroud workers sided with their master, both being convinced of its worth (Mann, 1987: 129). New machinery continued to be set up in many Gloucestershire mills, largely unopposed. Where potentially inflammable situations arose, these tended to be handled in a more diplomatic and conciliatory manner, as opposed to rioting. When Nathaniel Watts attempted to introduce the flying shuttle into Wallbridge Mill in Stroud in 1793, followed by the clothier Webb, of Stonehouse, in 1795, both were persuaded to withdraw it as a consequence of the unease that it caused amongst the respective workforces. Watts diplomatically sold his looms to independent weavers and Webb did likewise. (PP 1803. vii. Quoted by Loosley, 1993: 2). The situation was thus defused through a combination of persuasion from both workers and fellow clothiers. Despite the shuttle's withdrawal, some of the Stroud weavers themselves took it up and by the late 1790s, it was being used widely in the area. Elsewhere in the West, it remained a rarity, and rioting in the period 1801-3 in Chippenham may have been caused by attempts to introduce it into this region of Wiltshire.

In the same period, there was widespread upheaval caused by the Wiltshire shearmen, protesting
against the introduction of the shearing frame into the area. The unrest culminated in acts of violence and arson. An observer noted that such violence and disruption was being caused by workers:

"...who now and for many weeks past, refused to work on account of some machines being introduced which they consider as obnoxious, although the same have been used for many years in other parts of the kingdom" (Aspinall, 1949: 41).

The dawn of the new century did not see an end to the periods of unrest in various parts of the country's woollen districts and trouble was to again flare up in both the West and the North. In Gloucestershire, it appears that by the early years of the century, the increasing amounts of machinery being introduced into the county's mills were beginning to have an effect on the labour situation in the region. This led to overproduction plus an inability of the industry to fully absorb workers displaced by a combination of new machines and the gathering together of various groups of workers at mill sites. In particular, displaced journeymen weavers had little option but to accept jobs in the new loom shops and were prepared to work at any price (Herrick, 1980: 37). As happened in the previous century, poor harvests resulted in high wheat prices which inflated food prices in general during the period 1801-4, this further compounding the problem. Despite the problems resulting from technological and organisational changes within the industry, Gloucestershire remained largely peaceful, even when less than a decade later, parts of the northern woollen districts were being torn apart by the Luddite riots. There were a number of reasons for the latter, some politically motivated, behind these outbreaks of arson, violence and machine breaking, however it was the introduction of the latter that acted as the spark that ignited the fire. In 1811, the introduction of gig mills into Yorkshire triggered the first outbreak of unrest (Giles & Goodall, 1992: 13. Also Gregory, 1983: 139). Increasingly, mills and their owners were attacked, cloth destroyed and masters and workers intimidated. By 1812, almost on a weekly basis, workshops were being burnt down and shearing frames and other machinery smashed (Gregory, 1983: 165). Although such organised, widespread action was associated primarily with the North, riots against machinery continued in Wiltshire and Somerset and during 1816-19, a series of disturbances occurred associated with attempts to introduce finishing machinery into Trowbridge. In 1816, rioting against the introduction of the flying shuttle occurred in Chippenham (BC. 20 June 1816). The time of this latter batch of riots coincided with major strikes and disturbances in the North; in 1819, Leeds employers had tried to cut wages by 25%, resulting in a period marked by lengthy strikes and disturbances (Gregory, 1983: 224).

All that happened in Gloucestershire during this period were minor localised strikes in Kings Stanley (1819) and Uley (1821) over the level of wages. Meanwhile, widespread rioting continued to break out in the Frome area of Somerset, caused by a combination of low wages and attempts to bring in the flying shuttle (Mann, 1987: 232). Such were the extent and duration of the troubles, that troops
from various regiments were permanently stationed in parts of the county throughout much of the 1820s and 30s, in order to preserve the peace (ibid. 232). By and large, Gloucestershire had remained quiet throughout this turbulent time, the period up to c1825 being generally one of prosperity. However, in that year, a further depression in the trade saw wage reductions forced on the workers, leading to a rash of strikes in the area; major strikes occurred in 1825, 1828 and 1834. (Marling, 1913: 320). 1825 was to see the start of the most notable strike in the history of the Gloucestershire woollen industry. There had been protracted negotiations between masters and men over levels of payment and their equalisation between different employers. These discussions had initially raised hopes that an equitable settlement could be reached, however this was not to be the case, leading to great frustration amongst the weavers of the region. In March/April 1825, serious disturbances began and some 5000 weavers in both the Stroud and Wotton-under-Edge region struck in an effort to increase wages and equalise rates of pay. Exell commented that at this time:

"discontent began to show itself in every bosom". (Timothy Exell. Quoted by Herrick, 1980: 39).

On April 25th, the weavers stopped work, with the dual aim of increasing pay and the equalisation of rates. It was noted that:

"...an agitation was observed amongst the weavers and it soon afterwards found that they had organised committees and constituted Delegates for compelling the Manufacturers to sign a document binding themselves to adopt the weavers printed scale of prices" (Scrapbook. GRO. D4693/14).

Against this background of dashed hopes and recession, the weavers struck. The degree of organisation and coordination amongst the weavers was surprisingly high and compliance amongst the workers was enforced by leaders, accompanied by groups of weavers, touring the region demanding the surrender of shuttles. Miles noted the success of this tactic and commented that:

"...in about 48 hours, all the shuttles were laid in a silent grave".

In the meantime, membership of the Stroud Valley Weavers Union rose in a matter of a few days from 400 to over 5000. During the ensuring strike, around 5000 weavers and countless allied workers remained idle. Towards the end of this period, a "rancorous spirit prevailed against those who showed signs of weakening" (Playne, 1959: 17). Where weavers protested against enforced idleness or attempted to work, the usual response was the arrival of a group of workers who duly removed the beam from the offender’s loom upon which, the hapless individual was carried to the nearest stream or pond and thrown in. In particular, Chalford suffered in this way and so much violence ensued that magistrates were forced to read the Riot Act, a troop of Horse subsequently being sent in to restore order.
It was perhaps inevitable that the weavers demands were not met and there followed a traumatic three months for the area, characterised by violence and intimidation. June saw the arrival in Stroud of a squadron of the 10th Hussars, brought in to restore and maintain the peace. The strike was eventually settled, having cost both the workers and the masters dearly.

In November of the same year, weavers again struck in parts of the county. In Wotton, the Neal Brothers tried to reduce wages further and with their supporters, shot and injured a number of protesting workers. Ironically, the Neals and their supporters were not prosecuted, however the rioters, injured or not, were charged! (Herrick, 1980: 40). In the Wotton area, full order was only restored by the arrival of a troop of the 12th Lancers.

Although this was not the end of disturbances in the region, it marked the peak of unrest. In 1828, when clothiers once again attempted to reduce wages, the weavers struck. This time the clothiers were perhaps better prepared and held their ranks. The weavers funds were soon exhausted and they were forced to return, accepting work at whatever rate was offered them. Effectively, this had been the last major effort by the weavers to obtain improved rates of pay and from now on, Gloucestershire manufacturers effectively had a free hand to organise the industry along whatever lines they desired.

At least part of the problem behind such strikes was an overstocked labour market, some workers having been displaced as a direct result of the increasing mechanisation of the industry in the region. Despite this, riots and unrest in Gloucestershire were rarely a direct response towards the increasing uptake of new machinery. There may have been at least some appreciation on the part of the workers of the importance of continuing the process of mechanisation in the face of competition from outside the region although it was sometimes suggested that worker opposition was sometimes capable of hindering this process. By way of example, Hawker cited the situation regarding the Painswick mills and noted:

"an hostility on the part of the mill hands to the introduction of machinery". (Hawker, 1945: 48-9).

In fact, the demise of many of the Painswick manufacturers was as a result of a combination of underfinancing, small businesses, plus perhaps the conservative nature of the manufacturers to alter long-established working practices. Worker opposition and unrest doubtless figured in the equation but probably only influenced matters to a small degree.

Like most of the periods of unrest that occurred in Gloucestershire, unlike Wiltshire, the 1825 strike had not been as a direct consequence of the introduction of new techniques or machinery into the industry. Rather, it was a complaint related to rates of pay and the equalisation of rates between
different masters. As Miles explained:

"In reference to the strike of 1825, it was for the advancement of wages; although when the differences were settled, and a scale of wages were agreed, three manufacturers had to reduce their wages to meet the adjusted rates...trade previous to the strike was very good; some of the manufacturers, however, were paying 12/- of 13/- a piece under others, and the weavers struck not so much on account of the general lowness of wages, as to maintain more equalised rates throughout the district". (Miles, 1839: 451).

Following this period, there were a few highly localised disputes in Chalford in 1828 and at Longfords Mill in 1834 (Loosley, 1993: 7). In the latter, 400 weavers and 200 other workers went on strike for seven weeks in an effort to increase wages. Following this, the clothier Playne gave up making stripes, the cloth at the centre of the dispute; the weavers had struck for an additional 10 shillings a piece, but such were the miserable profit margins at the time that it became uneconomic to carry on, and Playne withdrew from this market. (GJ. 8 March 1834).

As noted, almost without exception, new machinery was introduced into the Gloucestershire industry without significant opposition from workers. One exception reputedly came when the Playnes began the introduction of power looms at Longfords Mill. Arthur Long described the temporary unrest that occurred, suggesting that this happened during the 1830s, however, in 1839, Longfords Mill had but a single power loom and still relied predominantly on some 90 hand looms (Miles, 1839: 376. Also Smith & Lewis, 1976: 31). Presumably the disturbance occurred sometimes in the 1840s, a time when the power loom was beginning to have a significant impact on the local industry. Long commented that up to the power looms' introduction, the Playnes had relied on hand loom weavers, working in their own homes in Avening, Box and Minchinhampton. The weavers, fearing for their livelihoods, planned to converge on the mill and destroy the power looms. Fortunately for the Playnes, the attack was a long time in coming, by which time preparations to counter the threat had been made. By now, the Playnes' supporters had been armed with a quantity of "fearsome pokers...pointed steel rods, 2' 10" in length, capped with a miniature man's head in brass". When at last the weavers began to approach the mill, the men of Longfords advanced towards them and speedily repulsed the attack (Playne, 1959: 57). It seems that the weavers hearts were not really in their shambolic attack and there appears to have been no further attempts, either here or elsewhere within the district, to hinder the accelerating introduction of machinery. Essentially, mass organised strikes and disputes in the county were now a thing of the past. Even the Wiltshire and Somerset woollen districts were now quieter although in 1830, machinery had been damaged in a number of factories in the Salisbury area.

In Gloucestershire, Arthur Twisden Playne commented that outbreaks of unrest such as the great
weavers strike of 1825 were anomalous, and that up to 1915, the woollen industry in Gloucestershire had been little interfered with by strikes. With the 1825 exception, there had been very few disputes in the district between masters and men and "long may the good feeling which now exists continue with us, as disputes and strikes are beneficial neither to one nor the other" (Playne, 1959: 18). In 1952, his comments were further reinforced by those of Arthur Long, the then Chairman of Playne & Co, who noted that during the previous 40 years, strikes and violence had had no part in the working life of Longfords Mill, mainly because of the desire on both sides in the industry to talk, rather than fight. Indeed, such an attitude prevailed throughout much of the industry in the region.

Overall, with few exceptions, the Gloucestershire woollen districts remained relatively untroubled in these often turbulent times. When trouble did break out, it was generally associated with the lowness and/or disparities in the level of wages, sometimes allied with a period of high food prices. The introduction of innovative machinery or changes in organisation of the industry rarely sparked off trouble, unlike the woollen districts of Wiltshire, Somerset and Yorkshire, where rioting and machine breaking were far more common. Ironically, following the last major outbreak of unrest in Gloucestershire, in some instances, the relationship between masters and men increasingly became one of cooperation and not confrontation. Many of the old "gentleman" manufacturers, perhaps characterised by rather autocratic styles of management, were gradually replaced by new individuals, businessmen, schooled and skilled in the ways of commerce, with little social pretensions or desire to join the ranks of the local landed gentry. Inevitably, a great social gulf still remained between mill owners and their workers, although this was nowhere near as great as the yawning chasm that had existed with the gentleman clothiers of earlier years.

It became increasingly common for many workers to treat their masters with a degree of loyalty and respect that had rarely been encountered under the regime of the earlier clothiers. Such mutual respect ensured that strikes and riots disappeared from the local industrial scene. Until well into the present century, such loyalty to a particular manufacturer was not uncommon; workers often spent their entire life working for the same manufacturer, often followed by several successive generations doing likewise.

Thus, even though the history of the woollen industry in the Stroud region had rarely been marked by bouts of serious worker unrest, there were a number of occasions when disturbances did occur, leading to rioting and temporary mob rule. However, when set against the actions of their peers in the North and the other parts of the West of England clothing districts, such mass unrest remained a comparative rarity. More often than not, serious trouble only occurred when workers were faced with fairly desperate situations, almost invariably as a result of circumstances outside their control. When unrest did occur in Gloucestershire, it was usually associated with rates of pay and rarely did the
introduction of machinery directly play a part.

Characteristics that helped shape the Gloucestershire Workforce

The workers of the Gloucestershire woollen region seem to have had a combination of characteristics, unremarkable in isolation, but not necessarily to be found in such a combination in other cloth making regions. In particular, Stroud workers were considered to be both hard working and compliant, and compared to the unrest that marked periods of change in other clothing districts in the West of England and the North, very tolerant to change. It is interesting to explore why these particular characteristics were to be found in the area and to examine the effect that they had on the industry at large.

As in several other parts of the country, the Stroud valley workers were raised in a region where for centuries, almost the entire local economy had depended on woollen cloth. From early roots, starting as far back as the 13th century, this had formed the mainstay of local life. Initially, under the domestic system of manufacture, spinning and weaving had been carried out in virtually every corner of the region, with the entire family being actively involved at one stage or another. Traditionally, the skills of the father were passed onto the sons. Sons of weavers tended to become weavers themselves although in reality, there may have been little option for many. Thus, skills were passed on down through the generations as indeed were the tools of the trade. Weavers bequeathed looms to their sons and croppers did likewise. For example, when Thomas Clutterbuck died in 1551, he willed "two payres of tucker's shears" to his son (EM. November 1883: 8). Similarly, when Symon Clutterbuck died in 1558, he bequeathed his "brode loom" to his son and on Richard Clutterbuck's death in 1583, his will read:

"Unto my son Richard my best broade loome, and half the apparel of same. Unto my son John, I give my other loome, and the other half of the apparel equally to be divided". (ibid).

Apart from agriculture, cloth-making remained the prime means of employment for many of the local population. Movement remained difficult and as a result, to a large extent, the average cloth worker was effectively tied to his immediate locale and although he might be able to move to a different village, he was still likely to have been dependent on the cloth trade for his livelihood. Overall, there was little in the way of local employment that was not linked in some way to cloth manufacture and choices for many workers were limited. At the time, most workers still worked independently in their own homes and, even though some of their efforts might be directed towards agricultural-based activities, regular work was clearly an important factor in a family's survival - there can have been few more pressing influences or incentives to do a good job.
As the industry began to change and processes were increasingly gathered around the clothier’s fulling mill, so a further factor began to influence workers’ lives. In Gloucestershire, unlike many other clothing districts, the clothiers all lived in close proximity to their mills and there seems little doubt that the constant presence of the employer had an important effect; Cunningham noted that:

"...personal supervision by an employer was more effective than guild regulation" (Cunningham, 1905: 437).

It was also likely to be more effective than supervision by a hired third party, as was sometimes the case in other clothing districts such as Wiltshire. The establishment of such a system of capitalistic management was, over many years, to prove compatible with the increasing division of labour and ultimately, the introduction of new machinery into the industry.

An increasing number of stages of manufacture were gathered at the clothier’s mill and consequently, under the constant supervision of the clothier himself. Sometimes he actually lived in part of the mill itself and in other situations, his house was attached or only a few yards away. From here, he was able to keep watch on both his tenter racks and his workers, although clearly he had less direct control over the spinners and weavers who still worked at some distance in their own homes. Such was the case with Samuel Wathen’s Grigshott Mill at Woodchester, where his house was nearby, giving good views of his tenters and ensuring that he was always on hand. Other examples of clothiers houses situated at mills sites include the now-demolished Ebley Court (1587), Salmons Springs (1607), Egypt Mill house (1698), Merretts Mill house (1672) as well as those at St Marys Mill, Southfields Mills and Brookfield House at Millend (eg. Hadfield, 1973 and Hawker, 1945).

Organisational changes within the industry coupled with periodic depressions from the latter part of the 18th century onwards resulted in periods when the number of jobs available diminished. This doubtless acted as a further good incentive for those actually in employment to work hard. Surplus workers became a constant feature of the industry, their presence doubtless acting as a visible incentive for workers to toe the line. Competition for jobs intensified and mill masters were increasingly in a position to pick and choose their workers. In the parish of Eastington, the clothier Henry Hicks brought in many new workers for his mills. However, he was later criticised for only employing the best, the remainder being thrown onto the parish relief system (GCL. RR 118.7.(6). Overall, the incentives for an individual to work hard in order to ensure that his job remained secure was always there.
Particularly from the later 18th century on, as further manufacturing stages were gathered at the mills, the clothier was increasingly in a position to supervise directly the workers engaged in numerous stages of manufacture, controlling both hours of work, quality and throughput. Hence, workers throughout the entire production chain were now constantly supervised and controlled by their employer. In this respect, the situation prevailing in the Stroud valleys was somewhat different from some other areas. In Yorkshire, for a time, production remained predominantly in the hands of a much larger number of smaller clothiers, still often based in their own homes, hence production was not dominated and controlled by a handful of all-powerful masters. In other parts of the West of England clothing districts such as Wiltshire, as around Stroud, the industry was controlled largely by wealthy master clothiers. However here, the worker was not necessarily afflicted by the constant supervision of his employer as, unlike Gloucestershire, even Wiltshire clothiers of only moderate means frequently preferred to build often opulent residences and to live some distance from their mills, inhabiting towns such as Bradford-on-Avon, Trowbridge and Chippenham (For example, see Rogers, 1986: 38, 40, 41).

The direct supervision of the workers was delegated to a third party who, as a paid worker himself, may not have been as vigilant as the master. Doubtless the Stroud workers felt that their master was constantly looking over their shoulders.

Figure 23. 18th century clothiers house with attached warehouse, Lodgemore Mill.
Figure 24. The Grigshott Mill estate, showing close proximity of the clothier’s house

Figure 25. Pitts Mill, showing attached clothier’s house
The Effects of Nonconformity

A further trait that may well have influenced the workers' apparent propensity for hard work can be related directly to the religious background of the area. For several centuries, nonconformity was widespread in the Stroud valleys and this played no small part in the attitudes of many workers - the work ethic was central to many beliefs.

Nonconformity in the area can be traced back to the 16th century. In 1571, as part of the general repression of nonconformity, The Act of Uniformity was instigated under which all clergy were obliged to undergo episcopal reordination. Some 2000 refused and were subsequently ejected from their livings. Some ejected clergy found flocks waiting for them in the Stroud valleys; in Nailsworth, the Congregationalist body originated in the late 16th century, one of the first promoters being William Tray, the ejected rector of Oddington. Likewise, Congregationalists at Painswick had been active from the mid 16th century, from 1672 being assisted by Francis Harris, ejected curate of Deerhurst. Another clergyman active in the area was Daniel Capel, former rector of Shipton Moigne, ejected for nonconformity in 1622 (Fisher, 1975: 253) and in 1672, William Hodge, the former rector of Kings Stanley registered a house in Shipton for Presbyterian meetings (VCH. x. 255).

The existence of commerce and industry was found to encourage independency in religious expression and in several areas around the Stroud region, by the 17th century, nonconformity was flourishing. Many other societies of the older denominations also came into existence during this period (Nonconformist Chapels and Meeting Houses - Gloucestershire, 1986: 59-61). Nonconformity found a ready congregation in the Stroud valleys and beyond, cloth workers proving to be open to new ideas and religious philosophies. Into the valleys came a number of travelling Quaker preachers who established a rapport with many workers and attracted considerable support from various groups initially in Nailsworth and Painswick, but also at a series of other locations stretching as far as Bristol (ibid). For instance, many nonconformist meeting houses were established in France Lynch and Chalford, both thriving cloth-making communities housing large numbers of weavers. In the case of France Lynch, the first meeting house was set up in 1695 (Rudd, 1937: 301). These initial movements were followed by the establishment of the Presbyterians followed by the Calvinistic Independents (ibid). In a similar fashion, nonconformity spread elsewhere in the valleys and it became increasingly common for clothing villages to boast nonconformist congregations of between 100-300. (Glos Diocesan Records, 1756: 393).

Often, several nonconformist groups were active in the same centre. In Nailsworth, there were Quakers from the 1660s (GRO. D2052 and Glos. N&Q. ii. 37-8), Presbyterians from 1676, later
added to by Whitfieldian Methodists and Primitive Methodists. The situation of the hamlets that then constituted much of Nailsworth, bordering three parishes, plus their distance from their respective parish churches, was conducive to the establishment and growth of nonconformity. Here, as in so many other areas around Stroud, there were strong links with local industry, predominantly cloth manufacture (VCH. xi. 216). For instance, in 1608, a Quaker chapel was built with aid from the clothier families of Small and Yeats (ibid). Thus, a number of influential clothiers shared similar religious convictions to their workers. Although many workers, like the clothiers, were still scattered, they gained a unity from common religious beliefs. (Moir, 1957: 253). Some of the most important clothiers were associated with the nonconformist movement; for instance, various members of the powerful Marling family were members of the local Congregationalist church. (Walmsley, 1994: 67).

Of the Nailsworth nonconformists, the Baptists were the most dominant. In 1735, they had a congregation in excess of 300 and in 1851, this had risen to over 1000. Throughout its history, this included the leading industrialists in the region, such as the cloth making Clissold, Francis and Flint families, and the engineering family of H J H King; the latter’s activities were also inextricably linked with the local cloth trade.

In Stroud itself, nonconformity was established from 1576 (VCH. xi. 140) and the town subsequently played host to Presbyterians, Plymouth Brethren, Congregationalists, Wesleyans, Baptists and Primitive Methodists. In 1884, no less than 35 meeting places were registered for worship in the town (Hockaday Abs. ccclix). Nonconformity continued to flourish through to the late 19th century and beyond when the six main chapels claimed a regular Sunday school attendance in excess of 1400 (Libby, 1890: 98-9).

Eventually, the influence of the nonconformist movements spread to virtually all of the important cloth-making centres in the valleys. Even where workers were not allied to the beliefs of the nonconformists, doubtless their behaviour and work performance was expected to match that of the latter in order to retain their jobs, especially in an industry where surplus workers were usually present. It appears that nonconformity, directly and indirectly, may have played a significant part in the apparently positive attitude to work adopted by many of the Stroud valley workers.
Table 5
Major Centres of Nonconformity in the Stroud Area*

<table>
<thead>
<tr>
<th>Faith</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baptist</td>
<td>Bisley, Chalford, Eastcombe, Eastington, Kings Stanley, Nailsworth, Painswick, Stroud, Uley, Woodchester, Minchinhampton</td>
</tr>
<tr>
<td>Congregationalist</td>
<td>Cam, France Lynch, Dursley, Leonard Stanley, Nailsworth, Painswick, Stroud, Uley, Whiteshill, Ebley, Ruscombe</td>
</tr>
<tr>
<td>Methodist</td>
<td>Eastington, Stroud, Horsely</td>
</tr>
<tr>
<td>Primitive Methodist</td>
<td>Chalford Hill, Kings Stanley, Painswick, Rodborough, Stroud, Brimscombe, Selsey</td>
</tr>
<tr>
<td>Wesleyan</td>
<td>Minchinhampton, Painswick, Randwick, Stroud, Brimscombe</td>
</tr>
<tr>
<td>Friends/Quakers</td>
<td>Nailsworth, Painswick, Horsley, Avening, Rodborough</td>
</tr>
<tr>
<td>Presbyterian</td>
<td>Stroud, Woodchester, Shipton Moyne, Rodborough</td>
</tr>
<tr>
<td>Plymouth Brethren</td>
<td>Stroud, Nailsworth</td>
</tr>
<tr>
<td>Anabaptists</td>
<td>Woodchester</td>
</tr>
<tr>
<td>Swedenborgian</td>
<td>Chalford</td>
</tr>
</tbody>
</table>

* Based on Author's knowledge of the area

Such was the ongoing response from the Stroud cloth workers that many of the leading figures of the Evangelical Revival of the 18th century were lured there to preach. George Whitfield and John Wesley were both active in the area, the latter being instrumental in the setting up of the Rodborough Tabernacle, amongst others. Many of the local workers enthusiastically took nonconformity to their hearts.

That the services of nonconformist workers were often highly regarded can be gauged from the comments of the Stroud industrialist Joseph Watts, who reported that "The best servants I ever had were Rodborough Tabernacle men". He goes on to mention two individuals, one of whom worked for him for 30 years and another, for more than 40. (Fisher, 1987: 120).

The high incidence of nonconformity within the working classes was not limited to the Stroud valleys as many other industrialised regions were also affected to varying degrees. Although nonconformity
played an important role in the Stroud region from at least the 16th century, in many areas it continued to thrive in industrial communities well into the 19th century and beyond. As in the Stroud region, the established church found it difficult to communicate with many new industrial populations. Some, such as Stroud, were essentially a rural population, although in other locations they were primarily urban in nature. For instance, both Macclesfield and Congleton were strong centres for nonconformity from the mid 18th century and throughout much of the 19th. (Calladine & Fricker, 1993: 147-8). Here, Methodist teachings found favour with the textile workers and were adopted widely. In a similar fashion to Stroud, it also found a ready audience in some of the mill owners and manufacturers who appreciated its emphasis on hard work and self discipline. Mill owners sometimes built chapels for the local congregations or endowed schools and although in the case of Congleton, where the chapel was financed by the congregation, large amounts of money were sometimes donated by mill owners to the church or for other charitable purposes. (ibid, 148).

Similarly, in the Stroud region there were always clothiers who were prepared to make contributions towards the well-being of their workers and neighbours. As noted above, the Hoopers of Eastington were regular contributors and in 1851, paid for the restoration of the village church (memorial plaque in church of St Michaels) as well as providing financial assistance to the local Methodists (GRO. P127/VE 2/2). William Dallaway of Brimscombe Mill also supported the Methodist cause and supplied a reading room in Stroud (GRO. D873/T83) and the Stonehouse clothier James Hogg, donated much of the cost of the Congregationalist chapel and minister’s house in the village (GRO. P263/M19). Other donations came in the form of land, such as that given by the Wise family of Woodchester; this was used as the site of a new chapel. (Back, nd: 37). Such contributions were found throughout the Gloucestershire clothing districts and in the south of the county, the substantial cloth manufacturer Samuel Long of Charfield Mills belonged to the Rowlands Hill Tabernacle and contributed greatly towards the British School (Perry, 1986: 127).

Thus, the nonconformist causes in the region may have had a significant effect, both through the work ethic ("working for God") which formed a central plank in many beliefs and by the bonds formed between masters and men through the experience of shared ethical and religious beliefs. However, in isolation, nonconformity was not a guarantee of good behaviour on the part of the workforce. For instance, parts of east Somerset and west Wiltshire had a high level of nonconformity within their respective workforces yet continued to be regions that experienced significant worker unrest and agitation. Thus, nonconformity may have played an important part in many workers lives, but was clearly not the only factor in the generally positive attitude adopted by many Gloucestershire mill workers.
Compliancy

By essentially replacing the Lord of the Manor and other members of the landed gentry, the new major Gloucestershire clothier assumed the mantle of power that had rested with the aforementioned for many centuries. As Lee comments (Lee, 1993: 36) as late as the early part of the 20th century, in many situations a single individual or family still often effectively ruled the village or parish. In Lee’s case, the squire still reigned supreme over the village of Slad where those not employed in the cloth mills of Stroud were almost entirely dependent on him for their living, a situation that was commonplace.

As noted above, many gentleman clothiers actively sought the status traditionally enjoyed by the landed gentry that they were usurping, and bought up considerable estates, farms and tracts of land. Because of the poor transport and communication systems in the region, there was little opportunity for workers to travel far to their respective places of work, hence mills usually drew their workforce from the surrounding villages and hamlets. In many cases, the clothier not only owned the local mill(s) but also the cottages that the workers lived in. Consequently, to fall foul of the employer was not only risking the loss of employment, but also the house and garden or small holding that accompanied it. Thus, some of the major clothiers such as the Hicks, Sheppards and Austins, were effectively able to influence the activities of their workers and their families seven days a week.

This may paint a somewhat bleak picture although in some cases, wealthy clothiers appear to have enjoyed playing the role of Lord of the Manor and accepted the responsibilities that were traditionally associated with the position. This is not to imply that they were particularly liberal or tolerant in their views on lifestyle. Apart from the threat of the loss of employment and home as an incentive for hard work within the confines of the mill, as noted, some clothiers were able impose what they considered to be the appropriate moral and ethical code on their workers and tenants. The power and influence wielded at least on a localised basis could be considerable, and workers were understandably compliant in their dealings with their master. This was likely to have been a factor in explaining why so little unrest occurred in the Stroud valleys when new machinery and techniques were introduced.

It has been well established that as a major centre of woollen cloth manufacture, Gloucestershire suffered little of the worker unrest that seemed to accompany inevitably the introduction of new technology elsewhere. In the North, machine breaking, mill burning and the activities of the Luddites were to be encountered. In Wiltshire, the Gloucestershire clothing district’s nearest neighbour, frequent rioting, mill burning and even murder accompanied attempts by clothiers to introduce machinery such as the gig mill, for centuries in constant use just across the border. Overall, apart from occasional outbursts (see section - Unrest and Disruption) connected largely with particular local
issues, the history of the industry in the Stroud valleys was one of relative peace, even in times of severe depression when desperation normally drove hungry men to illegal and violent acts. Elsewhere, such periods were marked with civil unrest and periods of mayhem, but around Stroud, with a few exceptions, workers appear to have accepted their fate in a different way. Precisely why may be difficult to define, however, it is possible that the early days of the industry shaped the way in which the workers would react, even generations later. Such compliancy was not unnoticed, even at the time. In 1839, Samuel Sevill, in a letter to Augustus Miles, commented that:

"It has often been a matter of astonishment to me that the workpeople have submitted so quietly to their fate. One cause is, that their spirit was completely broken by their failure in 1828; another is, that they are scattered over a greater surface of country, in valleys and villages. By not coming in contact as often as they do in manufacturing towns, their manners are more simple and less turbulent. They have not the same facility of irritating each other, or laying plans for the redress of real or imagined grievances" (Miles, 1839: 455).

The fact that some workers remained scattered over wide areas doubtless inhibited the possibility of banding together in order to take orchestrated action over a particular grievance. Although the trend was to gather increasing numbers of workers together at mill sites, the complete transition from predominantly out-worker to factory-based hand took a long time in some areas. In Wiltshire, in 1833, even the powerful Trowbridge manufacturing concern of the Salter family only had 150 mill-based workers and still relied heavily on the services of 450 out-workers comprising spinners, weavers, dyers and fullers (Information supplied by Trowbridge Museum). Similarly, in the Stroud region, many clothiers were still heavily dependent on hand looms although by now, a large number of looms were in centralised loom shops at the mills. However, significant numbers remained cottage-based and even the progressive Playne clothier family were heavily (if not totally) reliant on hand looms located in villages around Longfords Mill until the 1840s. Thus, the opportunities of banding together were limited through personal isolation and perhaps the dominance of a particular master. In such a situation, it is hardly surprising that the majority of the workforce appear to have been reluctant to become "tainted" through complaint, a situation that would imperil their livelihood, let alone band together in order to oppose the introduction of new technology.

Thus, the average Stroud worker generally did what he was told. Even when the power loom began to displace hand looms from the 1830s onwards, there was no mill burning and little if any malicious damage or interference with the process. Eventually, the total dominance of the power loom, coupled with depressions in trade, would lead to great hardship for many hand loom weavers, as graphically described by several writers (for example, see Smith & Lewis, 1976: 28, and Moir, 1957: 249-252),
yet even here, although there were localised incidents born of desperation, there was little mass unrest. Workers eventually accepted pay cuts, emigrated or simply starved in their cottages. Perhaps their almost stoic acceptance of their misfortunes came from many years of what was effectively often industrial serfdom. With few exceptions, there appears to have been little stomach for pitched battles with troopers or constables brought in to keep the peace. How different to situations that had occurred in other clothing districts at various times.

This stoic acceptance of their fate continued throughout much of the 19th century. The society in which the workers lived and operated remained a hierarchical one, a society in which the Gloucestershire mill hand, like everyone else, knew his place and by and large, accepted it. This attitude was doubtless a hangover from earlier days, when the Lord of the Manor, followed by the wealthy clothier, and finally the all-powerful cloth manufacturer dominated and controlled much of their lives. For generations, workers had been conditioned to these arrangements and their relative subservience had its roots planted firmly in the past. Simply, there had always been a powerful central figure organising their working and often, personal lives, and even though there was inevitably some dissatisfaction with their lot, the average Gloucestershire mill worker rarely had the opportunity to challenge these long-established arrangements. Even where a degree of mistrust existed between workers and their master, shrewdly, the latter sometimes called upon an individual who might have been considered to have little sympathy for the industrialist. For instance, a member of the landed gentry was brought in to "address the troops" and to remind them that this was the natural order of things. In 1878, the German traveller Professor Von Holtzendorff wrote of his experiences when staying with the Lloyd-Baker family of Hardwick Court. Although not directly involved with the Stroud woollen trade, Barwick Baker was asked to address a meeting of some 300 Stroud workers, touching on a number of, sometimes contentious, themes. Von Holtzendorff noted that one of the major thrusts of Baker's address was to warn against strikes, a theme he had taken up before. Baker noted that the squire (such as himself) was not exactly enamoured with the consequences of manufacturing industry and that:

"...precisely for that reason they believe in us [as opposed to the millowner] because we exhort them earnestly to stick to work". (Von Holzendorff, 1878: 69).

Von Holtzendorff commented that:

"The prospect of hearing a large landed proprietor address a workmen's meeting in a manufacturing town was very attractive to me. The thought was convincing in itself that workmen, who regard their factory lords with a certain distrust, might more easily be reconciled to their situation by an intelligent
landed proprietor than by others, who, rightly or wrongly, are suspected of partiality" (ibid. 70)

He went on to note that what might have been seen as a hostile audience received Baker's two hour speech with loud applause and hearty thanks, even though it had addressed issues that were somewhat contentious. Thus, even at this late date, some manufacturers were still able to influence their workers' opinions and actions through such relatively subtle techniques, as opposed to, perhaps, heavy-handed actions of earlier generations.

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And so, much of the history of the Gloucestershire woollen industry was characterised by relative peace and a workforce that appears to have been more easily controlled than those in some other regions. During the industry's earlier phase, workers remained relatively isolated which greatly inhibited their capability to band together. In later years, surplus workers and direct supervision by an often-powerful master doubtless has a significant influence on the way they behaved and responded to changes within the industry. The effect of these factors is likely to have been considerable. On a more positive note, the widespread acceptance of nonconformist teachings and latterly, the Temperance cause, did give some feelings of unity, both within the workers' ranks and with some of their masters. Doubtless the equation between "carrot and stick" varied from location to location although the final result was a workforce that was frequently less troublesome than many others.
CHAPTER 6
SOURCES OF POWER

Introduction

Gradually, the woollen industry evolved from the cottage- to the factory-based system of production. Throughout this transition, the importance of a reliable source of power increased systematically. Initially, adopted to drive the fulling stage alone, ensuing technical developments ensured that an increasing number of stages of manufacture became powered; in the light of this, the importance of a reliable power source becomes apparent.

In the initial period of the industry's development, power had been supplied solely by hand, with, in some areas, animal power playing a significant role. However, it was the widespread adoption of water power that was crucial to the overall development and expansion of the industry.

Water power reigned supreme for many years but inevitably, there were seasonal problems of gluts or deficits. By the latter part of the 18th century, the initial tranche of crude steam engines had taken their first tentative steps towards breaking the industry's almost total dependence on water power and as the 19th century progressed and engines were further developed, thus increasing the attractiveness of this form of power, so the ratio of water:steam power began to change dramatically. However, as will become apparent, this pattern of change was not uniform and significant differences occurred both within and between the various cloth-producing regions. The attraction of a reliable form of power was obvious, but both water installations and steam engines could entail a heavy investment cost. Increasingly, as competition from within Britain and from abroad heightened in the 19th century, the capacity for 24 hour operations increasingly became a necessity and the importance of a reliable source of power increased still further.

The increasing importance of a dependable, economic supply of power for a textile manufacturer was clear. Water power had provided significant advantages over hand/animal power although even this was not without its obvious drawbacks. Similarly, when steam began to erode water's long established monopoly, it was sometimes a case of replacing one set of problems with another; early engines were often unreliable and expensive to erect and operate, but they established a base of experience from which later developments could spring. Later, newer forms of technology, predominantly in the form of electrical drive, obviated the need for both water and steam power and once again, a successor technology replaced an earlier one. In this case, adoption throughout the woollen districts was to ultimately become almost universal. However, although electricity was eventually to reign supreme in the field of power supply, the date and rate of takeup varied markedly between districts. In some
situations, especially in the Gloucestershire mills, the natural progression from water to steam to electricity did not occur and the former, often in combination with steam power, outlived similar installations in competing woollen districts.

Industry in the Stroud valleys relied predominantly on water power throughout the greater part of its existence. The availability of water power was the most crucial factor in the industry's initial development in the region and it continued to play an important role almost to the end. Its use was both extensive and widespread, with water-powered mills varying enormously in both scale and output. Inevitably, during the 19th century, as the industry reorganised and eventually contracted in the face of competition, steam power began to increase in importance. However, as the following section will show, the adoption of steam power was comparatively slow compared with Yorkshire and even Gloucestershire's more traditional local competitor, Wiltshire. Unlike these two regions, steam power was rarely adopted as the primary source of power, merely acting as a supplement for water power in times of shortage. Several factors help to account for the slow takeup of steam, some related to the attitudes of the manufacturers in the region and others to the retarding effect caused by the high costs and difficulties associated with obtaining reliable supplies of coal. Compared with manufacturers in the North, the scale of investment during the second half of the 19th century was much smaller in Gloucestershire; the "average" Stroud manufacturer was but a small fraction of his peers in the North and this inevitably restricted funds available for the adoption of what may have been perceived by some as a relatively unproven and unnecessary form of technology. Overall, the reasonably reliable water supplies around Stroud, combined with manufacturers' reservation about steam, combined to greatly impede the latter's adoption in the region. The background to this situation and the evolution of power supply in the local mills is explored in the following section.

Animal Power

In the Stroud region, horse wheels crop up occasionally, but more often than not, unconnected with cloth manufacture. For instance, small 18th and 19th century brickyards in the area, such as that situated on the parish border between Eastington and Frocester (Keys, 1953: 7), relied on simple pug mills operated by a horse, and at Frampton on Severn, a small tannery housed a bark grinding mill similarly operated (Mills, 1991: 7). There were a mere handful of instances where horse power may have been used in textile operations. At Daunceys woollen manufactory in Uley, a horse wheel is mentioned in 1814 (GCL. Rx319.1,10) although like the "horse wheel" referred to in 1591 at Millend Mills (GRO D540/T59; and Tann, 1967: 143) then a small fulling mill, there is no conclusive evidence as to their purpose. Similarly, a horse wheel may have been used in Chestnut Mill, Nailsworth, although again, this has not been fully substantiated (Falcoener, 1993: 64). A horse wheel was also recorded in connection with Oil Mill in Berkeley in 1802 (Herrick, 1980: 25-6). A further wheel was
used to power a small cloth mill in Vicarage Street, Painswick in the early 19th century (GJ. 10 October 1804), and Hyett suggests that three small mills or workshops in Painswick were oxen-powered, namely two premises belonging to Samuel Wood in 1820 and a building in Edge Lane being operated by Zachariah Powell (Hyett, 1928: 113). Later in the 19th century, the modest needs of a silk mill in Chalford were being met by a donkey gin (Lane, P, letter in GSIA Jnl (1977-8), p44). However, these few examples of animal power being used in connection with the textile trades remain isolated instances.

Competing clothing districts made much greater use of horses as a source of power. In mills of Lancashire and Nottinghamshire, as many as ten or twelve horses could be used; this power output was equivalent to many water-powered setups and steam engines of the period (Giles & Goodall, 1992: 124). By the late 18th century, the horse wheel had been fully developed and this gave many small manufacturers a greater degree of freedom in terms of the organisation of their business. Many horse-powered workshops were set up in towns, locations that had previously been denied a source of power through the lack of availability of water-powered sites.

Similarly, in parts of the West of England, horse power was used widely for a variety of purposes from at least the 16th century. From this time, instances of horse power being utilised for cloth making processes crop up regularly. A Salisbury clothier owned a horse-driven fulling mill in 1784, several workshops in Bradford were horse driven in 1794 and 1796, and in Warminster in 1807 and 1808, two workshops were powered by teams of three and four horses respectively (Rogers, 1986: 73). In the centre of Frome, a horse-driven workshop was in operation in 1813 and even as late as 1825, a factory in Calne was using horses to drive fulling, scribbling, cutting and brushing machines (ibid). A vertical 36ft diameter horse wheel was recorded in Trowbridge in 1796 (S&WJ. 9 May 1796). As mentioned above, the last known horse-driven mill in Wiltshire was in 1825.

Although horses fulfilled the power requirements of many small workshops, their use was not without its drawbacks. Horses were associated with high running costs and as early as the 1780/90s, steam was beginning to replace horses in some locations. By the early 19th century, only a few Yorkshire woollen mills were relying on horse-power and by 1834, only a solitary example remained in use (Giles & Goodall, 1992: 124). Thus, the use of horses was fairly widespread and installations occurred in many parts of the region although their use in woollen-related situations in Gloucestershire appears to have been minimal.

Whereas numerous small workshops in Wiltshire were powered by horses, the equivalent in the Stroud valleys appears to have been reliant on hand power. A particularly good surviving example of a workshop attached to a clothier's house is at Kings Mill, Painswick, where an L-shaped three storey
workshop is attached to a sizeable clothier's house. The upper floor is well lit by deep windows (Tann, 1967: 203; Also Falconer, 1993: 64). It appears that here and in most similar workshops in the region, hand power as opposed to horse power was used. Later, when power was adopted, it was almost inevitably water-based.

**Wind and Water Power**

Gloucestershire never had a great number of windmills and where these did exist, their use was exclusively for grinding corn. There is no indication that wind power ever played even an insignificant role in the developments in and around the Stroud region. Overwhelmingly, water was harnessed to provide motive power as a replacement for hand power, this being the initial reason behind the siting of the vast majority of the trades and industries in the area. In particular, the cloth trade gravitated to the valleys as a result of the large number of suitable sites available along the many streams and minor rivers. Cloth making declined in many traditional centres of manufacture, such as the cities of Gloucester and Bristol and the towns of Cirencester and Tetbury, at least partially as a result of the lack of mill sites. The wealth of available water power was the magnet that drew the cloth trade from all quarters of the county.

*Figure 26. Confirmed water-powered sites in Gloucestershire, 1820s (after Langton & Morris)*
Perhaps surprisingly, for much of the industry's history there appears to have been little in the way of an overall water management strategy guaranteeing that mills received a specified regular supply of water. This may have been a reflection of the essentially rural nature of the area. In contrast, there are indications that, for instance, in Cheltenham, at least some form of rudimentary control was exercised by the local authorities who insisted on regularly abstracting water for street cleansing purposes, despite protestations by mill owners (Pers. Comm. Miss A Chatwin). Similarly, in the Stroud area, along some stretches of the Frome, water was abstracted for feeding water meadows belonging to powerful local land owners. However, in general, water in the region appears to have been controlled on a very localised basis, with little overall strategy for its efficient use. The history of the industry is littered with complaints and squabbles between mill owners over unfair/excessive impounding of water, etc. to the detriment of neighbouring mills.

Some parts of the valleys were particularly well endowed with available water-powered sites. Playne described one such area close to Longfords Mill:

"The base of the Inferior Oolite rests on Bed No 4, called the Cotswolds Sands, sections of which may be seen on the Pensile Road, leading from Nailsworth to Minchinhampton, at Holcombe Mill and at the bottom of Iron Mills Hill. These act as a filter for the water, which by faults and slips, gets through the three upper beds and is then thrown out by the Upper Lias Clay at the base of the sands….The water power of the mills in the valley is mainly supplied by the springs from the base of the sands". (Playne, 1978: 10).
Thus, water formed an important resource for the local woollen industry and was harnessed ultimately to provide power for the vast majority of the valley mills. However, as the available water power in the valleys became heavily utilised and existing sites along the main streams became exhausted, minor tributaries and springs were also harnessed directly. Congestion increased and it was not uncommon for operation of mills further down the water courses to be hampered at times. This was to remain a problem until steam power supplemented and/or supplanted water power. Although arrangements differed from site to site, "typical" water supply arrangements area shown below:

![Figure 27. Water Supply Arrangements, Stonehouse Lower and Beards Mills (1880s)](image)

Mill sites along this particular section of the Frome were clearly blessed with better water supply than those higher up the valleys - en route to the Severn, the Frome collected the outfalls from several major and many minor streams, augmenting its flow. Where supplies were more marginal, quite ingenious water collection schemes were sometimes developed. At Eyles Mill, situated part way up the valley side near Uley, one of the oldest surviving cloth mills in the region still stands. Set up as a fulling mill and operated by John Eyles, the adjoining mill house carried his initials and the date 1687. The mill was powered by a small stream fed by springs a short distance from the mill, water being stored in a series of small linked ponds. Power requirements were presumably modest but it seems likely that the mill may have suffered from seasonal water shortages as a result of its relatively elevated position. This may have played a part in its early demise as a fulling mill (this ended c1700) although equally, competition from the larger mills situated in the Uley valley bottom doubtless had an influence (Tann, 1967: 131). Similarly, a small situated in the Slad Valley, up the valley side above Vatch Mill, used two small linked ponds. (Mills, 1993: 23-27).

During the first part of the 19th century, as the cloth trade gravitated towards fewer and fewer centres of production, into mills of considerable size, increasing efforts were made to ensure that a reliable supply of water would be available to power the mill even under drought conditions. Extensive mill ponds were constructed at a number of the larger mills including Lodgemore, Stanley and Longfords. At Stanley Mill, a lake of 5 acres was built to supply the mill’s five water wheels (Tann, 1967: 150) and at Longfords, the 15 acre pond that became known as Longfords Lake was created by the Playnes.
in 1806. Here, the main stream plus many of the springs that fed it were dammed. Initially, a high
dry stone wall was built (150 yards long and 30 feet high), puddled with clay on both faces and backed
with earth. Clearly, the pond required a tremendous amount of water to fill it and during this
operation very little water was allowed to run downstream, much to the chagrin of the other mill
owners. Playne commented that actions were threatened by every mill owner in the valley, but it was
represented that the storage of so large a quantity of water would be very useful in dry seasons, hence
the opposition was gradually withdrawn (Playne, 1952: 11). The total cost of these extensive works
amounted to £945, although the Playnes were not entirely convinced of its reliability. As a precaution,
their mills were built at right angles to the dam, away from the direct line of flow from the lake,
should the dam burst - it never did. Even in later years, when steam power had been installed, water
power remained of some importance and was to prove a valuable asset for well over a century through
the use of a water turbine used to generate electricity. (Playne, 1952: 152; and Wilson, 1992: 18-26).
One of the largest mill ponds outside the valleys was reputedly that of Nind Mills, Kingswood, where
the pond was fed by several streams (Tann, 1967: 93).

A good supply of water formed a strong selling point when a mill was offered for sale. Along the
Painswick Stream, seasonal shortages were a well documented problem, although this was glossed over
when the seller deemed it appropriate. In 1838, Baylis’s Upper and Lower Mills were offered for
sale. The particulars made great play of:

"... cloth manufactories to be let, both supplied by the same powerful stream of water, having
excellent fall thereto". (GJ. 10 March 1838).

Likewise, when Olivers Mill, also on the Painswick Stream, was offered for sale, emphasis was placed
on the fact that it had "a powerful stream of water (17ft fall)". (GJ. 2 March 1844). However, a
substantial fall of water was of little use where insufficient volume was available and this was certainly
the case at various times of the year. Wherever the mill was situated, the emphasis on a reputedly
good all-year round water supply was inevitably stressed when mills were put up for sale or lease.
At Griffins Mill, sales particulars of 1846 laid emphasis on the fact that the mill was:

"possessing water power unequalled by any mill on the stream" (Tann, 1967: 170), a phrase that
cropped up with monotonous regularity!

Similarly, Dunkirk Mills was reputed to have the best water power in the Nailsworth Valley. There
seems to be some truth in this assertion as four water wheels were still in working order up to c1940
(ibid. 231).
Despite the seemingly never-ending problems with water supply along the Painswick Stream, by 1822 only a handful of mills had installed steam power. Most were too small and despite the irregularity of supply (PP 1834. xliii. 16-18) owners often had insufficient capital to enlarge their mills or install steam power. Their relative isolation further hampered their prospects. At the time, only Brookhouse Mill (GCL. RR229.23) and Sheepscombe Mill (ibid) had installed steam power.

Water shortages were not limited to such lesser tributaries of the Frome; even the larger ones suffered at times and as a consequence, the installation of steam engines eventually became fairly widespread throughout the valleys, with the exception of Painswick. Even one of the most prodigious streams, the Nailsworth Stream, had frequent problems. One of the largest mills this powered was Days Mill, in the centre of Nailsworth itself. In an effort to even out the seasonal fluctuations, twin mill ponds (one for each wheel) were created by damming the valley bottom. Similar arrangements were also made for Egypt Mill, the next downstream. The Days Mill ponds amounted to over 3.5 acres and were supplied by the Nailsworth Stream. Under average conditions, water flowed into the ponds at a rate of 750 gallons a minute, which equated to 180 tons of water each hour (Davis, B. Unpublished MS). This was capable of providing sufficient power up to the 1840s, when a dozen or so power looms were installed in the newly built loom shed, the first in the area. Initially, power from the two water wheels was channelled through "an elaborate system of [line] shafting, although summer shortages and uneven running of the wheels continued to cause problems". (ibid).

What probably constituted the last working water wheel in the region (although Fromebridge Mill continued to use a turbine up to 1989) was at Brookhouse Mill, Painswick, formerly a cloth mill, later turned over to making pins. By this time, the millpond had been severely silted and reduced in size, necessitating auxiliary power in the shape of an ancient gas engine. It was the eventual demise of the latter that led to the final abandonment of water power in favour of electricity (Hadfield, 1973: 189).

Choice of Mill Site

As the cloth trade in the valleys began to develop further during the latter part of the 18th century, the number of suitable mill sites became exhausted and other less convenient sites came under investigation. Particularly after 1800, new mills appeared on every suitable, and some less than suitable, watercourses. Prior to this, the majority of existing mills occupied the same sites that had been in constant use for centuries (Hadfield, 1973: 195). Although a steady, reliable supply of water was a distinct advantage in many cases, it was by no means a prerequisite and many small mills were set up high along the valley sides, powered by minor streams or springs. In the case of the former, such streams were often dammed and their entire flow impounded in a small pond or series of ponds. When the mill was not in operation, the stream's flow was collected and stored in readiness for the
next bout of operation. There must have been instances where this mode of working was very inconvenient, however, for whatever reason, where a more suitable site was not available, such locations had to suffice. Indeed, in many cases, such part-time operation of a fulling mill was quite acceptable, the volume of business being such that this mode of operation was appropriate.

There were a number of instances where mills were set up, not powered directly by a stream, but taking their water from springs. Fisher noted that:

"...from the base of the abrupt and rocky hill which forms the Minchinghampton side of the valley, issue numerous small rills of water, called the Hundred Springs, and these, collected within the space of a quarter of a mile into an artificial channel, are of sufficient power to drive the machinery of a small mill; after which they fall into the River Frome". (Fisher, 1975: 149).

Several other examples were to be found in and around Chalford. For instance, Randalls Mill (later Spring Mill) and Mugmore Mills were both fed directly from substantial springs known locally as the Black Gutter. These burst through the side of the valley and drove the mills before exiting into the Frome via their respective tailraces (VCH. xi. 28). The volume of water was such that in 1830, Spring Mill was powered by no less than three water wheels (GRO. D1388/SL, n61).

Similarly, a small mill built c1780 by Timothy Butt stood just south of Tayloe’s Mill, driven by several small springs rising there (GRO.O,Q/RUM 146). A further example was to be found at Clayfields Mill, where a culverted spring fed the small millpond powering a grist, but later, cloth mill (VCH. xi. 28). Yet another example of a mill driven directly by a spring was to be found in the shape of (another) Spring Mill, this forming part of the Holcombe Mill complex above Nailsworth in the Avening Valley. Here, the spring was led into an iron pipe that fed it onto the water wheel.

Such arrangements were not limited to the Stroud valleys and in Dursley, Rudder noted that:

"On the south east side of the church-yard are many springs, which rise perpendicularly out of the ground like boiling water, in so copious a manner that they drive a fulling-mill at about a hundred yards distance below".

Clearly, seasonal fluctuations influenced the input of woven cloth to the many small fulling mills and could be very irregular and vary significantly in volume. Assuming that sufficient water was available at the appropriate times, it was therefore possible for mills to operate at only certain times of the year. As a result, successful working could be carried out with what now appears to be quite minimal volumes of water, primarily through careful husbanding of the resource and a lack of need for constant
operation. Surviving examples of mills of this type of mill and mode of operation are not plentiful, although along a tributary of the Painswick Stream, the Washbrook, are several small mills (long converted to dwellings) that are likely to have been worked in such a manner. The Washbrook itself is not large, and even accounting for the present flow having been reduced over ensuing years by the general reduction in water tables in the area, it is perhaps surprising that the main stream came to be harnessed to power such a number of mills. These included those that came to be known as Washbrook and Upper and Lower Doreys Mills. In the case of Upper Doreys Mill, the operations were surprisingly comprehensive considering the nature of the supply. Irrespective of this drawback, in 1825, there was still sufficient power to drive "five pairs of stocks, three gigs, and a washer, driving machinery in three floors" (GJ. 31 June 1825). The water wheel was of no less than 40ft in diameter, a size that seems inordinately large. It was perhaps inevitable, in a period where competition was gradually becoming increasingly stiff, shortly afterwards a 23HP steam engine had been added to the site.

In the vicinity, a number of even smaller streams feeding into the Washbrook itself were also used to drive small cloth mills. For instance, a tiny tributary which rises near Painswick House powered Littles Mill. Remarkably, in 1816, this minuscule stream was recorded as supplying sufficient power to drive carding and scribbling machines and jennies (Haine, 1984: 28). Operation of such mills was only possible through the careful collection of water into small ponds when the mill was not working. The problems associated with such seasonal variations in water supply was summarised succinctly by Matthew Rice's comments to the Factory Inspectors. His power at Smalls Mill on the Painswick Stream was:

"14 horse water power in winter, varying to only 7hp during four months in summer season. Supply of water during said four months is very irregular".

Despite great play frequently being made of the regularity of the water supply whenever a mill was offered for sale, the reality of the situation was sometimes different and the Factory Inspectors reports are full of responses of clothiers bewailing the problems of seasonal shortages. At Ham Mills, the Marlings reported that during the summer months:

"water was very short in the daytime and the shortest time of water is about 10 hp of water in the night. viz. from six in the evening to six in the morning... during summer months the water is very short in the daytime".

The implication here was that problems were twofold in that water was short in the day because of seasonal influences and other mills working/impounding water upstream, and that at night, the same
mills were impounding water in readiness for the next day's work. Similar problems were faced at nearby Hope Mills where the owners reported that water power amounted to about 10hp although it was also irregular in Summer. Seasonal variations, sometimes of great magnitude, were simply a fact of life in the region, and flows regularly halved or in extreme cases, could reduce to such a level that effectively, work in the mills came to a complete stop. Although the following figures are comparatively recent and probably not relevant in absolute terms, they do indicate the magnitude of the variation in flow that could be expected under even normal seasonal conditions. It becomes clear that although the flow of the Frome would be sufficient to at least partially power, for instance, Ebley Mill, smaller streams such as the Slad and Rushcombe Brooks could virtually dry up under extreme conditions.

Table 6
Measured Water Flows of Streams and Rivers in the Stroud Valleys

<table>
<thead>
<tr>
<th>Watercourse</th>
<th>Site</th>
<th>Summer</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frome</td>
<td>Chalford</td>
<td>30.0</td>
<td>53.0</td>
</tr>
<tr>
<td>Toadsmore Brook</td>
<td>Toadsmore</td>
<td>2.5</td>
<td>5.3</td>
</tr>
<tr>
<td>Slad Brook</td>
<td>nr. Stroud</td>
<td>4.5</td>
<td>8.0</td>
</tr>
<tr>
<td>Painswick Stream</td>
<td>D/S Mill</td>
<td>4.8</td>
<td>8.4</td>
</tr>
<tr>
<td>Rushcombe Brook</td>
<td>Humphries</td>
<td>0.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Nailsworth</td>
<td>Gatcombe</td>
<td>9.4</td>
<td>16.7</td>
</tr>
<tr>
<td>Nailsworth</td>
<td>Nailsworth</td>
<td>14.9</td>
<td>26.4</td>
</tr>
<tr>
<td>Nailsworth</td>
<td>Egypt Mill</td>
<td>23.3</td>
<td>41.3</td>
</tr>
<tr>
<td>Inchbrook</td>
<td>Inchbrook Mill</td>
<td>2.1</td>
<td>3.7</td>
</tr>
<tr>
<td>Frome</td>
<td>Ebley Mill</td>
<td>90.0</td>
<td>160.0</td>
</tr>
<tr>
<td>Frome (South arm)</td>
<td>St. Downtown</td>
<td>32.8</td>
<td>58.2</td>
</tr>
<tr>
<td>Frome (North arm)</td>
<td>Ryeford Mill</td>
<td>53.0</td>
<td>94.0</td>
</tr>
</tbody>
</table>


In times of water shortage, the start of the day's work frequently had to be delayed progressively until mills upstream, similarly hampered, started work and allowed water to flow downstream. In situations where production schedules were delayed by water shortages, mills were allowed to exceed the
limitations on working hours imposed by the Factory Acts and to carry on working (assuming sufficient water continued to be available) in order to catch up. Seasonal water shortages were a feature of virtually all major clothing districts and were certainly not exclusive to Gloucestershire. For example, parts of Cheshire suffered similarly and c1806, Edward Collier of Ingersley Vale Mill was forced to make use of:

"...a steam engine of eighteen horse power attached to his factory which he occasionally uses when the water is scarce and whilst the reservoir replenishes". (Calladine & Fricker, 1993: 63).

In this case, as in many others at the time, the introduction of steam power was primarily as a substitute for water power in times of shortage, as opposed to a means of extending capacity.

Water shortages were not always due entirely to the weather and there were instances where these resulted from abstraction of water for alternative purposes. At Upton Lovell Factory in the Wylyle Valley, Wiltshire, not only was operation hampered by the usual seasonal shortages but also when water was diverted to adjacent water meadows (Rogers, 1976: 247). It seems likely that some of the mills along the lower Frome may have been similarly affected by the watering of meadows.

There were many attempts made in the Stroud valleys to improve the flow of water reaching mill sites. This took a variety of forms including straightening and embanking channels, as well as water catchment and storage schemes. Especially along the lower reaches of the Frome, a series of river improvements were carried out over successive generations:

**River Improvements - case study: Lower Frome - Beards, Bonds, Churchend, Millend and Meadow Mills.**

The five mill sites considered were all powered by branches of the River Frome. In earlier centuries, the Frome had been considerably larger as evidenced by the scale and location of a number of gravel beds that it laid down along the valley’s edge (Anderson, 1977: 4). It may, of course, not have been restricted to a few distinct streams as the bottom of the lower Frome valley consisted of a maze of rivulets and swamp. Precisely when attempts to increase its usefulness commenced are not clear however at some stage, efforts were made to restrict the river’s course to a limited number of distinct channels. Tradition has it that much of this work was carried out by Flemish immigrants and although they doubtless turned their skills in this direction, certainly, some work had already been carried out much earlier.

Throughout the centuries, alterations and diversions were made in order to harness the Frome to drive
mills in Stonehouse and surrounding parishes (VCH. x. 268). At Ryeford, just outside Stonehouse, the river splits into three channels. It has been suggested that the monks of Gloucester Abbey may have been responsible for the construction of the watercourse to Stonehouse Upper Mill during the 11th century, or alternatively, improving an existing stream. The mill channel was known as the Yare and the main channel as the Banty (Stickleback) Ditch (ibid). Certainly, the mill stream was referred to as the "mill ditch of Gloucester Abbey" during the 11th and 12th centuries.

In all probability, the other main arm of the Frome which fed Beards and Millend Mills also existed in some form at the time of Domesday, although it was claimed in a dispute of 1653 that this channel had been made only recently by the men of Kings Stanley (GCL. RF289.6; Also VCH. x. 268). Possibly the latter had carried out further improvements to "their" section, however there is no doubt that this arm was being utilised to power mills at a considerably earlier date.

It is probable that at least some of these early works were carried out in order to reduce the perennial problem of flooding and to free up further amounts of potentially rich water meadow. Although there were a few small corn mills in existence at this stage, as a result of their modest size, alteration and improvements to the streams supplying them would have been relatively localised. There is unlikely to have been any "master plan" to control the river throughout the lower valley.

It was not until the 15th and 16th centuries, when the continuing expansion in the cloth trade prompted the construction of an increasing number of fulling and gig mills that further extensive works appear to have been undertaken. Clearly, there were only a limited number of suitable sites in existence, ones that were situated on the major arms of the Frome in order to ensure an adequate water supply throughout the year, yet not prone to flooding problems during the Winter months. Once these few sites had been used, it became necessary to create others. Attention was turned towards controlling the Frome that up to this time, ran towards the Severn via a network of streams and channels, some of which meandered wildly across the valley floor (Figure 28). Gradually, the river was channelled into only two or three main streams, these improvements being targeted towards either increasing the flow to existing mill sites or creating new ones. Some of these works were undoubtedly further alterations carried out on top of those made in earlier times.

Such improvements to the river's course may not have been due entirely to the efforts of those engaged directly in cloth manufacture. Adjacent land owners were doubtless encouraged to contribute to these works in order to reduce the amount of flooding and decrease the amount of land erosion that was inevitably caused by the many meanders. An added bonus was that not only was flooding reduced, but the removal of the meanders effectively created additional land on either bank of the river. As part of an abortive scheme of the 1760s, John Kemmett and his partners attempted to turn
the Frome into a navigable waterway. He carried out a number of similar realignments, also cleaning and dredging the river. In the meadows below Meadow Mill, he cut through numerous meanders, similar to those adjacent to Bonds and Beards Mills. Not only did the problem of flooding diminish, but additional acres of land were made available to adjacent land owners. This was succinctly summarised in 1775 when Thomas Lawrence, who was at the time, working Whitminster Mill, reported that:

"Mr Kemmett’s cut through Mr Stephen’s land had been a great service to the mills by preventing the frequent flooding which had often stopped the mills in earlier years" (Handford, 1979: 107).

Not only were the mill operators pleased with Kemmett’s efforts, farmers and land owners also benefited from the river’s improvements. In the same year, William Dutton, one of Stephen’s tenant farmers, thought that the land had been greatly improved by cutting off the meanders. This operation had actually given his landlord an extra acre of land and made the river much less likely to flood. Overall, he considered that the lands were:

"both better and more valuable since Mr Kemmett’s cut". (ibid).

A map of 1776 (Dallaway’s) showing the route of the proposed Stroudwater Canal confirms that Kemmett cut off no less than nineteen meanders along the lower Frome. Clearly, controlling the river was to the advantage of land owner and mill owner alike, and other areas along the Frome and its major tributaries were similarly treated.

It has often been said that there is little, if any, of the lower Frome’s course that has not been altered by the hand of man and the accuracy of this somewhat apocryphal statement can be substantially verified from both early maps and existing evidence on the ground. This shows evidence of many realignments and improvements made to the river’s course. A good example, although typical of many in the area, is to be found in the valley bottom between Bonds and Beards Mills. Examination of the map of 1730 shows the main Southern branch of the river, downstream from Beards Mill, to be full of meanders, although by the close of the century these had been cut through and the river straightened. A map of 1804 distinctly shows the remains of the earlier meanders which by the time of the first 25" O S maps of 1884, had disappeared largely from view. There is little doubt that the water courses feeding the five mills have been considerably altered over the years, and in some cases are likely to be completely artificial in nature (Figure 28).
The Mill Sites

The northern arm of the Frome powered Beards and Bonds Mills. As is sometimes found with other mills in the area, the former was originally built on a natural meander of the river, on what was almost a 180° loop. The tailrace was dug so that it emptied back into the main stream several hundred yards downstream from the mill. The layout probably existed in this form since at least the 1660s (the first references to a mill at this point) up to the time of the opening of the Bristol & Gloucester Railway in 1844. The construction of a huge viaduct and its associated embankments resulted in much of the 180° loop being infilled and the river realigned through only 90°, over a new weir in front of the mill. Upstream, the river also appears to have been straightened at an earlier date. As mentioned, the section immediately below the mill was also straightened between 1730 and c1800.

Once the waters had passed Beards Mill, they flowed on via a meandering section to Millend Mill. Originally there were at least two streams that flowed to Millend. It appears that the northerly one was straightened and deepened in order to improve water supply to the mill. The southerly stream was either deliberately closed off or simply dried up as a result of the river adopting the improved northerly route. The southern stream actually passed several hundred yards away from the mill site, hence without redirecting would have flowed to waste. The section immediately above Millend Mill has been heavily embanked for nearly a mile and this acted as a linear millpond, allowing water to be impounded and fed onto Millend’s wheels in a controlled fashion. The southern arm powered Bonds Mill, and the supply to this looks suspiciously straight, even on the map of 1730. This would imply that water improvements had been carried out at an even earlier date. The first definite reference to the use of this mill site comes in 1714, although it is highly likely to have been in use much earlier than this. There may have originally been some form of natural water course running to the site and this may have been suitably enlarged, however the entire section runs in an almost perfect line, starting from a meander around a mile up stream. This would have made a logical place to tap into the river in order to supply a man-made leat to the site. It is therefore entirely possible that this entire section is artificial in nature, and although only a few yards from the meandering original course, gave sufficient head of water to make use of at least breastshot wheels. None of the mills along the Frome’s lower section were able to use overshot wheels, the relatively flat nature of the land precluding this. The section of the river between Bonds and Churchend Mill still retains a few gentle curves although there is some evidence to suggest that John Kemmett was responsible for straightening part of this during the 1760s. It seems that Kemmett’s improvement work may have progressed beyond Bonds Mill before abruptly ending part-way to Bridgend. At this point, the river once again begins its meandering ways. A Stonehouse clothier speaking in 1776 was certainly of the opinion that Kemmett got this far, however it is equally likely that this section had already been straightened and deepened as part of an earlier scheme to improve the mill’s water supply.
Figure 28
River Realignments along Lower Frome (1730-1884)

1730
Beards Mill

1804
Beards Mill

1884
Beards Mill
At Churchend, a mill site from the 14th century, the approach to the mill is once again, suspiciously straight and it appears that the channel could be entirely artificial, having been tapped into a natural meander upstream. The old river course may survive as the small stream which leaves the existing main course, over a stone weir, running parallel to the mill leat. It rejoins downstream of the mill, flowing into the lower basin. There was an appreciable fall of water between the leat and the basin, quite adequate for breastshot wheels, although not sufficient for overshot wheels. The tail race for this section was straight, as indeed, was the entire downstream section. The latter had reputedly been constructed by the clothier Hicks c1800, although certainly some work had been carried out prior to 1790. Possibly this had been a result of Kemmett’s efforts. This section joins both the southern and northern arms of the Frome at their confluence at Meadow Bridge. From here, the combined flow passed to the site of Meadow Mill, built c1806. Here, a substantial millpond was created by impounding much of the river’s flow. This was further topped up by tapping the overflow near to Court Orchard Lock on the nearby Stroudwater Canal. The water for this would have otherwise run to waste via the Oldbury Brook.

Of all the mill sites considered, Meadow Mill had the most plentiful supply of water. By the time the Frome’s waters had reached this point they had been augmented by additional supplies from numerous other streams. The siting of Meadow Mill was eminently logical, as not only was it blessed with good water supplies, there was also an effective means of water removal once past the mill. The section immediately downstream had been considerably improved by John Kemmett’s scheme.

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This case study helps to emphasise the importance of reliable water supplies to the Stroud valley mills. Similar schemes were undertaken throughout the valleys, river realignments often being combined with the creation of mill ponds (Figure 29).
Figure 29. Water courses between the Lightpill and Dudbridge areas. Note the former
course of the stream (marked by the dotted line) and the new straightened
course to its left. Note also the mill ponds at both ends (OS Map 1901/2).

From the industry's beginnings in the region, good water supplies were crucial and this factor alone
was the most influential in the industry's development. Thus, there was a long history of river
alterations, redirections and general improvements in water management stretching back at least several
centuries. When water formed the only real source of power in the valleys, clothiers often went to
great lengths in order to initially obtain, then improve/conserve what was an important resource. The
importance of an adequate water supply becomes clear when considering the fate of other clothing
areas of the county that were bereft of suitable sites for water-powered mills; here, the industry simply
withered and died.

Eventually, the Stroud woollen industry came to be housed in a diverse selection of mills, varying
greatly in size and sophistication. In virtually all cases, water power was to remain of crucial
importance through almost to the eventual demise of cloth manufacture in the region. In the following section, the use and importance of water power to the Stroud industry is explored.

Mill layouts, ponds/reservoirs

As in other clothing districts characterised by a varied topographical makeup, the types and magnitude of water collection and utilisation schemes was diverse and ranged from mills fed directly by small springs or mill ponds, to substantial river realignments. As always, characteristics of each scheme were site-specific and reflected not only the physical nature of the site, but to some extent, the attitude and financial condition of the mill owner.

Each mill site had its own individual characteristics in terms of water flow rate and volume and local topography. It was these physical characteristics that influenced directly the type and scale of the water power system adopted, the nature of the water courses and any water collection scheme employed. Essentially, in general, five basic configurations were encountered, namely:

- **collateral** - where the mill stands immediately next to the stream with an external wheel located on the end wall. There were some examples of early mills of this type in the region.
- **bridge type** - here, the mill straddles the stream and uses internal wheel(s). Some variants found in the Stroud valleys.
- **island type** - the mill stands on an island and one arm of the stream acts as the bypass channel. Usually found on larger rivers and not found in the Stroud valleys.
- **bypass type** - where the mill (partially) straddles the stream with a bypass channel to regulate flow.
- **leat-fed** - mills of various design located some distance from the stream. Water conveyed to the site by artificial channel.

Often, although the particular configuration can be identified, mill sites encompass features of several of these types and categorisation is not always as straightforward as may at first appear. In addition, to a degree, the date had an influence on the type of system adopted. For instance, in Gloucestershire and elsewhere, the collateral layout is usually associated with early mills, often with an external wheel. More often, this layout was found with small corn mills and not the larger cloth mills of the region; doubtless early fulling mills in the area also used a similar configuration although evidence is lacking.

In the Gloucestershire woollen districts, variants of the latter two type of systems were the norm, with artificial leats being generally associated with overshot wheel configurations. Archival sources and archaeological evidence suggest that the most common arrangement comprised water supplies regulated
by the bypass type, sometimes, but not exclusively, used in conjunction with a millpond. Particularly along the lower Frome, mills used embanked upstream sections as linear millponds and here, the bypass arrangement was universal. Bonds Mill was typical of the mills along this section:

![Bonds Mill Diagram](image)

**Figure 30 - Bypass arrangement at Bonds Mill**

**Water Wheels**

In the Stroud region, the attractions of water power often outweighed its potential disadvantages. Apart from technical drawbacks, some Stroud manufacturers operated on a much smaller scale than many of their counterparts elsewhere, the result being that the industry was characterised by a process of gradual adaption/adoption of existing infrastructure as opposed to the sometimes preferable complete replacement. Thus, existing water power systems tended to be improved and upgraded as opposed to being completely replaced with steam engines.

Water wheels and their variants have been examined extensively (e.g. Fairbairn. *Mills and Millwork*, 1865 & 1871; Reynolds. *Windmills & Watermills*, 1970; Vince, *Discovering Water Mills*, 1980; Syson. *The Water Mills of Britain*, 1980; Wailes. *Windmills & Watermills*, 1981; *Industrial Archaeology of Watermills & Water Power*, Heinemann, nd) hence will not be considered in great detail here, however, a variety of wheels was originally to be found in the Stroud valleys, the majority being of the breastshot type; the undershot type of earlier days had been supplanted later largely by breastshot wheels. Simple, undershot wheels were undoubtedly used in profusion during the industry’s early phase however, like most forms of power supply, evidence has been obliterated by later technological advances.

Evidence suggests that up to the 18th century, many water wheels remained of the external type,
usually located on the end wall of the mill. Increasingly, there was a shift away from this exposed configuration to wheels housed within the mill itself. In purely technical terms, this eased problems of maintenance and power transmission, however, where the sometimes acrimonious riparian disputes arose between adjacent mill sites, the all-important source of power was now housed securely within the building itself or in a dedicated wheel house, safe from deliberate damage. Certainly, the majority of 19th century mills in the Gloucestershire woollen areas relied on internal wheels, ranging in number from one to five. Examples of mills using a single internal wheel included Daunceys Mill in Uley and Crowlbrook Mill at North Nibley. The larger factory mills obviously used a greater number of wheels, these including Bonds with three, Churchend with four, and Stanley and Millend with five. Occasionally, a fairly substantial mill still retained an external wheel, examples including the wide iron breastshot wheel used at Dark Mill and an external wheel of c30 ft diameter at Selwyns Mill in the Toadsmoor Valley (Tann, 1967: 217). These were essentially anachronisms and all of the major manufactories relied on multiple internally-located wheels.

In some circumstances prior to the advent of the factory mill, there had been something of a transitional stage, as the external wheel became internal. Several small early mills along the Painswick Stream show indications of formerly having been powered by an external wheel which was subsequently absorbed into the building by later rebuilding or extending. At Suttons Mill in Cranham, the structure and fabric of the mill suggest that the original mill was extended in such a way, the original outer wall/water wheel now becoming an internal feature. Likewise, downstream at Damsells Mill, a similar transformation appears to have taken place (Pers. Comm. Sir Foliot Sandford). At Nibley, Crowlbrook Mill may have also seen such a transformation, as evidence suggests an earlier exposed wheel being replaced by a substantial internal wheel during a period of rebuilding (Pers. Comm. Mr R Knapman. MP). No doubt, evidence of similar examples at other sites has been swept away over ensuing years.

A detailed analysis of the locations of the different types of water wheels in the region would clearly be useful. However, this information is regrettably difficult to come by and it has only proved possible to determine the type of wheels used for a limited number of Gloucestershire mills (see Table 7). Frequently, evidence that would have given such indications has been destroyed or obscured by later works. Where water courses, or their remains, survive, it is sometimes possible to deduce the probable type of wheel although in many cases, apart from the main channel itself, bypass channels and/or leats have been obliterated. Documentary sources can sometimes throw light on the type of
installation where frequently, although the presence of a water wheel is acknowledged, only rarely is its type referred to. Thus, attempts to produce a comprehensive survey of the types of water wheels used in Gloucestershire mills have proved futile. Despite these drawbacks, it is still possible to discern certain trends and on the basis of confirmed evidence, perhaps from adjacent mill sites, some patterns can be determined.

Clearly, topography played a major role in the type of wheel adopted, although as with many aspects, circumstances were often site-specific and not only depended on physical considerations, but also fiscal ones. Overshot wheels were generally associated with hilly valleys and narrow streams, falling with considerable velocity. Confirmed sites of overshot wheels are shown in Figure 32.

For instance, an overshot wheel, although of greater efficiency, might entail construction of a lengthy leat in order to provide sufficient fall of water, and such works could be costly. The mill owner might decide to compromise through the installation of a breastshot wheel, along with its more modest requirements in terms of earthworks, etc. In terms of mechanical efficiency, breastshot wheels lagged behind overshots; the former were generally of 55-60% and the latter, \(~ \sim 68\%\) (Vince, 1989: 10). Thus, the breastshot formed a good compromise, having much greater efficiency than the simple undershot (\sim 35\%) but without the often complex water supply system needed for the overshot. Where the topography was suitable, there were instances where a cluster of mills were driven by overshot wheels; the upper reaches of the Painswick Stream were a case in point. Near its head in Cranham, Suttons Mill used a 10 ft diameter iron overshot wheel fed by an iron pipe from a small pond, and further downstream in Painswick itself, Smalls, Kings and Lovedays Mills are all known to have used overshot wheels. Conversely, many of the other Painswick mills probably relied on breastshot wheels (although evidence is lacking), such was the site-specific nature of the choice.
Clearly, there were a number of alternative arrangements that could be used to generate a specific horse power and factors to be considered included the type, diameter and width of the wheel, the fall and volume of water available, the consistency of flow, the possibility of using multiple wheels, and the availability of land suitable for the construction of a mill pond. The final choice may have been dictated by the financial condition of the mill owner and/or the particular preferences of the millwright.

Occasionally, different types of wheels were to be found on a single site. At Holcombe Mill, above Nailsworth, the main mill appears to have been driven by several breastshot wheels plus at least one overshot powered by the main stream, although an additional structure subsequently added to the site between 1850-55 (Spring Mill) used a 20 ft diameter overshot wheel fed via an iron pipe directly from a large spring (GCL. RX210. 1; Also VCH. xi. 212). Thus, although topography was of importance, it was not the only factor along this upper stretch of the Nailsworth Stream. Upstream from Holcombe Mill, Iron Mills relied on a wide breastshot wheel, whereas downstream, Dunkirk Mills utilised several large overshot iron wheels, water being supplied by a long leat from two substantial ponds. Three iron overshot wheels still survive, at least one supplied by local ironmasters, the Ferrabees of the Phoenix Iron Works. Two wheels remain inside the 1818 block (10 ft diameter x 7 ft 6 inches wide) and one inside the 1855 block (13 ft diameter x 12 ft wide). A detailed invoice for one of the Dunkirk wheels survives (See Plate in Mills & Riemer, 1989: 33). Predominantly, the upper reaches of the Frome
and its tributaries, in regions of the greatest fall of water, were the domain of overshot wheels although their use was by no means universal and frequently, adjacent sites made use of breastshots.

As the various streams wended their way toward their confluences with the Frome, the fall lessened. Once beyond Stroud, this decreased further as the Frome and other streams made their way towards their outfalls into the Severn. Now, there was little choice in the type of wheels adopted, as the fall of water was insufficient to support the use of overshots. Consequently, virtually all of the mills in this lower region relied on breastshots for power. Thus, all of the Stonehouse and Eastington Mills were powered by breastshots. The one isolated exception in the lower region was the iron overshot wheel which operated the water-powered tannery situated in Leonard Stanley. However even here, the wheel was too large for the available fall from the small Bitton Brook, to the extent that throughout its working life the wheel suffered problems of backwatering. (Mills, 1991: 2-5).

The effect of decreasing fall of water on water-power systems over the length of a particular water course can be seen clearly along the River Ewelme/Cam. Close to its head near Owlpenn, the stream drove a single overshot wheel at Owlpenn Mill. Further downstream in Uley, Daunceys Mill was driven by a breastshot wheel, as was Dursley Mill on the outskirts of the town of the same name. Anomalously, a short distance away, Rivers Mill was driven by an overshot wheel. Further downstream, evidence suggests that all of the mills in and around Dursley and Cam relied on breastshot variants, whereas the last mill on the stream, Cambridge Mill, was driven by an undershot wheel. Thus, although Rivers Mill does not fit the pattern, there was a tendency for wheels to change from overshot to breastshot and even undershot, over the length of a water course.

In terms of sheer number, variants of the breastshot wheel comprised the majority throughout the major part of the industry’s history. These provided increased efficiency over undershots often without the frequently expensive earth and water works associated with overshot wheels and although later refinements resulted in the development of the Poncelot-type undershot wheel, evidence for the use of the latter in the district is lacking. Indeed, very few examples are known in the entire county. The breastshot wheel offered the most cost-effective power supply, giving significant advantages over earlier designs of wheel but without recourse to the added expense often incurred with the use of overshot wheels. Fairbairn (Fairbairn, 1871: 115-116) considered that some of the prime advantages of the breastshot wheel were:

- water was best applied to the wheel \( \sim 30^\circ \) from the vertical - this ensured that the support for the pentrough was much less expensive than for an overshot wheel.
- The breastshot wheel was more effective where the head of water was likely to vary widely. This characteristic allowed a mill pond to fall by 3-4 ft before refilling became necessary.

- The breastshot wheel was better suited to situations where backwatering was likely to occur and was capable of operating with a greater depth of backwater than overshots.

*Figure 33. Large external iron breastshot wheel at Dark Mill, c1880*
Table 7
Water Wheels - Examples of Confirmed Types of Installation

<table>
<thead>
<tr>
<th>Mill site</th>
<th>Water course</th>
<th>Wheel type</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grindstone</td>
<td>Little Avon</td>
<td>Overshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Hussingford</td>
<td>Little Avon</td>
<td>Overshot</td>
<td>Falconer. 1980. 29</td>
</tr>
<tr>
<td>Supea</td>
<td>Painswick Stream</td>
<td>Overshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Damsells</td>
<td>Painswick Stream</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Kings</td>
<td>Painswick Stream</td>
<td>Overshot</td>
<td>Ind. Glot. 18</td>
</tr>
<tr>
<td>Lovedays</td>
<td>Painswick Stream</td>
<td>Overshot</td>
<td>Haine. GSIA Jnl.</td>
</tr>
<tr>
<td>Smalls</td>
<td>Painswick Stream</td>
<td>Overshot</td>
<td>Haine. 1985. 15</td>
</tr>
<tr>
<td>Owleyn</td>
<td>Ewleme/Cam</td>
<td>Overshot</td>
<td>Mills &amp; Riemer. 1989. 144</td>
</tr>
<tr>
<td>Daucetys</td>
<td>Ewleme/Cam</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Dorsley</td>
<td>Ewleme/Cam</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Rivers</td>
<td>Ewleme/Cam</td>
<td>Overshot</td>
<td>Tann. 129</td>
</tr>
<tr>
<td>Middle, Cam</td>
<td>Ewleme/Cam</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Holmore</td>
<td>Ewleme/Cam</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Cambridge</td>
<td>Ewleme/Cam</td>
<td>Undershoot</td>
<td>Tann. 129</td>
</tr>
<tr>
<td>Egypt</td>
<td>Nailsworth Stream</td>
<td>Undershoot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Duskerk</td>
<td>Nailsworth Stream</td>
<td>Overshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Churches</td>
<td>Nailsworth Stream</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Iron</td>
<td>Avening Stream</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Holcombe</td>
<td>Avening Stream</td>
<td>Breastshot + overshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Spring</td>
<td>Avening Stream</td>
<td>Overshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Sehwn (adjacent to)</td>
<td>Toadmoor Stream</td>
<td>Overshot</td>
<td>Tann.</td>
</tr>
<tr>
<td>Crowbrook</td>
<td>Doverton Brook</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Ils</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>St Marys</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Dark</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Old plate c1900</td>
</tr>
<tr>
<td>Bourne</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Old plate c1900</td>
</tr>
<tr>
<td>Lodgsmore</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Fromsholl</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Bley</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Falconer. IA Review</td>
</tr>
<tr>
<td>Oil</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Stanley</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Pers comm. Mr M Griffiths</td>
</tr>
<tr>
<td>Stonehouse Upper</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Churchend</td>
<td>Frome</td>
<td>Breastshot</td>
<td>B &amp; Want Collins. map</td>
</tr>
<tr>
<td>Meadow</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Eastington Mag.</td>
</tr>
<tr>
<td>Milled</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Meadow</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Site visit</td>
</tr>
<tr>
<td>Fromebridge</td>
<td>Frome</td>
<td>Breastshot</td>
<td>Old plates. c1905</td>
</tr>
</tbody>
</table>

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The Arrival of the Suspension Wheel and Rim Gearing

Undoubtedly, the biggest advance made in the further development of the water wheel was the advent of the suspension water wheel early in the 19th century. Earlier designs had all relied on the wheel’s axle to transmit power into the mill, a potential source of weakness and a serious limitation on the amount of power available. With the suspension wheel, the size and weight of both the axle itself and the wheel’s arms were dramatically reduced. The axle was only required to support the weight of the wheel itself and the arms, to link the axle to the rim. Arms could now be manufactured from lightweight iron rods as they were no longer expected to act as levers. Although they now had little resistance to bending, as each was securely tied to the wheel’s centre, the rim was unable to deviate from its truly circular form. Power was now transmitted by a system of rim gearing, obviating the need for a substantial power-transmitting axle. Even with an iron axle, there was a limit to the power that could be carried, if the shaft diameter was not to become uneconomically large. Wheels were now often made almost entirely of iron, apart from, perhaps, paddles. With rim gearing, one face of the wheel comprised what was essentially a large iron gear, cast in sections and bolted to the wheel, which meshed with a small iron pinion gear. The pinion shaft rotated at high speed hence there was only a small torque involved. In contrast with earlier designs, the axle now experienced minimal torque and only had to be strong enough to support the weight of the water wheel and rim gear. Being made largely of iron, wheels were not only lighter but also less bulky, an added bonus where multiple wheels were being squeezed into the sometimes tight confines of the basement section of cloth mills.

The first known example of the suspension wheel/rim gearing was installed c1810 in the Strutt’s (West) cotton mill at Belper, driven by the River Derwent (Quoted in 'Rees’s Cyclopaedia’, v38 (1819) "Water"). Here, two suspension wheels worked side by side, operating as a single unit. Each was 21¼ ft in diameter and 15 ft wide; a wall supported the central bearings at the mid point. Each wheel utilised cast iron rims, with wrought iron rods acting as arms. Rim gearing was attached to the outer ends of the wheel, each driving a pinion carried on a common shaft. These were driven by the descending side of the wheel. (Gifford, 1994: 2-13).

Traditionally credited to the Manchester engineer T C Hewes, it now appears that William Strutt himself was responsible for the wheel’s design, Hewes acting as manufacturer and installer. Fairbairn was certainly of this opinion and even he could subsequently do little to improve on the basic design which he described as:

"...the most effective and perfect that has yet been introduced". (Fairbairn, 1871: v1. 120).
Throughout the 19th century, iron was the predominant material used for water wheel construction whatever the type, although wood continued to be used for the buckets in some cases. Some wheels had a remarkably long life span, operating well into the 20th century. Examples of iron suspension-type wheels around Stroud included Churches, Bonds, Stonehouse Upper, Ebley, St Marys, and Days Mills. The advances in design had helped to make some wheels a viable source of power until comparatively late dates; for instance, the 19th suspension water wheels of Ebley Mill were not removed until 1935 (Falconer, 1993: 62-80. Plate 14, from the Watkins Collection).

In terms of surviving examples of rim geared wheels in the Stroud region, these include a particularly good example at Fromebridge Mill. Here, an external 19th century iron breastshot wheel provided power for various uses via such a system (Figure 34). However, perhaps the most significant survivors are the wide iron breastshot wheel of c1840 which powered St Marys Mill, Chalford and the restored iron overshot wheels in Dunkirk Mills.

![Figure 34. 19th century iron breast shot wheel with rim gearing, Fromebridge Mill](image)

**Water Turbines**

It was not only water wheels that engineers concentrated on improving, numerous variants of the water turbine also being developed during the 18th and 19th centuries. Although the turbine is often viewed as a transitionary step between the water wheel and the steam engine, in fact, for many years, all three existed side by side. Water turbines had been in restricted use from the early 18th century (Mills, 1990: 53-59) although they initially had only limited impact on the overall use of both water wheels and steam power. Development of many variants was pursued by a number of manufacturers
throughout the world during the 19th century. Compared to water wheels, turbines had a number of advantages. They were generally much smaller for a given horse power, hence retrofitting into locations formerly occupied by a water wheel appears to have been relatively straight forward in many cases. The greater efficiency of later designs usually ensured that savings were made in water consumption. In addition, some designs could operate successfully on heads of water too low for a water wheel to utilise (Sales brochure. Gilbert Gilkes & Co. 1898). The output shaft from many designs rotated at a much higher rate than a water wheel shaft which often reduced complications of gearing, etc. between the power source and the end use. This was particularly useful when used in textile mills (as opposed to corn mills) as was the tendency for some designs to be self-governing (Crabtree, 1983: 45-60). Thus, potentially, in many situations the turbine had a number of advantages over even relatively sophisticated water wheels.

Overall, how much impact did the turbine have on the Stroud industry? Although not numerous, the advantages offered by the turbine were recognised by a handful of mill owners in the area but in most cases, their dates of installation came surprisingly late. Even though steam power became available widely, additional costs were clearly associated with its use; water power, despite its drawbacks, still had a part to play and where manufacturers judged its continuing use to be cost-effective, it was retained. For a handful of manufacturers, the turbine was a logical choice, especially where water supplies were deemed to be adequate. For instance, a large unit was installed at Stanley Mill, at what was considered to be a state-of-the-art cloth manufactory. Here, an 80 hp turbine was installed in 1868. (Tann, 1967: 150).

Overall, there was little general pattern to the turbine’s uptake in the region, schemes ranging in scale from substantial manufactories to small mills. The smallest and one of the earliest turbines to be installed in the region was not related to textile manufacture but was used to power dairy and milling equipment housed in the great tithe barn at Frocester (Price, 1970: 222-229). Two Whitelaw & Stirrat turbines were installed some time between 1859 and 1881, the larger of the two being used sporadically up to the time of the Second World War. Power output of this unit was of the order of 5-8hp. Such relatively meagre power was clearly not suited to textile mill use. In addition, water consumption of even these small units was excessive.

The period from the 1860s onwards saw marked improvements in the efficiency and power output of turbines. Earlier designs were typified by low efficiency and the requirement for large volumes of water. Even the diminutive Whitelaw & Stirrat unit at Frocester reportedly emptied the millpond at an alarming rate and flooded the village street downstream (Pers. comm. Mr E Price of Frocester Court).
Many of the more powerful turbines installed in textile mills came later in the 19th and the first quarter of the 20th century. For instance, examples of turbines installed in Yorkshire woollen mills included Gayle Mill in 1879 and Glasshouses Mill in 1871 and the 1890s (Giles & Goodall, 1992: 132). Thus, the 80hp Stanley Mill turbine was on a par with what is often viewed as more progressive areas such as Yorkshire. However, as in many other respects, Stanley Mill was the exception to the rule in the Stroud region, as water turbines made little impact on the powering of local mills, a combination of water wheels and steam engines being the norm.

Predominantly in the north of England, during the latter part of the 19th century, many textile mills installed turbines either as a direct replacement for water wheels or to boost overall power output (examples are given in Table 8). In the case of Stanley Mill, it is interesting to note that in the previous year (1867) new high pressure steam engines had been installed at the mill; here, we find the rather unusual situation of a water-powered system post-dating a steam one.

Table 8
Examples of Gilkes Turbines installed in Textile (cotton) Mills in the North of England*

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Output (hp)</th>
<th>Type</th>
<th>Flow (cu.ft/sec)</th>
<th>rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarry Bank Mills</td>
<td>1904</td>
<td>20</td>
<td>Francis</td>
<td>7</td>
<td>291</td>
</tr>
<tr>
<td>Quarry Bank Mills</td>
<td>1904</td>
<td>200</td>
<td>Trent</td>
<td>79</td>
<td>231</td>
</tr>
<tr>
<td>Stanley Cotton Mills</td>
<td>1908</td>
<td>100</td>
<td>Lunedale</td>
<td>59</td>
<td>248</td>
</tr>
<tr>
<td>English Sewing Cotton, Stockport</td>
<td>1919</td>
<td>51.5</td>
<td>Turgo</td>
<td>59</td>
<td>212</td>
</tr>
<tr>
<td>Belper Mills</td>
<td>1926</td>
<td>45</td>
<td>Francis</td>
<td>43</td>
<td>204</td>
</tr>
<tr>
<td>Masson Mill, Matlock</td>
<td>1928</td>
<td>205</td>
<td>2 x</td>
<td>212</td>
<td>90</td>
</tr>
<tr>
<td>Milford Mills, Belper</td>
<td>1936</td>
<td>340</td>
<td>Francis</td>
<td>257</td>
<td>110</td>
</tr>
<tr>
<td>Dean Clough Mills, Halifax</td>
<td>1949</td>
<td>115</td>
<td>Francis</td>
<td>23</td>
<td>750</td>
</tr>
</tbody>
</table>

(* Based on sales records supplied by Gilkes & Co.)

It was usual to find turbines supplying only part of a mill’s power, not solely responsible for all of it. Thus, the combination of turbine and steam engine at Stanley Mill was mirrored by a similar
combination at Apperly-Curtis’s large Dudbridge Mills where a 50hp turbine supplemented the power
supplied by a pair of large steam engines. Where turbines were adopted in Wiltshire, similar
combinations were encountered, such as the large Staverton Factory where, in 1897, a 50hp Gilkes
turbine supplemented the power of a 100hp compound tandem horizontal engine supplied by Pollitt

In Gloucestershire, a number of more modest schemes were also installed, although most of these
considerably post-dated the Stanley Mill installation, all dating from the close of the 19th century and
beyond (Table 9). At Oil Mill, Ebley, a former fulling mill turned over to corn milling, a water
turbine of unknown provenance was installed c1910 by a Mr Lane (Pers. comm. Mr M Smith. 1987).
In this instance the intention was not to supply mechanical power directly to the mill, but to drive a
dynamo, producing electricity. The scheme failed to live up to expectations and was dogged with
technical problems, becoming known locally as "Lane’s Folly". Part of the turbine and its attendant
infrastructure still survives. A smaller installation was also constructed at Iron Mills in the Nailsworth
Valley, providing electricity to a large house.

Further downstream, a water turbine possibly supplied by the Kendall-based company of Gilkes was
installed at Fromebridge Mills around the same period although the fact that the company’s records
show no installation here, infers that it was probably installed second-hand from another site. The
turbine replaced one of a pair of iron breastshot wheels. Remarkably, the turbine still survives in full
working order and was the sole means of mechanical power in use up to the close of the mill in 1990
(Pers. comm. The late Mr S White of Fromebridge Mills).
### Table 9
Water Turbines installed in Cloth Mills in Gloucestershire

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Output (bhp)</th>
<th>Maker</th>
<th>Type</th>
<th>Flow (cu.ft/sec)</th>
<th>rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stanley Mills</td>
<td>1868</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Mills</td>
<td>1893</td>
<td></td>
<td>HJH King</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Mills</td>
<td>1895</td>
<td></td>
<td>HJH King</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Mills</td>
<td>1895</td>
<td></td>
<td>HJH King</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toadsmoor Mills</td>
<td>1916</td>
<td>4</td>
<td>Gilkes*</td>
<td>Francis</td>
<td>2.35</td>
<td>567</td>
</tr>
<tr>
<td>Dudbridge Mills</td>
<td>pre 1904</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longfords Mill</td>
<td>1920</td>
<td></td>
<td>Gordon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wallbridge Mill</td>
<td>1929</td>
<td>37.6</td>
<td>Gilkes</td>
<td>Francis</td>
<td>70.8</td>
<td>96</td>
</tr>
</tbody>
</table>

### Table 10
Water Turbines in Non-cloth Use in Gloucestershire

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Output (bhp)</th>
<th>Maker</th>
<th>Type</th>
<th>Flow (cu.ft/sec)</th>
<th>rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>R A Lister, Engineers</td>
<td>1895</td>
<td></td>
<td>Kings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J Humpidge, Woodchester</td>
<td>1901</td>
<td></td>
<td>Kings</td>
<td>Flume</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Mill</td>
<td>c1908</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fromebridge Mills</td>
<td>c1910?</td>
<td></td>
<td>Gilkes? (S/H?)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E Peterson, Stroud</td>
<td>1925</td>
<td>8.5</td>
<td>Gilkes</td>
<td>Francis</td>
<td>8.75</td>
<td>390</td>
</tr>
<tr>
<td>Meadow Mill</td>
<td>c1920?</td>
<td></td>
<td>2 x ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron Mill</td>
<td>1912</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea Mills, Berkeley</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coaley Mill</td>
<td>c1920?</td>
<td></td>
<td>C L Hett</td>
<td>Trent</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c1905</td>
<td></td>
<td>Armfield</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erinoid, Lightpill Mill</td>
<td>1926</td>
<td>24</td>
<td>Gilkes</td>
<td>Francis</td>
<td>33.8</td>
<td>166</td>
</tr>
</tbody>
</table>
Thus, it appears that the water turbine played little part in the Stroud woollen industry although at New Mills (Wotton), Tubbs & Lewis were clearly great proponents of the system. New Mills had always been blessed with a good water supply from the Little Avon and during the 1890s, water wheels were replaced with turbines. Three Kings turbines were installed between 1893 and 1895 (GRO. Kings Order Book No 1. Orders dated 24 January 1893, 11 February 1895 and 21 October 1895). The last of the three was used to drive power looms. Kings also supplied an assortment of associated control equipment to the site; turbine No 3 was equipped with a Kings speed governor in 1895 and a "float governor to turbines (Nos 1 and 2) to couple to two gates and gear", ordered in the same year. The turbines apparently gave good service and Kings repaired the weaving shed turbine in 1911 (ibid).

Kings also supplied a 32 inch equilibrium turbine to the Dursley engineering firm of R A Lister in December 1895; much of the latter’s success had been based on supporting the local cloth trade. Interestingly, in 1911, Kings took an order for a number of Pelton wheels. Two were of 15 inch diameter and rated at 7.5 bhp at 970 rpm, and three of 18 inch diameter, rated at 3.75 bhp at 824 rpm (ibid). Their destination is unknown although it is highly unlikely that they were used locally. The Terrett Brothers, formerly millwrights of Wotton-under-Edge took over the old H J H King engineering works in the Newmarket Valley and carried on turbine manufacture for some time. It is believed numbers were small, customers presumably preferring to opt for alternative non-water power sources by this time.

Thus, overall, the uptake of the water turbine in Gloucestershire was limited. In Gloucestershire as a whole, cloth mills installing turbines were limited to Stanley, New, Dudbridge, Wallbridge and Longfords Mills. Apart from the latter, all provided mechanical power as opposed to generating electricity. The small unit installed at Toadsmoor Mills post-dates cloth manufacture and was installed during its flock making phase. With the exception of Stanley Mills, the majority of turbines installed were at a relatively late date, mainly from the 1890s onwards. Compared with the power output of turbines being installed in textile mills in the north of England during the same period, the Gloucestershire turbines were modest, once again, reflecting the differences in scale of textile operations in the two regions, and indeed, the size of the average Stroud business in general. Similarly, turbines installed in other cloth mills in the West of England, like Gloucestershire, were also of modest output although a few such as the Staverton Factory in the Avon Valley, were comparable in output with many of the northern turbines (Table 11). The latter was something of an exception in the region as a whole, and was able to capitalise on a relatively reliable water supply of sufficient volume; many other sites within Wiltshire did not share this benefit.
Table 11
Gilkes Turbines installed in Cloth Mills in Other Parts of the West of England

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Output (bhp)</th>
<th>Maker</th>
<th>Type</th>
<th>Flow (cu.ft/sec)</th>
<th>rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staverton Factory, Avon Valley</td>
<td>1897</td>
<td>50</td>
<td>Gilkes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spencer Moulton &amp; Co, Bradford</td>
<td>1900</td>
<td>38</td>
<td>Gilkes</td>
<td>Vortex</td>
<td>79</td>
<td>34</td>
</tr>
<tr>
<td>Churchyard &amp; Sons Woollen Mills, Totnes</td>
<td>1903</td>
<td>25</td>
<td>Gilkes</td>
<td>Vortex</td>
<td>14</td>
<td>190</td>
</tr>
<tr>
<td>Ray Mill, Chippenham</td>
<td>1925</td>
<td>29</td>
<td>Gilkes</td>
<td>Francis</td>
<td>73</td>
<td>116</td>
</tr>
<tr>
<td>Ray Mill, Chippenham</td>
<td>1934</td>
<td>13.5</td>
<td>Gilkes</td>
<td>Francis</td>
<td>21</td>
<td>175</td>
</tr>
</tbody>
</table>

Summary - the Merits and Demerits of Water Power

Overall, water had significant attractions for mill owners in Gloucestershire, many of whom were strong proponents of this type of power. On a local level, many developments were made in its use. However, Gloucestershire was not alone in this as significant advances were also being made in other textile districts. Some of the most important developments took place in the sphere of mechanised silk throwing, with the construction of Cotchett’s and Lombe’s water-powered mills in ~ 1704 and 1721 respectively. These comprised the first such textile factories in the country and set the scene for a series of others built in Cheshire in the later 18th century. These developments took place significantly earlier than the introduction of powered cotton and wool processing. In the case of the latter, like Stroud, significant developments were also taking place in the North. For instance, Leeds was one such centre of innovation of the woollen trade. Here, Benjamin Gott built his fire-proof woollen mill in 1805-7 and continued to make further advances and developments in the powered processes of woollen manufacture.

Although in many manufacturers’ eyes, water power was essentially a "free" source of power, it was not without its well-documented drawbacks. On the positive side, water power systems were tried-and-trusted, an important point to the conservative clothiers of the Stroud valleys. Almost like a battery, during the night, water could be accumulated in ponds ready for the next day’s operations. Systems were pollution-free and the water released from one mill passed down the water courses to be used again in those below. On the negative side, the very presence of so many mills along the
same stream inevitably led to times when mills were unable to work as a result of too much water being impounded by those upstream. This could lead to a cessation of operations or at least, night time working. Clearly, water formed a limited and/or variable resource; there were often times when too little or too much was available. In dry seasons, flows reduced or streams even dried up. At wetter times of the year, mills could be flooded or damaged or at the very least, lose power through backwatering of water wheels, as stream levels rose unacceptably high. Flooding could result in expensive repairs to civil works associated with water power installations.

In addition, the costs involved in the construction of the larger millponds created especially during the 19th century could be considerable, both in terms of labour and purchase of land. Additional costs were sometimes involved in the purchase of water rights. A further drawback sometimes occurred as a result of the individual nature of each mill/water power system. As each was almost inevitably tailored to a specific site, repair times could be lengthy. Components were often constructed for a particular mill, the requirements being dependent on local topography, etc. Hence, for instance, a damaged wheel axle could involve a long period for its replacement.

In light of the above, it becomes apparent why steam power was increasingly adopted by mill owners, anxious to ensure that they were able to carry on operating as and when necessary.
The Introduction of Steam Power

Adoption of Steam Power into the Gloucestershire Mills

Steam power came to be adopted widely into Britain’s textile mills. Even when the technology was still in its infancy, some textile manufacturers remained in the forefront of its on-going development and exploitation. Over the course of a century or so, steam engines were advanced from expensive, crude, unreliable machines to highly efficient sophisticated forms of power. Their impact on the woollen mills of the Stroud district throughout this formative period is examined in the following section.

Pumping Engines

The first use of the steam engine in textile mills was based around the Newcomen-type engine, used to pump water back from the water wheel’s tailrace into the mill pond for reuse. The first reliable engines were developed in the early 18th century and pumping engines were in use at such sites as Low Mill, Keighley, c1780 (Giles & Goodall, 1992: 133) and Shudehill cotton mill (built 1782) near Manchester (Williams & Farnie, 1992: 50-51). At this stage, engines had not been developed sufficiently to drive directly textile machinery hence were limited to this type of operation. During the 18th century, many Yorkshire mills adopted this form of auxiliary engine and at least 35 such examples are known, mainly in textile mills, before 1800 (Giles & Goodall, 1992: 133-134). Their consumption of coal was heavy but despite this, they clearly found favour in a number of locations. The coal consumption for a Newcomen engine used for pumping duties was noted as 32lbs of coal per horse power per hour (Law, 1965: 28).

Such installations of this type used engines of small power, typically 4-6hp, and clearly were only pressed into service when seasonal water shortages demanded it. Apart from Yorkshire, there is little to suggest that this system was adopted widely in other woollen districts although there may have been the occasional example in Wiltshire. At Home Mills, Trowbridge, sales particulars of 1885 mention four engines, one of which was a 12hp beam engine associated with a wheel house containing an 18ft diameter overshot water wheel. The River Biss, at this point, would have been unable to provide a sufficient head of water for such a wheel (Rogers, 1976: 131-3). Thus it appears that the engine was used to pump water up to the wheel and had probably existed since 1842; even by this date, such a system could be considered outdated. Precisely why such an archaic system survived in use up to this comparatively late date is not known however, it does confirm that at least one pumping installation was operating in Wiltshire. Another relatively late survivor was still working c1820; this had been
suitably improved with automatic valve gear and was powering a workshop in London (Law, 1965: 6). In Gloucestershire, there is no documentary or archaeological evidence to suggest that such pumping systems were ever installed; the first definite reference to a steam engine in the county did not come until 1799 (in Bristol, which then formed part of Gloucestershire). Doubtless the enormous coal consumption of these early engines reduced significantly their attraction for the West country clothiers (Rogers, 1976: 36). The lifetime of the pumping engine was relatively short as the design and construction of rotative steam engines advanced to the point where they were capable of driving directly textile machinery. Apart from exceptional circumstances, this obviated the need for pumping engines. It seems unlikely that many survived beyond the first few decades of the 19th century.

**Later Developments of the Beam Engine**

As the steam engine was developed further, it became possible to adopt rotary motion to drive machinery directly, as opposed to pumping water for reuse in water power systems (for instance, see Greatrex, 1986: 37-56). In Gloucestershire, the first tranche of steam engines of this type installed in woollen mills were supplied exclusively by Boulton & Watt (Table 12).
Table 12
Boulton & Watt Engines Supplied to Gloucestershire Cloth Mills*

Sun & Planet Engines

<table>
<thead>
<tr>
<th>Customer</th>
<th>Date</th>
<th>HP</th>
<th>Cylinder &amp; stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthony Amott &amp; Co, Woollen</td>
<td>1799</td>
<td>12</td>
<td>19.25&quot; x 4'</td>
</tr>
<tr>
<td>Manufacturer, Bristol</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Boat Type Engines (side lever)

<table>
<thead>
<tr>
<th>Customer</th>
<th>Date</th>
<th>HP</th>
<th>Cylinder &amp; stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wyatt &amp; Co, Vatch Mills, Stroud</td>
<td>1823</td>
<td>20</td>
<td>--- x 2' 6&quot;</td>
</tr>
<tr>
<td>E &amp; T Neal, Wotton</td>
<td>1823</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Richard Ford, Wotton</td>
<td>1825</td>
<td>20</td>
<td>26.75&quot; x 2' 6&quot;</td>
</tr>
<tr>
<td>Samuel Long, Charfield</td>
<td>1825</td>
<td>20</td>
<td>26.75&quot; x 2' 6&quot;</td>
</tr>
<tr>
<td>William Long, Kingswood</td>
<td>1827</td>
<td>20</td>
<td>26.75&quot; x 2' 6&quot;</td>
</tr>
<tr>
<td>Edward Davies, Stonehouse</td>
<td>1824</td>
<td>30</td>
<td>31.5&quot; x 3'</td>
</tr>
<tr>
<td>Nathan Driver, Peghouse Mill,</td>
<td>1825</td>
<td>30</td>
<td>31.5&quot; x 3'</td>
</tr>
<tr>
<td>Stroud</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E &amp; T Neal, Wotton</td>
<td>1825</td>
<td>50</td>
<td>39.5&quot; x 3' 6&quot;</td>
</tr>
</tbody>
</table>

Independent Engines

<table>
<thead>
<tr>
<th>Customer</th>
<th>Date</th>
<th>HP</th>
<th>Cylinder &amp; stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>H Hicks &amp; Sons, Eastington</td>
<td>1818</td>
<td>10</td>
<td>19.75&quot; x 2' 6&quot;</td>
</tr>
<tr>
<td>W &amp; P Playne, Dunkirk</td>
<td>1820</td>
<td>14</td>
<td>--- x 3'</td>
</tr>
<tr>
<td>Humphrey Austin, Alderley</td>
<td>1820</td>
<td>14</td>
<td>--- x 3'</td>
</tr>
<tr>
<td>Davies, Beard &amp; Davies, Leonard</td>
<td>1821</td>
<td>14</td>
<td>--- x 3'</td>
</tr>
<tr>
<td>Stanley</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H Hicks &amp; Sons, Eastington</td>
<td>1821</td>
<td>14</td>
<td>--- x 3'</td>
</tr>
<tr>
<td>Humphrey Austin, Alderley</td>
<td>1821</td>
<td>10</td>
<td>19.75&quot; x 2' 6&quot;</td>
</tr>
<tr>
<td>J &amp; W Strange, Wotton</td>
<td>1822</td>
<td>10</td>
<td>19.75&quot; x 2' 6&quot;</td>
</tr>
<tr>
<td>W &amp; P Playne</td>
<td>1823</td>
<td>10</td>
<td>19.75&quot; x 2' 6&quot;</td>
</tr>
<tr>
<td>R &amp; W Helme, New Mills, Stroud</td>
<td>1823</td>
<td>14</td>
<td>--- x 3'</td>
</tr>
</tbody>
</table>

Small Side Lever Independent Engines

<table>
<thead>
<tr>
<th>Customer</th>
<th>Date</th>
<th>HP</th>
<th>Cylinder &amp; stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>H &amp; G Austin, Wotton</td>
<td>1802</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>
There is nothing to suggest that any form of steam installation in a Gloucestershire mill predates that of the Austins in Wotton-under-Edge who installed a small Boulton & Watt engine in 1802. This was followed a few years later by the first sizeable engine ordered by Edward Sheppard and installed in his burgeoning Uley mill in 1805. The latter remained almost the sole herald of the new age for almost a further decade and it was not until 1814 that the Playnes took delivery of their first engine. Four years later they were followed by Henry Hicks of Eastington, long time business partner of Sheppard, who installed the first of his five engines in one of his mills. Hence, the dawn of the new century was notable for the small number of engines installed in the county and their relatively minimal impact on the local woollen industry as a whole. Their appearance did not trigger a rush to install engines in the region and indeed, it was to be two decades following the installation of the first engine before significant activity was to occur in this field. Indeed, even before 1800, Boulton & Watt had been involved with the construction of ~500 engines nationally, with only a tiny minority coming to the West of England (Law, 1965: 15).

These first four engines were all installed by major manufacturers; the Austins, Sheppard, Playnes and Hicks all operated on a considerable scale and were doubtless in a stronger financial position to investigate the use of steam, compared to the myriad of smaller manufacturers in the region. At the time, the price of a Boulton & Watt engine was considerable and their purchase clearly reflected the status of the manufacturer. It could be construed that many of the latter adopted a 'wait and see' policy, monitoring the usefulness of these first engines before following suit, however two decades

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**Beam Engines**

<table>
<thead>
<tr>
<th>Customer</th>
<th>Date</th>
<th>HP</th>
<th>Cylinder &amp; stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edward Sheppard, Uley</td>
<td>1805</td>
<td>14</td>
<td>20.75&quot; x 4'</td>
</tr>
<tr>
<td>N S Marling, Lodgemore Mills, Stroud</td>
<td>1814</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W &amp; P Playne</td>
<td>1814</td>
<td>14</td>
<td>20.75&quot; x 4'</td>
</tr>
<tr>
<td>R P &amp; G A Smith, Wallbridge Mill, Stroud</td>
<td>1821</td>
<td>24</td>
<td>--- x 5'</td>
</tr>
<tr>
<td>D Lloyd &amp; Co, Uley</td>
<td>1821</td>
<td>20</td>
<td>--- x 5'</td>
</tr>
<tr>
<td>Harris, Stephens &amp; Co, Stanley</td>
<td>1822</td>
<td>40</td>
<td>32.5&quot; x 6'</td>
</tr>
<tr>
<td>Hicks &amp; Sons, Churchend Mill, Eastington</td>
<td>1822</td>
<td>24</td>
<td>--- x 5'</td>
</tr>
<tr>
<td>H &amp; E Austin, Wotton</td>
<td>1823</td>
<td>32</td>
<td>--- x 6'</td>
</tr>
<tr>
<td>W Overbury, Avening</td>
<td>1822</td>
<td>14</td>
<td>--- x 5'</td>
</tr>
<tr>
<td>Henry Wyatt, Vatch Mill, Stroud</td>
<td>1825</td>
<td>30</td>
<td>29&quot; x 5'</td>
</tr>
<tr>
<td>Hicks Brothers, Eastington</td>
<td>1826</td>
<td>30</td>
<td>--- x 5'</td>
</tr>
</tbody>
</table>

* Based on information supplied by N Kingsley, Boulton & Watt Collection, Birmingham Library Services.*
seems an inordinately long time to consider the matter. Undoubtedly, the major factor was financial, only the larger manufacturers being willing to risk sizable sums of capital required.

During the initial period of steam's adoption in the West, there are some indications that the size of the engines differed between regions. In Gloucestershire, pre-1805, engine sizes varied between 6-24hp whereas in Wiltshire, many of the engines installed during the same period tended towards the lower end of the range. For instance, Cooper & Sons of Trowbridge installed a 6hp Boulton & Watt engine pre-1805, there were several small engines of ~3hp near Bradford c1808, as well as a number of others around Trowbridge, Chippenham and Bratton (Rogers, 1986: 81-82). The reasons for the comparatively small size of many of the Wiltshire engines probably reflects the fact that much of the industry, unlike Stroud, was urban-based and was being carried on in small workshops and other premises that were reliant on hand or horse power. By contrast, in the Stroud valleys, the wide availability of water power ensured that this form of power predominated and where steam engines were installed, they were to supply perhaps virtually all of the mill’s power requirements but only in times of drought, hence their higher capacity.

In Gloucestershire, during the first half of the 1820s, Boulton & Watt engines were being installed at the rate of around five a year. These engines were essentially of three variants:

- Boat engines (power range 20-50hp)
- Independent engines (power range 10-14hp)
- Beam engines (power range 14-40hp)

Over this period there were some indications that engines installed were becoming more powerful although as ever, factors influencing power requirements remained site-specific. The most powerful engine (50hp) was the boat engine supplied to E & T Neal of Wotton-under-Edge in 1825 although many others fell in the 10-20hp range (Table 13).

It appears that all of the engines supplied during this period came from Boulton & Watt. In Yorkshire during the same period, the company’s business remained only limited and even before the expiration of the Watt patents in 1800, local manufacturers were pirating various aspects of the design and supplying the woollen industry with their own engines (Gregory, 1983: 200). This does not appear to have happened in Gloucestershire. The first Boulton & Watt engine installed in a Yorkshire mill was in 1792 and by 1800, there were a total of 14 (Giles & Goodall, 1992: 135). During the 1820s, in terms of power output, most Yorkshire engines fell into the 10-40hp category, however, the occasional engine was bigger. In 1824, the most powerful engine in the area was the 70hp engine at...
Marshalls Mill, Holbeck (ibid. 136). This was two or three times the size of the average Stroud engine.

**Figure 36. Details of Churchend Engine House, Eastington. Boulton & Watt plans of 1822**

Section through Churchend boiler house  
Section through one of the Churchend boilers

The configuration adopted at Churchend Mills was typical of that to be found at many Gloucestershire sites that installed Boulton & Watt engines.

In Yorkshire, it was not long before local competition in the form of Fenton, Murray & Wood of Leeds and the Low Moor Iron Company of Bowling both began supplying mills with engines of their own design and manufacture. By the close of the century, Boulton & Watt's competitors had supplied a total of around 80 engines into Yorkshire woollen mills. These were made up of a combination of
pumping, beam and rotative engines (ibid). Of these, it appears that the beam engine predominated. By this time, over 35% of the mills in the West Riding had some form of steam power (Gregory, 1983: 74).

Wiltshire took its fair share of Boulton & Watt engines although here, they later came to face competition from George Haden of Trowbridge, Fisher of Frome, Rogers of Frome, and Spencer & Gillott of Melksham, all producing their own design of engine destined for the county's cloth mills (Rogers, 1986: 110). Similarly, in East Cheshire, there were six engines in textile mills before 1809 (Calladine & Fricker, 1993: 65). Here, as elsewhere, local engineering firms were able to supply engines more cheaply than Boulton & Watt and in addition, were more easily available for maintenance work. In the region, engine suppliers competing with Boulton & Watt included Francis Thompson of Chesterfield, Bateman & Sherratt of Salford, Galloway & Bownan of Ormerod, and Joshua Wrigley of Manchester (ibid. 60).

Steam engines produced by a particular manufacturer were not necessarily sold only to local customers and despite the obvious difficulties associated with transportation, engines sometimes travelled considerable distances. Apart from the Boulton & Watt engines already alluded to, pre-1812 the Salisbury clothier Ambrose Courtney bought a 4-5hp engine with a 12ft flywheel made by a Mr Woods of Oxford (Rogers, 1976: 254). Similarly, in Peter Warren's Warminster mill, the odd combination of a horse wheel and a 10hp steam engine by Bramah & Sons was used to grind corn and drive cloth making machinery at the site (ibid. 242).

**Competition**

Until 1796, Boulton & Watt restricted the provision of engine parts supplied directly by themselves to valves (although all of their later engines were supplied complete). Apart from these, customers were provided with a set of drawings and the services of an engine erector. Thus, much of the engine was sourced and manufactured by local suppliers. Cylinders were often produced in local foundries and timber for the main beam etc. was similarly acquired. Consequently, it was not difficult for local engineers to become proficient at building engines of their own. After all, effectively it was they who were actually constructing a considerable proportion of many engines ostensively built by Boulton & Watt. In addition, it was not unknown for Boulton & Watt's own engine fitters to set up in business on their own. This is precisely what George Haden did, establishing his business in Trowbridge in 1816 (Rogers, 1986: 82. Plus information supplied by Trowbridge Museum). In this case, he continued to act as agent for Boulton & Watt but also manufactured his own steam engines (ibid).
Especially with early Boulton & Watt engines, running costs could be high and some engineers attempted to achieve the same or better levels of efficiency without infringing the Watt patents. Consequently, many, what were referred to as "mongrel" engines, combining various aspects of both Boulton & Watt and individual engineers' design, appeared in the latter part of the 18th century. Less scrupulous engineers simply built engines of the Boulton & Watt design without paying the appropriate premiums (Trinder, 1987: 73-4). George Haden does not appear to have been one of the latter and it was not until c1824 that he built his first small engine. By the 1830s he had supplied several engines to mills in Wiltshire, one of which was a 50hp unit installed at Cradle Bridge Mills, Trowbridge, one of the biggest in the area (Rogers, 1986: 82). At a somewhat earlier date, John Dyer also of Trowbridge, built his first engine (in 1811), installed in the Silver Street Mill. By 1816, he had sold ten others. Despite such local competition in Wiltshire, Boulton & Watt during the period 1805-1828, supplied 27 engines to the region.

Apart from striving to bring down running costs of Boulton & Watt engines, local builders also attempted to bring down capital costs involved. In some cases they were quite successful. The 12hp engine that John Dyer installed in Upper Greenland Mill, Bradford, cost £600. This compares with the cost of the Playne's Boulton & Watt engine installed around the same time at Longfords Mill, which cost them £970. Indeed, by the time the Playne's bought their next two engines in 1823 and 1826, Boulton & Watt's prices had fallen accordingly, the cost having been driven down significantly by the competition.

Operational Experience

A great advantage of most early types of beam engines was their relative simplicity although in the early years, there were certainly some problems with the standard of engine manufacture plus a shortage of skilled engine operators. Often, fairly constant maintenance was required (Giles & Goodall, 1992: 136). However, although component parts inevitably broke or wore out, it was often possible to continue operations over long periods of time, increasingly maintenance being provided by local engineers. Although by the 1830s alternative types of engine were already having an impact, beam engines frequently carried on giving stalwart service for decades, often with a minimum of attention. Remarkably, some engines carried on in regular use until well into the 20th century although by this time most had been compounded or "McNaughted". In 1845, John McNaught of Bury introduced a system whereby the efficiency and power of beam engines was increased by adding a high pressure cylinder between the beam centre and the flywheel end. Steam of higher pressure than had previously been used, after driving the new cylinder, passed into the old (low pressure) cylinder.
where it was further expanded. This system was adopted widely in order to boost the output of existing engines no longer capable of meeting the increased demands placed on them by the addition of more machinery. Apart from boosting power, McNaughting also improved fuel economy, an added bonus. Such uprating was responsible for extending the working lives of many engines that would otherwise have had insufficient power to drive the particular application (Enc Brit. 1970. v21. 180; and Williams & Farnie, 1992: 134-5). In the Stroud valleys, mills still relying at least partially on a beam engine included Nodes (1896), Brimscombe (1906) and Lewiston (1906). McNaughting or compounding was carried out by H J H Kings on a number of engines including five beam engines in Bourne and Nailsworth Mills, c1880, and the Lower Toadsmoor Mill engine in 1891. In some cases, efforts had been made to increase overall efficiency. For instance, at Dunkirk Mills, during a stack rebuild of 1875, a Greens Economiser was fitted. This preheated the boiler feed water using waste heat escaping via the stack (Wilson, 1991: p49).

Efforts to increase the efficiency of steam plant continued and by the early part of the present century, a number of the larger mills were installing increasingly efficient superheater systems; at least some of these were supplied by H J H King. In 1905, Apperly-Curtis of Dudbridge Mills ordered:

"1 patent 3 unit superheater with 4 inch pipes, tees, thermometer, front 2'6" and grate 2'6" wide, side examination door, deadplates and 3 4" peet valves" (GRO. Kings Order Books. 1905. Entry 2938).

Similarly, in the same year P C Evans & Sons of Brimscombe Mills ordered an independently-fired superheater and Marling & Co, of Stanley Mills ordered a similar arrangement to the Dudbridge unit except here it was to be:

"...delivered and fixed by your man, you to find 1 unskilled labour and doing necessary brickwork. £210-0-0" (ibid. Entry 2992).

From an early date, simpler efforts to restrict heat loss from pipes had been made and it became common practice to lag pipes. The millwright/engineer George Haden noted that:

"Those pipes not wanted to give out heat should be well coated with straw rope and plaster" (note on plan of Churchend Mill. Boulton & Watt Collection. pf474).

The last surviving beam engine in a Gloucestershire woollen mill was the c1840 engine of Ebley Mills. This had been compounded c1875 to boost its output to ~100hp (Falconer, 1993: 77) and was still in situ up to 1938 when it was broken up for scrap (Walrond, 1967: 177).
Such longevity was also not unknown elsewhere. At least one beam engine in Wiltshire had an even longer working life. At Bitham Mill in Westbury, a beam engine of 1829 provided the power until 1939. This had been uprated in 1858, being McNaughted by the addition of an extra cylinder. In addition, the stroke was lengthened from 7 ft to 8 ft and the stroke rate increased from 17 to 28 strokes per minute (Rogers, 1976. 121). Similarly, in 1885 the power requirements of Home Mills in Trowbridge were being met by a combination of four steam engines, producing between them 127hp. One was a 35hp Hadens beam engine installed some time before 1862 and not removed until 1921. Clearly, the Haden engine was still providing a sizable percentage of the mill’s power requirements (ibid. 131).

In 1952, A T Playne of Longfords Mill, commented when referring to one of the three Boulton & Watt engines installed between 1815 and 1826:

"one of these early engines was only scrapped three years ago" (Playne, 1952: 47).

Although its last period of operation is not known, to have survived so long gives an indication of the long working lives enjoyed by some early beam engines.

Thus, as the 19th century progressed, an assortment of engines of varying capacity and manufacture were installed in Gloucestershire mills. Frequently, these were subsequently replaced on several occasions. Confirmed engine installations are as follows:
Table 13
Details of Steam Power Installations in Gloucestershire Mills

<table>
<thead>
<tr>
<th>Mill</th>
<th>Earliest recorded Date</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steep, Wotton</td>
<td>1802</td>
<td>Sun &amp; Planet 6 hp B&amp;W small side lever independent engine. Steam power alone</td>
</tr>
<tr>
<td>Framilode</td>
<td>1803</td>
<td>B&amp;W 24hp</td>
</tr>
<tr>
<td>Sheppards, Uley</td>
<td>1805</td>
<td>B&amp;W 14hp beam. 1837 40, 28 and 20 hp engines</td>
</tr>
<tr>
<td>Stranges, Wotton</td>
<td>1808</td>
<td>Small supplementary engine</td>
</tr>
<tr>
<td>Lodgemore</td>
<td>1814</td>
<td>B&amp;W. 1875 2 x 35 hp</td>
</tr>
<tr>
<td>Longfords</td>
<td>1815</td>
<td>B&amp;W 20hp; others 1823 and 1826. c1897 Compound King engine.</td>
</tr>
<tr>
<td>Waterloo, Wotton</td>
<td>1815</td>
<td>Non-B&amp;W engine. Steam power only</td>
</tr>
<tr>
<td>Old Town, Wotton</td>
<td>1817</td>
<td>20hp non-B&amp;W.</td>
</tr>
<tr>
<td>Bonds, Stonehouse</td>
<td>1818</td>
<td>B&amp;W 10 hp independent. New horizontal engine in 1923</td>
</tr>
<tr>
<td>Neals, Wotton</td>
<td>1820</td>
<td>Small Trevithick supplementary engine. 1823 20hp B&amp;W; 1825 27 and 50hp B&amp;W</td>
</tr>
<tr>
<td>Hillesley</td>
<td>1820</td>
<td>14hp B&amp;W</td>
</tr>
<tr>
<td>Dunkirk</td>
<td>1820</td>
<td>B&amp;W 14hp. 1977 Excelsior engine</td>
</tr>
<tr>
<td>Alderley</td>
<td>1820</td>
<td>B&amp;W 14hp independent. 1821 10hp B&amp;W independent</td>
</tr>
<tr>
<td>Upper Cam</td>
<td>c1820</td>
<td>B&amp;W 20hp</td>
</tr>
<tr>
<td>Beards</td>
<td>1821</td>
<td>B&amp;W 14hp independent</td>
</tr>
<tr>
<td>Millend</td>
<td>1821</td>
<td>B&amp;W 14hp independent. c1872 20 hp engine</td>
</tr>
<tr>
<td>Lloyds, Uley</td>
<td>1821</td>
<td>B&amp;W 20hp beam</td>
</tr>
<tr>
<td>Wallbridge</td>
<td>1821</td>
<td>B&amp;W 24hp beam. 1871 24hp engine</td>
</tr>
<tr>
<td>Avening</td>
<td>1822</td>
<td>B&amp;W 14hp beam</td>
</tr>
<tr>
<td>Churchend</td>
<td>1822</td>
<td>B&amp;W 24hp beam</td>
</tr>
<tr>
<td>Brookhouse, Painswick</td>
<td>1822</td>
<td></td>
</tr>
<tr>
<td>Wights, Sheepscome</td>
<td>1822</td>
<td></td>
</tr>
<tr>
<td>Stanley</td>
<td>1822</td>
<td>B&amp;W 40hp beam. 1833 40hp engine. 1867 high pressure condensing engine by Hadens of Trowbridge</td>
</tr>
<tr>
<td>Alderley New</td>
<td>1823</td>
<td>32hp B&amp;W</td>
</tr>
<tr>
<td>Vatch</td>
<td>1823</td>
<td>B&amp;W 20hp boat type engine. 1825 B&amp;W 30hp beam</td>
</tr>
<tr>
<td>Rockstowes</td>
<td>1823</td>
<td>2 engines. 1824 10hp and 8hp</td>
</tr>
<tr>
<td>New Mills, Stroud</td>
<td>1823</td>
<td>B&amp;W 14hp independent</td>
</tr>
<tr>
<td>Bowbridge</td>
<td>1824</td>
<td>B&amp;W 20hp. 1833 20hp</td>
</tr>
<tr>
<td>Stonehouse Upper</td>
<td>1824</td>
<td>B&amp;W 30hp boat type</td>
</tr>
<tr>
<td>Charfield</td>
<td>1825</td>
<td>B&amp;W 20hp boat type. 1833 55hp</td>
</tr>
<tr>
<td>Upper Doreys</td>
<td>1825</td>
<td>23hp</td>
</tr>
<tr>
<td>Peghouse</td>
<td>1825</td>
<td>B&amp;W 30hp boat type</td>
</tr>
<tr>
<td>Meadow</td>
<td>1826</td>
<td>B&amp;W 30hp. c1910 Robey engine</td>
</tr>
<tr>
<td>Location</td>
<td>Year</td>
<td>Details</td>
</tr>
<tr>
<td>---------------------</td>
<td>------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Abbey, Kingswood</td>
<td>1827</td>
<td>Small engine</td>
</tr>
<tr>
<td>Waterloo, Wotton</td>
<td>1827</td>
<td></td>
</tr>
<tr>
<td>Daunceys, Uley</td>
<td>1828</td>
<td></td>
</tr>
<tr>
<td>Old Town, Wotton</td>
<td>1830</td>
<td></td>
</tr>
<tr>
<td>Nailsworth</td>
<td>1830</td>
<td>1886 3 engines compounded by H J H Kings</td>
</tr>
<tr>
<td>Dyehouse, Little Avon</td>
<td>1833</td>
<td>14hp</td>
</tr>
<tr>
<td>Stranges, Wotton</td>
<td>1833</td>
<td>16hp</td>
</tr>
<tr>
<td>Woodchester</td>
<td>1833</td>
<td>40hp</td>
</tr>
<tr>
<td>St Marys</td>
<td>1833</td>
<td></td>
</tr>
<tr>
<td>Ham</td>
<td>1833</td>
<td>30 hp engine</td>
</tr>
<tr>
<td>New Mills, Chalford</td>
<td>1834</td>
<td>12hp high pressure engine</td>
</tr>
<tr>
<td>Walk</td>
<td>1839</td>
<td></td>
</tr>
<tr>
<td>Ebley</td>
<td>c1840</td>
<td>Engine McNaughted c1875. 100hp</td>
</tr>
<tr>
<td>Woolings</td>
<td>1841</td>
<td>1hp low pressure engine</td>
</tr>
<tr>
<td>Port</td>
<td>1843</td>
<td>18hp engine. 1871 20 hp engine</td>
</tr>
<tr>
<td>Lower, Dursley</td>
<td>1844</td>
<td></td>
</tr>
<tr>
<td>Brimscombe Upper</td>
<td>1845</td>
<td>2 engines</td>
</tr>
<tr>
<td>Brimscombe Lower</td>
<td>1845</td>
<td>20hp engine</td>
</tr>
<tr>
<td>Hope</td>
<td>1845</td>
<td>20hp and 40 hp engines</td>
</tr>
<tr>
<td>Griffiths</td>
<td>pre-1846</td>
<td></td>
</tr>
<tr>
<td>Randalls</td>
<td>1860</td>
<td></td>
</tr>
<tr>
<td>Staffords</td>
<td>1872</td>
<td></td>
</tr>
<tr>
<td>Sevilles</td>
<td>pre-1873</td>
<td>Beam engine</td>
</tr>
<tr>
<td>Hawkers</td>
<td>1873</td>
<td>10hp high pressure engine</td>
</tr>
<tr>
<td>Bourne</td>
<td>pre-1886</td>
<td>3 engines compounded by H J H Kings in 1886</td>
</tr>
<tr>
<td>Nailsworth</td>
<td>pre-1886</td>
<td>2 engines compounded by H J H Kings in 1886</td>
</tr>
<tr>
<td>Dark</td>
<td>1887</td>
<td>20hp compound condensing engine</td>
</tr>
<tr>
<td>Dudbridge</td>
<td>1887</td>
<td>20hp compound condensing engine. 1899 compound engine. 1900 Double</td>
</tr>
<tr>
<td>Merretts</td>
<td>1887</td>
<td>Corliss compound condensing engine</td>
</tr>
<tr>
<td>Toadsmoor Lower</td>
<td>1891</td>
<td>Beam engine compounded by H J H Kings. 1892 10&quot; Tangye compound</td>
</tr>
<tr>
<td>Brimscombe</td>
<td>1895</td>
<td>Vertical compound. 1906 beam engine</td>
</tr>
<tr>
<td>Nodes</td>
<td>pre-1896</td>
<td>Beam engine</td>
</tr>
<tr>
<td>Cam</td>
<td>pre-1904</td>
<td>500hp engine</td>
</tr>
<tr>
<td>Bliss</td>
<td>1904</td>
<td>2 x horizontal engines</td>
</tr>
<tr>
<td>Toadsmoor Upper</td>
<td>1906</td>
<td>Tangye tandem compound condensing engine</td>
</tr>
<tr>
<td>Frogmarsh</td>
<td>1906</td>
<td>Horizontal compound Corliss* condensing engine</td>
</tr>
<tr>
<td>Lewiston</td>
<td>pre-1908</td>
<td>Beam engine</td>
</tr>
</tbody>
</table>

*The "Corliss" engine produced by Kings were based on the design of George Corliss of the USA, who developed an engine with rocking.*
cylindrical valves, four per cylinder. The design was subsequently adopted by a few British firms. Corliss engines were particularly well suited to textile mills because of their close speed control, good economy and relatively low running speed.

Local Engine Suppliers

As in many other respects, the Stroud valleys industries were able to rely heavily on the self sufficient nature of the region. Thus, following the initial period dominated by Boulton & Watt, requirements in terms of size and type of steam engine came to be met by a number of local manufacturers. Throughout the first half of the 19th century, the beam engine reigned supreme although local manufacturers such as the Ferrabees of the Phoenix Iron Works still had to face competition from the likes of Hadens of Trowbridge, the latter being successful in selling some engines into the region. Although most of the engines produced for mill use at this time were of the beam variety, direct acting horizontal engines had been in regular manufacture since c1825 (Law, 1965: 17) however, these had made little headway until c1850 and did not become adopted widely in the region until after 1870. It appears that during the first half of the century, Stroud cloth makers relied predominantly on engines supplied by Boulton & Watt with occasional engines (eg. the Hadens engine installed at Stanley Mill) coming into the district from elsewhere. Certainly, from c1850 on, local engine builders were becoming increasingly active, with the Ferrabees producing beam engines from this time if not earlier. These were joined by a variety of engines of horizontal design, some of which were of the "compact" type. For instance, by the 1860s, the Ferrabees were building compact vertical engines with an overhead crank, thus minimising the footprint of the engine. Engine manufacture continued at the site even following the Ferrabees departure as their successors, George Wailes & Co, carried on producing a variety of beam and horizontal engines. They were in turn replaced by George Waller & Sons, who continued the manufacture of various types of engine (for further details, see section describing Machine Makers, Millwrights and Engineers). In addition to the above, the Nailsworth-based company of H J H King began producing, repairing and uprating steam engines from the mid 1880s (see Table 14) and within a few years, were also supplying compact vertical engines to their own design. In terms of engines, their range of products eventually became quite diverse although it is likely that the company was acting as agent for some designs of engine. Other suppliers who were active in this field included T H & J Daniels, the Dudbridge Iron Works, Excelsior Engineering, and Fielding & Platt of Gloucester.

Despite the obvious advantages associated with local manufacture, competition from outside the region increased in line with improvements in transport systems and engines from the likes of Robey, Haden and Tangye found their way into the valley mills, both during the woollen cloth period and after it, powering a number of the successor industries. Few survive although the c1870 Tangye engine installed in St Marys Mill, Chalford, during its walking stick making phase is still in situ.
Table 14
Steam Engines Installed or Worked on by H J H Kings *

<table>
<thead>
<tr>
<th>Customer</th>
<th>Date</th>
<th>Location</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>W Dangerfield</td>
<td>1886</td>
<td>Bourne Mill</td>
<td>Engine compounded</td>
</tr>
<tr>
<td>W Dangerfield</td>
<td>1886</td>
<td>Bourne Mill</td>
<td>2 engines compounded</td>
</tr>
<tr>
<td>Harper &amp; Chamberlain</td>
<td>1886</td>
<td>Nailsworth Mill?</td>
<td>2 engines compounded</td>
</tr>
<tr>
<td>Critchley Brothers</td>
<td>1887</td>
<td></td>
<td>20hp compound condensing engine</td>
</tr>
<tr>
<td>Apperly Curtis</td>
<td>1887</td>
<td>Dudbridge Mills</td>
<td>20hp compound condensing engine. Pre-1904, 2 x 500hp HJH King engines installed</td>
</tr>
<tr>
<td></td>
<td>1887</td>
<td>Merretts Mill</td>
<td>Vertical compound condensing engine</td>
</tr>
<tr>
<td>W Selwyn</td>
<td>1891</td>
<td>Toadsmoor Lower Mill</td>
<td>Beam engine compounded</td>
</tr>
<tr>
<td>W Selwyn</td>
<td>1892</td>
<td>Toadsmoor Lower Mill</td>
<td>10&quot; Tangye engine compounded</td>
</tr>
<tr>
<td>A T Playne</td>
<td>1893</td>
<td>Longfords?</td>
<td>25 hp compound condensing engine</td>
</tr>
<tr>
<td>P C Evans</td>
<td>1895</td>
<td>Brimscombe Mill</td>
<td>Vertical compound engine</td>
</tr>
<tr>
<td>F Drake</td>
<td>1896</td>
<td>Nodes Mill</td>
<td>Beam engine repairs</td>
</tr>
<tr>
<td>G Waller</td>
<td>1897</td>
<td>Phoenix Ironworks</td>
<td>2 high pressure engines</td>
</tr>
<tr>
<td>Humphidge &amp; Holborn</td>
<td>1897</td>
<td></td>
<td>Vertical high pressure launch type</td>
</tr>
<tr>
<td>G Walker</td>
<td>1897</td>
<td>Stroud</td>
<td>3 Horizontal high pressure engines</td>
</tr>
<tr>
<td>Apperly Curtis</td>
<td>1899</td>
<td>Dudbridge Mills</td>
<td>Compound engine</td>
</tr>
<tr>
<td>Apperly Curtis</td>
<td>1900</td>
<td>Dudbridge Mills</td>
<td>Double Corliss compound condensing engine</td>
</tr>
<tr>
<td>Selwyn</td>
<td>1906</td>
<td>Toadsmoor Upper Mills</td>
<td>Tangye tandem compound condensing engine</td>
</tr>
<tr>
<td>R Grist</td>
<td>1906</td>
<td>Brimscombe</td>
<td>Beam engine repairs</td>
</tr>
<tr>
<td>Perkins &amp; Marmont</td>
<td>1906</td>
<td>Woodchester</td>
<td>Horizontal compound Carliss condensing engine</td>
</tr>
<tr>
<td></td>
<td>1908</td>
<td>Lewiston Mills, Brimscombe</td>
<td>Beam engine repairs</td>
</tr>
</tbody>
</table>

* Compiled from Kings order books in GRO plus other sources)
Rate of Takeup of Steam Power in Gloucestershire Mills

As noted above, the rate of takeup of steam varied significantly between Britain’s textile districts. Gloucestershire’s major competitors in the shape of Wiltshire and Yorkshire, generally took to steam with open arms. However, in the Stroud region steam’s progress was much slower. There were several reasons for this. The typical Stroud manufacturer was conservative by nature and this, coupled with the relatively modest size of his business meant that he had less capital than his Northern peers to invest in either new buildings or new technologies. He was fortunate that many parts of the Stroud valleys were blessed with good "unfailing" water supplies and although there were inevitable seasonal shortages, most seemed willing to tolerate the situation. Steam power was gradually adopted but usually alongside existing water power system - steam did not replace water, it merely supplemented it.

Some parts of the county’s woollen districts never actually got to the stage of installing steam power; such was the situation with the numerous mills in and around Painswick where steam remained notable by its absence. Intriguingly, it seems shortly before the final demise of cloth making in the area, one mill was clearly on the brink of adopting steam power. In 1840, sales particulars for Painswick Mill noted:

"...a new steam cylinder and sundry castings for a 20 horse power steam engine" (Haine, 1981: 22).

As will become clear in the following section, overall, the Stroud region lagged far behind its competitors in its adoption of steam power.

The foregoing comments go some way to explaining the region’s slow uptake of steam, however, undoubtedly the major reason was the price, and perhaps more importantly, the relative scarcity of coal in the region.

The following table and graph give an indication of the steam horsepower available in Gloucestershire woollen mills during the period 1800-1870. The figures for the first half of the century are comparatively reliable, most of the early orders being well documented in the Boulton & Watt order books; at this time, Boulton & Watt were the main, although not exclusive, supplier to the region. Thereafter, it becomes increasingly difficult to segregate new engines from those already installed, as frequently their only mention may be in, for instance, sales particulars. The accumulated figures for each year cannot claim to be exhaustive, having been totalled up from assorted sources such as the Boulton & Watt records, Herrick, Tann, H J H King order books, the Victoria County History and
documents held in the Gloucestershire Record Office and County Library.

The total horse power shown is that confirmed; in some cases, additional engines are known to have been in service however their horse power is not known hence figures are on the conservative side although up to c1840, they are probably fairly reliable. Beyond this date it becomes increasingly difficult to disentangle situations where newer engines are replacing older units or early engines are being uprated or compounded in order to boost output. As the 19th century progressed, an engine became less of a novelty and was accepted simply as another piece of mill hardware, hence featured less prominently in the mill’s working life. It became increasingly common for a multiplicity of smaller engines to power parts of sites or individual buildings. For instance, the 1858 spinning mill of Longfords Mill was powered by such an engine (RCHME Building Report. Longfords Mill. 1858 Mill. Buildings 1,1a). In some documentary sources, there may be passing mention of an engine or even none at all. Nevertheless, the figures are presented in Table 15. Despite its incompleteness, it is clear that the great burst of engine installation occurred during the 1820s and 30s.

Table 15

Total Steam Horsepower in Gloucestershire Woollen Mills (1802-1870)

<table>
<thead>
<tr>
<th>Year</th>
<th>02</th>
<th>03</th>
<th>05</th>
<th>14</th>
<th>15</th>
<th>17</th>
<th>18</th>
<th>20</th>
<th>21</th>
<th>22</th>
<th>23</th>
<th>24</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cum.total</td>
<td>6</td>
<td>30</td>
<td>44</td>
<td>64</td>
<td>84</td>
<td>104</td>
<td>114</td>
<td>176</td>
<td>258</td>
<td>336</td>
<td>422</td>
<td>490</td>
<td>670</td>
</tr>
<tr>
<td>26</td>
<td>33</td>
<td>34</td>
<td>37</td>
<td>43</td>
<td>45</td>
<td>50</td>
<td>56</td>
<td>61</td>
<td>67</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>915</td>
<td>927</td>
<td>1015</td>
<td>1033</td>
<td>1093</td>
<td>806</td>
<td>740</td>
<td>1079</td>
<td>1954</td>
<td>922</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
From 1802 up to the middle of the 19th century, the total horsepower figure has been based on the various sources mentioned above. Those post-1845-50 have been sourced from Mann’s studies.

The graph shows a steady, almost linear growth in the uptake of steam power throughout the first half of the century although Mann’s figure for the total horsepower available around the mid point is somewhat lower than that suggested in the present study. However, even allowing for this disparity, steam power on an accumulative basis continued to rise up to the late 1860s, falling off rapidly after this period, a reflection of the contraction of the woollen industry.

The capacity of the majority of steam engines at work in the West was generally lower than many in Yorkshire. For instance, in 1838, ~800 horse power was being generated in Yorkshire by engines of 50 hp or greater. In Gloucestershire at the same time, only around 100 hp was being produced by engines of such size; most were smaller (Gregory, 1983:72). Indeed, in Yorkshire, the output of some individual installations was enormous compared to their Gloucestershire peers. For instance, Saltaire Mills was powered by two pairs of compound beam engines working together; this setup generated some 1250 hp (Giles & Goodall, 1992: 134-5).

The Influence of the Price of Coal

During the 18th century, the appearance of the steam engine created a whole new market for coal, with major industrial consumers taking increasing tonnages. The market increased substantially after Watt’s adaption in 1781 of the engine to rotary motion, resulting in many new uses, particularly in the country’s textile mills (Flinn, 1984; 246). Coal consumption, especially with early engines was high and of the 2500 engines in operation in the country before 1800, the average coal consumption was 20lbs per horse power per hour. By the end of the 18th century, typical consumption by the various types of engine was as follows:

- Newcomen-type reciprocating engines 25lb coal per hp per hour
- Boulton & Watt-type reciprocating engines 12.5-15lb coal per hp per hour
- Boulton & Watt-type rotative engines 22lb coal per hp per hour (ibid)

As engines became increasingly refined, so their efficiency increased and their coal consumption fell; by 1856, this averaged out for all engine types at ~12lbs. The development of a market for "engine coal" had been of considerable benefit to many collieries, as engines were generally fired on small coal that had hitherto been largely valueless to mine owners.

At different times, the price of coal at the pithead varied widely throughout the country, although even
where coalfields were separated by considerable distances, general fluctuations in prices were mirrored:

Table 16

Regional Pithead Coal Prices 1882-1913 (shillings + pence/ton)

<table>
<thead>
<tr>
<th>Date</th>
<th>Lancs &amp; Cheshire</th>
<th>Yorkshire</th>
<th>South West</th>
</tr>
</thead>
<tbody>
<tr>
<td>1882</td>
<td>5.10</td>
<td>6.6</td>
<td>7.0</td>
</tr>
<tr>
<td>1885</td>
<td>5.6</td>
<td>5.0</td>
<td>6.7</td>
</tr>
<tr>
<td>1890</td>
<td>8.2</td>
<td>8.9</td>
<td>10.1</td>
</tr>
<tr>
<td>1895</td>
<td>6.5</td>
<td>6.5</td>
<td>7.7</td>
</tr>
<tr>
<td>1900</td>
<td>10.9</td>
<td>10.1</td>
<td>13.1</td>
</tr>
<tr>
<td>1905</td>
<td>7.4</td>
<td>6.8</td>
<td>9.5</td>
</tr>
<tr>
<td>1910</td>
<td>8.6</td>
<td>7.8</td>
<td>9.11</td>
</tr>
<tr>
<td>1913</td>
<td>10.3</td>
<td>9.5</td>
<td>10.9</td>
</tr>
</tbody>
</table>

(From: Mineral Statistics, quoted from The History of the British Coal Mining Industry. II. 58-9)

Clearly, the South West was at a distinct disadvantage although pithead prices only paint part of the picture; subsequent transport costs, either by road, canal, rail, or a combination of these, need to be added and in the South West, these could form a considerable part of the as-delivered price, widening the gap still further. Overall, there were significant regional differences between coal prices with the more isolated regions, such as Somerset, being characterised by prices well above the national average (Church, 1986: 56). Despite the high costs associated with many parts of the West of England clothing districts, once steam power had been adopted, there was no going back. A shortage of coal for whatever reason, could lead to near-panic amongst mill and factory masters owners wherever they were located. As the North-eastern "viewer" and industrialist George Elliot commented in 1872:

"If there is a scarcity of coal you are on your beams end; you do not know what to do; you must have it at any price" (quoted by Church, 1986: 57).

From these comments it becomes apparent that demand was relatively unaffected by price, such was the importance to mill owners, many of whom in Wiltshire, were totally dependent on steam. No coal meant no production, whereas in Gloucestershire, where water power capacity had been retained, at least some production was generally possible.

The above figures help to emphasise the point that, depending on the area, the price of coal varied widely across time and even within a particular region, significant differences could occur. Local circumstances such as proximity to a canal could greatly influence prices. In Gloucestershire during
the first half of the 19th century, although there were wide fluctuations at times, coal prices averaged between 17-21s/ton. This high price, coupled with the natural conservatism of the Stroud clothiers, ensured that there was only limited initial enthusiasm for steam. Despite the fact that part of the county was rich in coal (the Forest of Dean), prices remained relatively high as a result of the monopolies associated with the Forest coal masters. The result was that coal was brought into the area from the Midlands coalfields and Newport in South Wales, in both cases add-on transport costs forming a significant part of the total purchase price.

There is no doubt that the poor transport system into the valleys was hampering the expansion of the cloth trade even though coal was not yet being used to power steam engines in the local mills. Rudder comments on the "vast increase of the consumption of coals [and that] the consumption of raw materials used in the local woollen industry has nearly doubled over the last twenty years" (Rudder, 1779; 712). Where clothiers were still reliant on land carriage into the area, there were many reports of a:

"great scarcity of coals [that were] often only available at 18s to £1 a ton, a price little short of extortionate". (GJ. January 1763).

In pre-canal days, coal’s use was limited to the heating of buildings, stoves, dye vats, etc., the nearest source being Framilode on the banks of the Severn, where coal from the Midlands and South Wales was unloaded from Severn trows. From here, it was carried by waggon a distance of 8-15 miles, depending on its destination, to the various valley mills. Needless to say, a variety of factors increased the uncertainty of supply, ranging from the weather to the state of the local roads; the latter were frequently poor and in certain times of the year, impassable. Land carriage from Framilode clearly resulted in additional costs and in 1756, to carry coal to Stroud incurred charges of 7s/ton in Summer and 8s/ton in Winter, a considerable extra burden (Handford, 1979: 81). Proponents of the Stroudwater Canal at the time suggested that canal carriage would reduce this to 3s 6d/ton.

Even before the canal’s eventual opening in 1779, the Stroudwater company was advertising for a supplier to provide 10,000 tons of coal to be delivered to the various wharfs (GJ. 6 January 1777). Even now, it was self-evident how important coal was going to be, both to the local industry and the canal company itself. From the start, the company directors, many of whom already had links with the cloth trade, ensured that a suitable strategy was put in place. They were intent that recurring coal shortages would become a thing of the past and were of the opinion that the availability of such a large tonnage would reduce prices in the region and provide sufficient competition to drive down the high prices previously charged by coal merchants, a continuing complaint of the local clothiers. It was also envisaged that such large amounts of coal at competitive prices would stimulate further demand by
encouraging the industry to make greater use of coal (Handford, 1979: 279). The company further encouraged the wider use of coal through deliberate pricing policies. For instance, when the canal had reached the Bristol Road wharf, about half way to Stroud, the company declared that:

"All coals sold to waggons at a price exceeding 12s 6d/ton shall be free of wharfage, and all sold above that price shall pay one shilling per ton" (GRO. D1180 1/1. Stroudwater Canal Committee minutes. 3 December 1776).

House coals were invariably more expensive than engine coal hence the above could be construed as an attempt to boost the industrial market through a deliberate pricing strategy.

Once the Stroudwater Canal was open, a few existing mills that actually bordered it were able to take full advantage of its proximity. Along the lower Frome, coal for Hicks' Eastington mills was unloaded into a central coal pen close to Meadow Mill, from where it was carted to the other sites. Upstream, coal for Bonds Mill was unloaded directly from boats into the mill's bunkers. Later, when the Thames & Severn Canal had been opened along the Chalford Valley, many mills were able to do likewise. However, although the opening of both canals helped to drive down coal prices in the area, parts of the region were still some considerable distance from either the canal itself or from centralised stocking points in and around Stroud. Thus, the numerous mills along the Nailsworth valley were still reliant on coal brought in by waggon, a clear disadvantage. The few mills in the Painswick area that had installed steam were at an even greater disadvantage in that they were cursed with a long uphill haul from Stroud.

Despite reduced coal prices following the opening of the local canals, the region remained at a disadvantage compared to Yorkshire. However, it was still blessed with a relatively reliable supply of water power, unlike some other regions. In the region, apart from a few locations in the Wotton clothing district which were bereft of water-powered sites, few mills were built specifically as steam mills. Even what constitutes one of the last mills built in the region, Stonehouse Upper Mills of 1875, still retained water wheels as well as a steam engine.

That the opening of the Stroudwater Canal would have an impact on coal prices in the region could never have seriously been in doubt. Prior to its opening, coal prices in Stroud were usually in the 19s to £1-2-0 range (GJ. 17 August 1778) assuming that it was available at all. By the time that the construction of the canal had reached the Chippenham Platt wharf at Eastington, coal was available at 13s-3d to 15s/ton, and even with the addition of 3s 6d haulage costs to Stroud, this remained a step in the right direction. By the time the canal reached Ryeford wharf near Stonehouse, Shropshire coal

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was selling at 13s 9d/ton, Forest of Dean at 14s 9d/ton, and best Staffordshire at 15s 3d/ton (GJ. 31 May 1779). Clearly, the Stroudwater Canal was having a major impact on depressing coal prices being charged to local industry and perhaps more importantly, of ensuring that regular supplies were now reasonably well assured. The impact on local mills varied, depending on their location. Those in the immediate vicinity benefitted most, whereas those in outlying districts were still faced with additional haulage costs.

In 1783, work started on the building of the Thames & Severn Canal; this joined end on with the Stroudwater Canal at Wallbridge and carried on via the Chalford Valley, joining the Thames at Lechlade. It was fully completed in 1789. Like the Stroudwater, importation of coal into the area was to be a major part of its working life. The company built a large central base of operation known as Brimscombe Port, part of this including an 'island' on which coal was stored securely. As with mills lower down, supplied by the Stroudwater Canal, mills especially in the Chalford Valley benefitted from some reduction in coal price. In 1811, prices at Brimscombe Port were:

- Bullo coal, Forest of Dean 18s/ton
- Lydney coal, Forest of Dean 20s 6d/ton
- Newport, South Wales 21s/ton
- Staffordshire 23s 6d/ton (Household, 1969: 122)

Prices were certainly lower than in pre-canal days although mill owners in the region remained at a substantial disadvantage to their peers in Yorkshire, secondary transport costs continuing to inflate the pithead price significantly.

Initially, coal was carried to Brimscombe Port in lighters laden with 45-50 tons; it took 1-2 days for each to travel from Framilode to Brimscombe. Subsequent developments resulted in the appearance of the "Stroud barge", a vessel of suitable dimensions, capable of carrying up to 60 tons of coal to Stroud, Brimscombe or Chalford (Household, 1969: 124). The peak year for coal carried on the Thames & Severn Canal was c1850, thereafter, tonnages gradually declined. Throughout the canal’s working life, coal remained the main cargo and although manufacture in the area undoubtedly benefitted from reduced coal prices, throughout the history of the Stroud industry, these were to remain considerably higher than those in the North.

The opening of the local canals had helped to reduce the price and increase the availability of coal and it might be expected that the coming of the railways to the Stroud region might have had a similar impact. However, even though the Gloucester-Birmingham Railway was opened in 1840 (swiftly
joined by the line to Bristol), the Great Western’s Bristol-London line was opened in 1841, and the
GWR Union Railway arrived in Stroud in 1845, there was to be little immediate impact on the cloth
producing regions, both in Gloucestershire and Wiltshire. Despite the usefulness of these main lines,
the lack of branch lines into the clothing districts meant that there was still no facility for the direct
transportation of coal. Where coal was carried by the railways, it still had to be carted from
centralised stocking points, often some considerable distance from local mills, resulting in further
delays and additional carriage costs. It was not until c1845 that a branch was built linking Stroud,
c1848 when one reached Trowbridge, and not until 1857 that the railway arrived in Bradford-on-Avon,
both the latter already being almost totally dependent on steam power (Gregory, 1983: 74). However,
as both were situated on a canal, the late coming of the railway was of little consequence in this
respect. In the Stroud region, as with the canal links, the Nailsworth valley remained devoid of a rail
link and it was not until the eventual opening of the Stonehouse-Nailsworth Railway in 1867 that the
town’s relative isolation was ended. However, this was too late to be of much use to the cloth trade
in the area which by now, was in a state of steady decline. Elsewhere in the region, where mills were
still at work, a number of spurs were taken off the main lines, allowing coal to be transported directly
into their sites. For example, the sprawling Cam Mills site was linked by rail to the main Bristol line
at Coaley Junction and similarly, Stanley Mills had its own spur, enabling coal to be unloaded directly
into the mill’s bunkers.

Gradually, the pressure to install steam power increased on manufacturers in the Stroud region
although even the larger manufacturers were often reluctant to abandon existing water powered systems
and switch entirely to steam. The result was that overall, Stroud had a long-running dependence on
water power, steam in many instances being installed to supplement water power in times of seasonal
shortages. The decision to install steam power was not always an easy one and was very dependent
on the particular circumstances. If the owner had sufficient capital to proceed, and many of the
smaller ones did not, this could be a risky proposition especially if the mill was only marginally
profitable. If the gamble did not pay off and the hoped-for increase in profits failed to materialise,
the spectre of bankruptcy was never far away. In addition, the existing mill building(s) may not have
been structurally suitable for the adoption of a large, bulky steam engine. The add-on costs could be
substantial and involve considerable alteration to the fabric of the building or the expense of an add-on
engine and boiler house. Under such pressures, some manufacturers collapsed, others left the industry
because they lacked the capital and others retired to the peace and quiet of landed property (Moir,
1957: 264).

Clearly, from an early date, the North embraced steam power with a vengeance; there were a number
of reasons for this substantial uptake. Many of the streams supplying existing water-powered sites
were very variable, their flow fluctuating throughout the year (Gregory, 1983: 74). As important as
this fact was, it was the easy availability of inexpensive, readily available supplies of coal that really
pushed steam to the fore. However, even where coal was not available in the immediate vicinity,
transport costs remained relatively low (compared to the West of England), especially as the railway
network expanded in the region. Hence, even crude pumping engines with their enormous appetite
for coal could be tolerated in the North, whereas they could not be countenanced in the West where
coal was less readily available. In addition, as the industry continued to expand in the North, it
became increasingly difficult to find sufficient water-powered sites capable of generating the amount
of power required; in short, power demands began to outstrip the capabilities of water wheels in many
areas.

For the woollen industry to operate in a particular area, reliable power was needed. As already
indicated, in Yorkshire it was steam power and in Gloucestershire it was water augmented by steam.
If a region had neither, it soon withered away. Even as early as the 1830s, a Select Committee
reported that as a result of lack of access to adequate water power and/or inexpensive coal, the woollen
industry had largely migrated from various southern counties such as Suffolk and Essex, mainly "to
northern districts where coal for engines is much cheaper".

Throughout the first half of the 19th century, steam power continue its inexorable rise in the North
and by 1838, was meeting a significantly greater percentage of power requirements than water.
During this period, in much of the West of England (Gloucestershire in particular) water still played
an important role. In that year, the West Riding was generating some 7492 hp from steam power and
2067 hp from water (see Table 17). At the same time, Gloucester was producing 873.5 hp from steam
and 1720 hp from water. Gloucestershire was producing this level of water power from a large
number of water wheels rated 20hp or less. Water wheels of >20hp were found in relatively small
numbers in Gloucestershire (with only a few of up to 40hp) but in greater profusion in Yorkshire; such
wheels were almost totally absent in other regions. However, it was in terms of steam power that the
differences between the clothing districts became very apparent. Yorkshire had many engines ranging
from <10hp up to 50hp, whereas Gloucestershire had meagre numbers of engines, mainly in the
<10-20hp range; there were few exceptions to these figures (Gregory, 1983: 72). Thus, the West
lagged far behind the North and even in Wiltshire, where steam power had made a greater impact than
across the border in Gloucestershire, the reliance on steam power was nothing like as great as in
Yorkshire. Although steam was now providing the greater percentage of power in Wiltshire, as noted
above, in Gloucestershire, the percentage of power produced by water remained much greater than
that produced by steam.

Writing in 1871, Fairbairn was in no doubt as to the overall position:
"The steam engine as an instrument of propulsion is at the present time of such vast importance as to sink into insignificance every other known agent as motive power...the whole of water power in great Britain falls immeasurably short of that obtained from steam, in every department of useful art...It is now thirty years since it was found desirable to increase the power of steam engines employed in manufacture, and instead of engines of from 20 to 50 nominal horse-power, as much as 100, and in some cases 200 horse power were required to meet the demand" (Fairbairn, 1871: 186, 242).

Despite Fairbairn’s comments and the clear message it carried, at least in parts of the Gloucestershire woollen districts, water still remained an important source of power although clearly, its dominance was set to continue to wane in the face of steampower.

The Choice of Power Source

Depending on the particular region, manufacturers potentially had four options in terms of power combinations:

- water power alone
- water power with supplementary steam power
- steam power with supplementary water power
- steam power alone

Gloucestershire fell predominantly in the first two categories, with steam power only making slow progress as a result of the manufacturers cautious approach coupled with high coal prices. As a result, steam engines were installed long after most competing regions were almost entirely dependent on steam power and even then, often only as a backup in times of water shortage. Wherever possible, Stroud manufacturers stuck with water, increasing the power available and reliability by installing improved water wheels and occasionally turbines, straightening rivers to improve flows, and creating large millponds to tide them over in times of shortage. In contrast, Gloucestershire’s immediate neighbour and competitor, Wiltshire, was heavily reliant on steam power from a relatively early period. Here, steam was adopted as the major centres of production had insufficient water power available to allow sufficient expansion. In reality, the Wiltshire clothier had little option - install steam or wither away. Thus, these two neighbouring clothing districts came to rely on significantly different technologies in terms of power sources, despite their proximity to one another.

In the North, the situation was again different, the abundance of cheap coal ensuring that steam would predominate from an early date. With the exception of a few areas, steam reigned supreme, allowing expansion on a scale that was almost inconceivable in the West of England. Whereas much of the
West’s clothing trade remained in rural or semi-rural locations, the Yorkshire trade gravitated to towns and cities, becoming substantially urban-based from an early date. In the Stroud valleys, up to a point, manufacturers appear to have been willing to tolerate seasonal water shortages and only reluctantly installed steam power, for the reasons discussed above. The pressure to adopt steam increased as the 19th century wore on and the region’s competitive edge diminished in the face of competition from steam-powered Yorkshire. The differences in mode of power production within these regions contributed directly to their fate in later years as initially the markets of the Wiltshire and later, Gloucestershire woollen districts were gradually eroded through a combination of factors, but primarily by competition from the North.

As crucial as coal had been to the development of the industry, its passing was not necessarily lamented. Although by the 1940s, electricity was providing the bulk of the power requirements of local industry, there were occasions when a degree of independence was to prove crucial. A protracted miners strike during the latter part of the 1940s caused considerable difficulties for manufacturers still reliant on coal for process steam. This may have been a major factor in Longfords Mill finally abandoning coal burning. Although coal had long been the dominant fuel for steam raising, during the post-war period its use began to diminish as oil-firing in particular, began to make inroads into its traditional markets. In 1947, Longfords ended its long association with coal, opting for oil to fire its steam boilers. Arthur Long, then chairman of Playne & Co, was convinced of the advantages this brought:

"coal BTUs varied from 9800-12000, a constant 17000 with oil; so gone for ever was the anxiety of inadequate and varying steam pressure. Also gone was the laborious process of clinkering and all the other dirty processes entailed...oil burners updated in 1949 - up to now, steam had been used for atomising the oil, which was a rather costly business; we fitted new burners of the rotary cup type and atomised by compressed air...new installation has been a considerable improvement...reduced fuel costs and stack emissions to virtually nil". (Playne, 1952: 54-55).

The fact that Longfords Mill still retained its power station, housing generators driven by water turbine, steam engine and diesel, helped it to remain in production when others in the region were not so fortunate. As the mill continued to work throughout the 1940s miners strike, so it continued in full operation during the "three day weeks" resulting from the lengthy miner's strike of 1974. Public supply provided the power for three days operation and the site's own power house for the remainder of the working week. However, Longfords Mill was the only one in the region to retain this degree of independence; by now, all those mills still at work were dependent entirely (and at the mercy of) the public supply.
Combinations of Water and Steam Power

The vast majority of steam engines installed in the Stroud valley mills were primarily to boost power during periods of water shortage. As such, they were mainly there to act as a supplement to water power, not as a replacement. However, as the level of mechanisation increased, so the power requirements rose, in some cases outstripping the level of power available from the watercourse even at times of peak flow. There was a clear limit to how much water could be impounded (apart perhaps from the Playne’s lake at Longfords) or further improvements made to the watercourse. In many of the larger mills this gave rise to combinations of water and steam power, both used regularly during the mill’s operations. However, at Ebley Mill, even during the 1830s, the increased power requirements were being met by water power alone, in this case by five large water wheels running side by side (Falconer, 1993: Plate 14 and p77). In some other instances, it became necessary to operate steam power on a regular basis alongside water power. In 1833, Vatch Mill on the Slad Brook was using two 12hp water wheels and three 22hp steam engines. The owners reported to the Factory Inspectors that both were used daily. At nearby Peghouse Mill, a 10hp wheel drove the fulling stocks and a 30hp engine operated the remaining machinery (Tann, 1967: 212). The flow of the Slad Brook was much less than that of the Frome itself, which probably accounts for the differences in the power sources between Ebley and Vatch Mills.

Water power continued to be an important source of power even when steam power had made great advances. In 1873, the silk thrower William Chapman of Sevilles Mill, Chalford, was using a combined input from a 13 ft diameter x 8 ft wide water wheel along with a beam engine, both operated on a continuous basis (GRO. D1241). His power requirements would have been comparatively modest compared with many woollen mills in the district but even here, both sources of power were needed on a daily basis. In other instances, silk mills survived on water power alone; Charles Barton of Hope Mill was reliant on a 15 hp iron water wheel (Langford, 1988: 10).

In the foregoing examples, it appears that the power sources were each assigned to operate distinct sets of machinery. However, as explored later, some mills such as Dunkirk, adopted a combined power input from water wheels and a steam engine, coupled together via mechanical systems. This acted effectively as a single source of power to the mill although the ratio of water:steam power could be varied, depending on the prevailing conditions. The coupling together of water wheels and steam engines to effectively provide a single power source was not confined to Gloucestershire mills and wherever water power still had a role to play, such systems were often adopted. In Eden Vale Mill in Westbury, Wiltshire, the three-storey mill was powered by an 8hp engine and a water wheel that could be either run together or independently ( Rogers, 1976: 228-9).
In other parts of the region, there were isolated instances of a mill only being operable when another one further upstream was working. Such a combination was to be found at Bagendon, near Cirencester, some 10 miles from Stroud. Here, water was fed to Trinity Mill, the upper one, from where it flowed downstream via a leat, to a second mill, at Baunton. The latter was only able to operate when Trinity Mill was working. As both mills were worked by different owners, this must have caused considerable difficulties at times. Although there are no such instances recorded nearer to Stroud, realistically, there must have been occasions where limited water supplies were impounded by a mill higher up the stream, causing the lower one to cease operation, even when situated on a natural water course.

As mentioned previously, even the major tributaries of the Frome such as the Nailsworth Stream sometimes suffered from seasonal water shortages. In fact, the lower Frome itself, even with the benefit of supplies from its various tributaries, also suffered the same fate. In 1838, even the grandiose Ebley Mill had problems. As Marling reported to the Factory Inspectors (PP 1843. xx):

"power employed in principal building only water; irregular in summer months; sometimes no water until noon; power of about 80 horses".

So, the problem of seasonal shortages was to be found throughout the district and was not confined to minor streams or minor mills. At the time, it appears that virtually every mill was afflicted, a clear incentive for the owner to consider the adoption of steam power.

The rate of uptake of steam engines throughout the country's various woollen districts varied enormously, both in terms of overall total of individual engines and in the percentage of power supplied compared with water power. Certainly, by the latter part of the 18th century, steam engines were having a big impact in Yorkshire with the first engines being installed during the 1780s or 90s; Gregory suggests the former although the RCHME puts the first confirmed engine in the region at 1792 (Giles & Goodall, 1992: 135). 1786 saw the installation of the first Boulton & Watt rotative engine, bought by the Robinsons at Papplewick, Nottinghamshire. Here, the engine was harnessed to drive cotton spinning machinery (Greatrex, 1986: 37). The first engine in the region came in 1799, and was installed in Bristol. The second engine did not come until 1802 leading to the situation whereby Gloucestershire had a single engine and Yorkshire had ~94, supplied by Boulton & Watt and others (Giles & Goodall, 1992: 135). By 1805, Gloucestershire was still dependent on a single engine and in the same year, neighbouring Wiltshire could also only boast a solitary engine (TA. 11 April 1857). Clearly, Yorkshire and the Midlands were off to flying starts in this respect and by 1815 were far more dependent on steam power than their peers in the West.
By now, Gloucestershire’s total had climbed to a meagre four engines although both Wiltshire and Somerset had left their neighbour behind in terms of the number of engines in operation (Mann, 1987: 154-155). This trend was now set to carry on throughout much of the 19th century with Yorkshire dominating in terms of number of engines installed, overall horse power available and highest dependence on steam (as opposed to water) power, although in the West, parts of Wiltshire were also set to become heavily dependent on steam.

By c1820, an increasing number of Stroud manufacturers were becoming aware that they had little choice but to install steam power, primarily as backup in times of water shortages, in order to remain competitive, not merely with Wiltshire and Yorkshire but also with their immediate neighbours; by 1820, the number of engines in Gloucestershire had crept up to ~10 and by 1830, to ~34. Mann suggests that the Stroud manufacturers were spurred into installing steam engines by crises occurring in the industry in 1826 and 1829 (Mann, 1987: 190) however, as noted, engine installing was well underway even before the first date cited. Meanwhile, both Wiltshire and Yorkshire had continued to place increasing reliance on steam, whereas most Gloucestershire manufacturers, wherever possible, stuck doggedly with water as their prime source of power. In 1833, the Returns to the Factory Inspectors (quoted by Mann, 1987: 190) indicated that there were 23 engines in use within the county, although this appears to be much lower than indicated in the present study which suggests that the total was in fact at least 37 engines. Even allowing for this disparity, Gloucestershire was still more heavily dependent on water power than any of its competitors.

In 1833, Wiltshire had at least 24 mills reliant on steam power (ibid). At the close of the 1830s the situation remained essentially the same, with Gloucestershire remaining tied closely to water power, whereas generally in Wiltshire and Yorkshire, steam power was dominant. Only the Somerset woollen districts still placed any sizable reliance on water power and even here, water power was roughly balanced by a similar amount of steam power (Gregory, 1983: 72).

By the close of the 1830s, steam was meeting a greater part of power requirements compared to water, in most woollen districts. In fact, from c1830, steam became the dominant force in Yorkshire, with an overall higher capacity than water power. In addition, average steam installations were of higher power output than corresponding water-powered sites. In 1838, the Return of Mills and Factories showed that in terms of the percentage of power requirements being met by steam, Gloucestershire was the lowest (Table 17). Wiltshire far exceeded Gloucestershire in this respect and even Somerset was reliant on steam to a greater degree.
Table 17

<table>
<thead>
<tr>
<th>Region</th>
<th>No. mills</th>
<th>Steam hp</th>
<th>% Total</th>
<th>Water hp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gloucestershire</td>
<td>101</td>
<td>873.5</td>
<td>34</td>
<td>1720</td>
</tr>
<tr>
<td>Wiltshire</td>
<td>48</td>
<td>688</td>
<td>68</td>
<td>320</td>
</tr>
<tr>
<td>Somerset</td>
<td>30</td>
<td>260</td>
<td>41</td>
<td>372</td>
</tr>
<tr>
<td>West Riding</td>
<td>543</td>
<td>7492</td>
<td>78</td>
<td>2067</td>
</tr>
</tbody>
</table>

(*Based on Returns of Mills and Factories. 1838)

Some extent of Gloucestershire’s continuing heavy reliance on water power can be gauged from the fact that the amount of water power available was similar to that of Yorkshire, the latter being of a much greater geographical area.

For the next few decades, water power remained of prime importance to the Stroud manufacturers although in percentage terms, steam made steady if unspectacular progress at water’s expense. By 1850, there were around 80 mills at work in South Gloucestershire, having between them ~50 engines producing a total of 806hp (Mann, 1987: 220-221). This equated to some 35% of the region’s power requirements being met by steam power. By 1861, this had crept up to >1000hp, the increase being greater than might be suggested as the total number of mills had fallen to around 50; in percentage terms, steam had now reached ~51%. By way of comparison, the Wiltshire woollen districts were now meeting 87.5% of their requirements by steam, a figure comparable to the woollen districts of Yorkshire.

By 1870, the total figure for the Gloucestershire industry had declined to 922hp although in percentage terms it had increased to 62% (ibid). Meanwhile, throughout the 1860s and 70s, steam continued to meet 85-90% of power requirements in both Wiltshire and Yorkshire (Giles & Goodall suggest ~84%). Despite this apparently dominant position in both areas, certain regions, like Stroud, still clung tenaciously to water power. In Wiltshire, important centres such as Trowbridge were almost entirely dependent on steam power, whereas more remote regions continued to operate with a combination of steam and water or even water alone. For example, Scutts Bridge factory in Rode was totally reliant on water power up to the time of its closure in 1904 (Rogers, 1986: 82). The lack of suitable water-powered sites in both Bradford and Trowbridge was largely responsible for steam’s dominance, these pockets helping to inflate the overall impact that steam had on the region as a whole.
As explored above, availability and pricing of coal was a major factor in the regional adoption of steam power.

By the 1870s, the situation regarding power in the Yorkshire mills was as follows (Giles & Goodall, 1992: 136):

- 84% steam power alone
- 12% steam and water power combined
- 3% water power alone

This rise in steam power was reflected by significant changes in technology and by this time, the dominant role of the traditional beam engine had started to diminish in the face of new designs of engine. After ~1870, the horizontal engine became the most common type encountered in the Yorkshire woollen districts (Giles & Goodall, 1992: 142) although as noted later, a number of McNaughted beam engines in the Stroud valleys continued to operate much later.

**Horse Power Available**

Particularly, during the 1830s, despite a significant burst of engine installing in Gloucestershire, water power requirements remained dominant, especially on the larger more reliable water courses. In some cases, at least for part of the year, water and steam power was supplied in similar quantities; in others, water power still predominated. The following examples were reported to the Factory Inspectors in 1833 and serve to illustrate the point that as with many aspects of the industry, power requirements were influenced by a variety of factors and varied from site to site:

**Table 18**

<table>
<thead>
<tr>
<th>Mill</th>
<th>Stream</th>
<th>Maximum water hp</th>
<th>Steam hp</th>
<th>Ratio water:steam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charfield</td>
<td>Little Avon</td>
<td>50</td>
<td>55</td>
<td>0.9</td>
</tr>
<tr>
<td>Stranges</td>
<td>Little Avon</td>
<td>30</td>
<td>16</td>
<td>1.9</td>
</tr>
<tr>
<td>Bowbridge</td>
<td>Frome</td>
<td>30</td>
<td>18-20</td>
<td>1.5</td>
</tr>
<tr>
<td>Ham</td>
<td>Frome</td>
<td>30</td>
<td>30</td>
<td>1.0</td>
</tr>
<tr>
<td>St Marys</td>
<td>Frome</td>
<td>30</td>
<td>30</td>
<td>1.0</td>
</tr>
<tr>
<td>Stanley</td>
<td>Frome</td>
<td>200</td>
<td>40</td>
<td>5.0</td>
</tr>
<tr>
<td>Dunkirk</td>
<td>Nailsworth Stream</td>
<td>40</td>
<td>14</td>
<td>2.9</td>
</tr>
<tr>
<td>Vatch</td>
<td>Slad Brook</td>
<td>24</td>
<td>66</td>
<td>0.4</td>
</tr>
<tr>
<td>Peghouse</td>
<td>Slad Brook</td>
<td>10</td>
<td>30</td>
<td>0.3</td>
</tr>
</tbody>
</table>
As evidenced by these examples, power requirements varied widely from site to site. However, it is clear that water power still played an important role, especially with the bigger mills such as Stanley and Dunkirk. Although these suffered from seasonal shortages, they were situated on fairly regular streams hence could rely on water power for a good percentage of the year. Where more marginal streams such as the Slad Brook were involved, steam power clearly assumed a major role. Here, power requirements outstripped that available from water alone, hence there was every incentive, if not necessity, for manufacturers to turn to steam power. Within a decade or so, the situation began to change and even on the Frome itself, power requirements were increasing to the point that additional power was required. In 1845, Hope Mills was relying on 17hp generated by water and 60hp by steam engines, a sign of what was to become an increasingly frequent occurrence in the region, a situation that already common in parts of the Wiltshire and Somerset clothing districts. By way of example, at Spring Gardens Mill in Frome, by 1814, the site possessed a single engine. By 1833, this had risen to four engines producing between them 96hp. This was augmented by 30hp derived from water power (Rogers, 1976: 208). This split of power was the reverse of what was generally to be found in the majority of the mills of the Stroud region.

Stroud was not entirely alone in its late dependence on water power and at least a few other woollen cloth districts operated in a similar fashion. Ironically, these were predominantly in Yorkshire, traditionally viewed as the heartland of steam power in the woollen industry. However, even here there were parts of the region that were remote from large centres of population and well away from either a railway or a source of inexpensive coal. For instance, around Upper Wharfedale, water remained the dominant source of power throughout the 19th century and in a situation akin to that prevailing in the Stroud valleys, continued to drive machinery in this way, in some cases well into the 20th century (Giles & Goodall, 1992: 125).

Manufacturers operating under these circumstances retained their support of water power and both in the Stroud valleys and parts of Yorkshire, even with the relatively easy availability of coal in the latter, plus the great increases in efficiency of mid 19th century steam engines, some manufacturers stuck doggedly with water (ibid. 126). Even in the face of water shortages caused by drought, ice and excessive impounding by mills further upstream, a number of manufacturers could not be seduced by the perceived merits of steam power.
The Post-Steam Era

Throughout the most productive period of the Stroud valleys industry, power sources remained a combination of water and steam. Later in the 19th century, a number of alternative power sources became available, primarily in the shape of gas and oil engines.

Gas Engines

Gas engines formed the first internal combustion engines and in terms of efficiency, were often twice that of corresponding steam engines. In addition, they were more economical to operate (Bowen, 1981). Gas engines were powered by Producer Gas which was generally made by the controlled primary combustion of various types of solid fuel; in the Stroud region it was usually coal-based, although engines could operate on gas produced from peat, wood, straw etc. Gas was made in a separate generator plumbed directly to the engine, being drawn into the engine by suction created by the piston of the engine itself. This system had the advantage that the quantity of gas produced was dependent on the amount required by the engine, hence there was no requirement for the system to operate under pressure. Alternatively, gas engines could operate on Town Gas, where available.

The first crude gas engines were developed in 1859 although a considerable degree of refinement was subsequently necessary before they were accepted as a commercial proposition. In terms of numbers and horse power available, the effect of the gas engine on the Gloucestershire woollen industry was relatively slight, compared with the impact that steam had had. There were a number of reasons for this. By the time that gas engines were becoming easily available (essentially from the 1880s onwards), the local woollen cloth trade was in the throes of its contraction to fewer, but larger production sites. Increasingly, mills were becoming powered by one or two large steam engines, often of considerable horse power. For instance, c1900, Dudbridge Mills was powered by two 500hp steam engines supplied by H J H Kings. Although gas engines were manufactured in both Stroud and Gloucester, producing power up to ~160hp, those encountered in typical industrial sites in the valleys were generally much smaller and in operation, tended to be used to power perhaps an individual building or workshop. They did not normally comprise the main central power source, as did the water wheels and/or steam engine(s). Similarly, in Wiltshire, gas engines were generally used in combination with another power source and like those of the mills in the Stroud region, were of small power output. For instance, c1900, Broadway Mill in Frome was powered by a 4hp steam engine and a 4.5hp gas engine (Rogers, 1976: 205). Their use as the prime mill power source may have been hampered by the difficulties associated with obtaining supplies of town gas in sufficient quantity and at suitable price for the scale of engine that would have been required; many of the valley mills were
in relatively remote locations, away from centres of population.

As noted above, where gas engines were installed in Gloucestershire cloth mills, they were never the sole provider of power: inevitably they were used in conjunction with other sources such as water and/or steam. For instance, at Nind Mills, Wotton, the large mill was partially driven by means of three water wheels supplied by the "unfailing Little Avon". The remainder of the power requirements were met by a combination of steam and gas engines, the latter being fuelled by gas generated on site. The gas producer plant had been designed and erected by a Gloucestershire engineering firm (Industrial Gloucester, 1904: 25). Even in Yorkshire, the gas engine failed to make a major impact on the woollen industry. In fact, in much the same way as they were utilised in the Stroud area, they were generally used to supplement power produced by water and/or steam. A handful of small Yorkshire mills were wholly dependent on gas engines although these were few in number: Stadium Mill (built 1912) and New Close Shed, Silsden (built 1913) were entirely powered by gas engines (Giles & Goodall, 1992: 163). Larger mills continued to rely predominantly on steam power until the advent of electric drive. In many cases, the latter effectively displaced the need for small steam and gas engines.

Depending on the mill’s location, gas could be supplied from either the central supplier (eg. Stroud gasworks) or from gas produced on site. The latter option was sometimes adopted through a case of necessity and in some cases, cost. For instance, the large engineering concern of Newman-Henders, situated in Woodchester, from the beginning of the 20th century, reportedly made much use of electricity within their works. This was generated partly by water and partly from their own power house which was equipped with gas engines supplied from their own producer plant on site and was doubtless similar to installations encountered in local mills. The company noted that the gas supplied to the engine was:

"...at a very economical price compared with ordinary town gas" (Industrial Gloucester, 1904: 10).

Similarly, one of the main local suppliers of gas engines, the Dudbridge Iron Works (VCH. ii. 204), not surprisingly, powered their own premises with one of their own engines supplied with gas generated on the premises (ibid. 16). A number of such installations stored gas on the site in small dedicated gas holders. Where the mill did not generate its own gas, it was reliant on the supply from the gas works. Such was the case with the c1860 Fielding & Platt unit at Millbottom Mill in the Horsely Valley, where the gas supply had to be specially brought up the valley from Nailsworth (Pers. Comm. Mr A Gordon of Ruskin Mill). However, a gas supply did not necessarily indicate the
presence of a gas engine as in many cases its use was restricted to lighting and perhaps heating. For instance, Churchend Mill in Eastington was thus supplied.

Thus, the gas engine proved to be a useful workhorse for many industrial applications although relatively few were to be found in the cloth mills in the region. Their main period of use overlapped greatly with water and steam power, as well as electric power. It was the introduction of electricity and the development of more advanced internal combustion engines that essentially removed the requirement for both the small steam and gas engine, although as a result of the longevity of the latter, some carried on working until well into the 20th century; the gas engine in Brookhouse Mill, Painswick, did not expire until c.1964.

Figure 38. Invoice of 1912 from Fielding & Platt, showing patent gas engine

Overall, despite the gas engine’s advantages of compactness, efficiency, reliability and economy, in the Stroud region their use was limited largely to applications requiring small-modest levels of power. Although a few were used for supplementary power in the region’s cloth mills, their full commercialisation effectively came too late to have a major impact on the shrinking cloth trade. By now, cloth production was increasingly in the hands of a small number of major manufacturers whose mills were already usually equipped with combinations of water and steam power. As in many other respects, the Stroud manufacturers stuck with what they knew and there was little uptake of the gas engine in the cloth trade. However, it did meet with greater success in industry at large and a number were installed in a variety of non-textile related industries in the region. Much as the identity and provenance of the smaller steam engines that were being installed in the region’s mills during the latter part of the 19th century remains unknown, such is the situation encountered with gas engines used.
There were at least three important suppliers of gas engines in the region, the Dudbridge Iron Works and TH & J Daniels in Stroud, and Fielding & Platt in Gloucester, however, in no case have company records survived. Hence, although all three undoubtedly supplied gas engines into the Stroud valley industries, details of location, engine type and horse power remain scant. For instance, it is known that in the case of the Dudbridge Iron Works, which had been set up in 1891, hundreds of "Dudbridge" engines were sold to both local and international markets, in sizes ranging from 1-160hp (Industrial Gloucester, 1904: 16) although their fate is largely unknown. Their high reputation was based on the simple and robust design, interchangeability of parts and ease of maintenance, as well as factors of economy and efficiency compared with steam. The characteristics of corresponding engines produced by Fielding & Platt were similar, the simplicity and robustness proving an important selling point. Engines typically comprised a single horizontal cylinder mounted on a cast iron bed, with twin flywheels and a flat belt pulley, carried on an open crankshaft. Gas could either be supplied from a central supply or from Producer Gas generators, also manufactured by the company.

H J H Kings of Nailsworth also supplied gas engines although judging from the surviving order books, the number of engines produced is likely to have been small. These included an order for a 9.5hp gas engine complete with water tank, gearing, shafts and pulleys (GRO. Order Book 1900. Order n1824). Daniels, like Fielding & Platt, also produced suitably sized gas producers and gas holders, tailored to supply their engines.

![Image of gas engines being assembled at TH & J Daniels works, Stroud, c1900](image-url)

*Figure 39. Gas engines being assembled at TH & J Daniels works, Stroud, c1900*
Table 19
Confirmed Gas Engines in the Stroud Region

<table>
<thead>
<tr>
<th>Location</th>
<th>Manufacturer</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dudbridge Iron Works</td>
<td>Dudbridge Iron Works</td>
<td>Engineering</td>
</tr>
<tr>
<td>Nind Mills, Wotton</td>
<td></td>
<td>Woollen cloth</td>
</tr>
<tr>
<td>Millbottom Mill</td>
<td>Fielding &amp; Platt</td>
<td>Leatherboard, brass foundry</td>
</tr>
<tr>
<td>Newman-Hender, Woodchester</td>
<td></td>
<td>Engineering</td>
</tr>
<tr>
<td>Listers works, Dursley</td>
<td></td>
<td>Churn manufacture</td>
</tr>
<tr>
<td>Brookhouse Mill, Painswick</td>
<td></td>
<td>Pin manufacture</td>
</tr>
</tbody>
</table>

Often, gas engines were used in combination with other power sources; for instance, the engine at the Listers works was used in conjunction with water power (Industrial Gloucester, 1904: 9).

Although less common, oil engines were also found in a few locations. For instance, Coaley Mill used a power combination consisting of water wheels, two water turbines and an oil engine (ibid. 11).

Electrical Power

Since its first introduction, steam power had been utilised in a succession of increasingly efficient ways, starting with simple Newcomen-type engines and progressing through beam and rotative engines, and finally to the steam turbine, the latter being adopted in order to generate electrical power. With this system, it was possible for manufacturers without access to a public supply to reap the benefits of electricity, generating their own electrical power on site. Although electricity swiftly found many applications in the textile mills of the North and the West of England, its use in the West was directed primarily towards providing lighting as opposed to powering machinery. For instance, in 1899, Chamberlains Mill at Nailsworth ordered an electric utility plant of 60 incandescent lamps powered by a steam-driven dynamo from H J H Kings. Dunkirk, Dudbridge and Stanley Mills were similarly lit, either steam or water power being used to drive dynamos at the sites; this route was apparently a very economical way of producing electricity (Tucker, 1978; 22). At Ebley Mill, in 1896, Marling & Co. installed a 35hp high speed steam engine driving an 18kW dc dynamo. This was used to provide lighting in the mill in the form of 350 lamps (Electrical Engineer. n18. 13 November 1896. 562). Such privately-operated generation schemes became fairly widespread and ironically, it was this factor that probably retarded the provision of a public supply in the area. Clearly, for economic viability, a public supplier needed guaranteed sales to commercial customers, however, many of these were already meeting their lighting, and perhaps partially, their power needs, from on-site generation systems.
The adoption of electricity as a source of mechanical power did not start in earnest until the early part of the 20th century; the first recorded example of a mill powered in this fashion was Becks Mill in Keighley, built in 1907 (Giles & Goodall, 1992: 163). By the 1920s, electricity as a power source, at least in Yorkshire, was fairly commonplace, although in the West of England its use was more limited. In the Stroud area, a few of the larger mills were now generating electricity for lighting and power, although steam power frequently continued to provide much of the latter. At the extensive Dudbridge Mills of Apperly-Curtis, it was noted that:

"The mills, which are among the largest in the district, are equipped with a complete electrical installation for power and lighting" (Hawker, 1945: 65).

At least some of the electrical equipment supplied to the site came from the Nailsworth engineering firm of H J H King. In 1920, Kings supplied a:

"30kW generator. 225 volts. 850 rpm. Side rails and rope pulley. 4 pole type. £140-0-0; also a 30 BHP motor with slide rails, pulley. Automatic no voltage and overload protection. 4 pole type. £138-0-0" (GRO. Kings Order Books. 1900. Entry 1843).

In the same year they also supplied a 10hp 110 volt electric motor destined to drive one of the site's (boiler) stokers (ibid. Entry 1750). It was from the Dudbridge Mill site that, in 1916, the fledgling Stroud Electricity Supply Company was being supplied with electricity. A 220v dc supply was carried by cable to a substantial house some half mile distant, feeding into a bank of large rechargeable batteries located in the basement (Wilson, 1995; 43-44), from where it was distributed to the company's customers. The supply from the mill was sometimes terminated in the evening and on other occasions, continued over night. Presumably the requirements of the mill were met before that of the electricity company. In later years, the tables would be turned and following the arrival in 1924 of a more robust electrical supply system in the district, mills increasingly began to take their electricity from the public supply.

Depending on their location, manufacturers had a choice of buying in their electricity from a public supplier or producing their own on site. If the latter option was adopted, the main requirement, apart from steam boilers, consisted on the steam turbine and its associated electric generator. In terms of infrastructure, requirements were comparatively simple compared with earlier steam engine houses; in general, all that was required was a robust base of masonry or concrete on which to mount the turbine and generator. In some locations, old engine houses were adapted and reused for the purpose. The introduction of the steam turbine made obsolete high speed steam engines driving dynamos (Law, 207)
1965: 25). The turbine had a number of advantages over earlier electricity generating systems; it could be made smaller, lighter and cheaper than a reciprocating steam engine of comparable size. In addition, mechanically, it had the advantage of producing rotary motion without the necessity of using a crankshaft or other means of transforming reciprocal to rotary motion (Microsoft Encarta. Funk & Wagnall Corp. 1990. CD entry B536).

Clearly, capital outlay on such a system could be considerable and the capital cost of installation and conversion to electrical drive could only be countenanced where the business was large enough to justify the costs. From this, it becomes apparent why no such systems were to be found in the mills of the contracting West of England woollen mills. In contrast, in Yorkshire many businesses were of sufficient scale to justify the wholesale adoption of electricity and here, turbine/generator systems were installed in a number of mills. It is doubtful that, even if the West’s mills had still been thriving, many such installations would have been set up; with a few exceptions, the scale of the average business in the West would have not justified the initial capital outlay required for a wholesale switch to electric power generated on site. Usually, electricity was adopted as a replacement for water and/or steam power when it became freely available via public supply although there were instances of lengthy overlap. In some instances electrical power was not adopted until the existing power source reached the end of its working life. Even the grandiose Ebley Mill did not switch fully to electrical power until 1937 (Falconer, 1993: 77) and St. Marys Mill in c1946.

As noted, the alternative to on-site generation was to buy in from a public supply. Here again, many northern mills were at an advantage as a result of their urban locations. In many parts of the West, especially with the mills of the Stroud valleys, sites had originally been selected on the basis of the availability of water power. Clearly, this placed many in relatively isolated, thinly populated locations, areas that were often late in obtaining a public electricity supply. The sites furthest from Stroud itself were at the greatest disadvantage in this respect. For instance, a public supply did not penetrate to Longfords Mill in the Avening Valley until the latter part of the 1920s. Here, the Playne’s had already recognised the merits of electrical power and had been generating their own on site for some time using a combination of steam and water-driven generating equipment. As with the earlier Oil Mill scheme, the turbine installed at Longfords Mill was not used to directly power machinery, rather to produce electric power. Longfords was one of the first mills in the district to adopt large scale electrical drive and by the early part of the 20th century, was heavily reliant on this form of power. Writing in 1915, Arthur Twisden Playne commented that:

"[the] whole mill is run by electric power except the fullers and washers (water driven). Electricity is supplied from a central power station, current conveyed from dynamos to motors in various
workshops...much cleaner and neater system than the cumbersome cogwheels of former days, and the loss of power by friction is very much less". (Playne, 1952: 48).

At Longfords, the company installed its own generating plant, located in the basement of one of the oldest buildings of the complex. This still houses a 1904 Bellis & Morcom steam engine, a Gordon water turbine of c1920, and two large diesel engines dating from c1940 (Wilson, 1993; 18-26). Each system had its own dedicated generating equipment and switchgear, allowing it to operate in parallel with the local supply system which did not become available until the 1920s. Even when the public supply was available, the Longfords power station was to prove its worth during several periods of crisis.

Playne’s comments support the notion that at this stage, machines did not have individual motors, rather, were still driven indirectly by a series of line shafts powered by a single electric motor; photographs from this period confirm that this was at least partly the case. In Yorkshire, by this time, many mills were similarly equipped for electric power although often, machines had their own dedicated motors. Longfords was not alone in still relying on this means of secondary power transmission as at least one of other major mills in operation, Strachen & Co. of Lodgemore Mills, was certainly relying on electrically driven line shafting to power both its spinning and weaving shops up to and beyond 1937.

With the exception of the above mills, large-scale on-site generation remained a relatively rare occurrence in the mills around the Stroud region and where electricity was adopted as the main source of power, this predominantly came from a public supply. Although a number of mills had already been using modest water and steam-powered setups to provide electricity for lighting purposes, relatively few came to depend entirely on electricity as the primary source of power until public supplies became available in the vicinity.

Unlike a number of major textile mills in the North, no local manufacturer installed a steam turbine-based generating system although intriguingly, in 1905, the H J H King order books list a steam turbine as being in stock (GRO. H J H King Order Books. 1905). There is no indication of its source or its eventual location although neither is likely to have been local. If Kings had hoped to encourage the use of a turbine-based system in the locality, they were clearly unsuccessful.
Overall Summary

In the Stroud valleys, the early introduction of steam power was at best patchy, and in overall terms was slow compared with competing woollen areas. Some manufacturers clearly believed in the merits of steam over water power, but generally, the traditional use of water power outlived that in many similar manufacturing districts, long heavily dependent on steam power. Many manufacturers were very conservative in their outlook, not merely in the products they made but also in their takeup of technological advances. Consequently, some preferred to stick doggedly with water power despite the well documented seasonal shortages that regularly afflicted them. Even when steam power had been adopted widely in other cloth making districts, Stroud manufacturers preferred to pump money into schemes designed to improve their water supply, still visible in the shape of large reservoirs at Longfords, Lodgemore and Stanley Mills. Generally, water remained the prime mover, water wheels being the main means of harnessing its power, as opposed to turbines of potentially greater efficiency; surprisingly, the uptake of water turbines in an area so heavily dependent on water power was meagre. Hence, where for instance, newly installed machinery required an increase in power input to the mill, this was not necessarily met by the introduction of a steam engine; improvements in water power were often the first line of attack even though the overall costs of such works may well have equalled or even exceeded the cost of a steam engine. However, increasingly, the situation arose whereby power requirements of mills began to exceed that available solely from water, even at times of peak flow. In these situations, mill owners who wanted to remain competitive had little option but to install steam power, although this was generally as a supplement to water power.

In most cases, Stroud manufacturers were relatively slow in adopting steam power. In 1805, there was little to choose between Gloucestershire and its traditional local rival in the shape of Wiltshire, both counties having a single engine employed in a textile mill (TA. 11 April 1857). The only one in the vicinity of Stroud was Sheppard’s Boulton & Watt engine in use at his large Uley mill complex (Mann, 1987: 154) although the Purnells also had a similar unit in operation at their Framilode tin plate rolling works from 1803. Within a decade or so, the position had changed dramatically and by 1815, Gloucestershire could still only boast four engines while Wiltshire had dozens in use.

Around Stroud, water power continued to dominate with various technologies being used to increase its effectiveness. Rivers were realigned, such as at Ham Mill, and completely artificial channels created, such as Churchend Mill, in an effort to increase both the horse power available and improve the regularity of supply in times of drought. For much of the 19th century and beyond, water power was to continue to play an important role and improved designs of water wheel increasingly replaced earlier less efficient variants. The increasing use of iron for wheel construction was an important step
as was the adoption of advances created by the development of suspension wheels and rim gearing.

It is interesting to note that some of the biggest mills in the region were still totally reliant on water power even during the 1830s. In 1833, John Apperley told the Factory Inspectors that the large Dudbridge Mill had been built mainly within the preceding three years and that water power alone was used (Tann, 1967: 156). Downstream, Ebley Mill was being powered by five large water wheels and on the Little Avon, New Mills was also being driven solely by water, three of the biggest mills in county. Presumably the owners' requirements were still capable of being met by water power alone, despite the inevitable setbacks in times of water shortage. By now, the vast majority of mills in the region, both large and small, capable of adding steam power to supplement their water wheels had done so, hence it is surprising to find these three major manufactories some way behind them. Such conservative behaviour was characteristic of many aspects of the Stroud manufacturers.

Water power continued to be used in some of the dwindling number of mills until well into the 20th century although its use in textile-related operations was limited to a few examples. Messrs Strachen & Co of Lodgemore and Fromehall Mills were reported to be using water power in one department in 1907 (VCH. vii. 198), Iles flock mill still used water power in 1913 (Gardiner & Padin, 1984: 100), a water wheel was in use at Bonds Mill up to c1930, and Days Mill continued operations partly dependent on a water wheel up to the time of the Second World War. Even the massive Dunkirk Mills still had water wheels in operable condition up to the 1940s (Tann, 1967: 231). Possibly, water turbines were also in use at Stanley and Dudbridge Mills at the time. Occasional non-textile-related uses were encountered such as Brookhouse Mill in Painswick, partially water powered up to the 1960s, and Fromebridge Mill, where remarkably, a water turbine continued operations up to 1989.

The appearance of the gas and oil engine had little impact on the local cloth trade although such engines were more widely used to provide power for some of wool's successor industries. As with the earlier reluctance of local manufacturers to relinquish water power for steam, in later years there was a general tardiness when it came to abandoning combinations of water and steam power, then in widespread use. It appears that many mills in the region bypassed the use of oil and gas engines, switching directly to electric drive. In a few cases, electricity (as the main power source) was generated on site, however many mills did not switch to electric drive until the availability of the public supply. The latter came to be the sole means of powering the dwindling number of mills at work in the Stroud region.

The foregoing comments help to emphasise that power source(s) adopted in the region's mills were very site-specific, a combination of local circumstances and market conditions dictating hours of
running and actual horse power required for the process. Moreover, the more usually accepted progression of power sources, through water wheels of increasing efficiency, possibly to water turbines, thence to steam, gas and oil engines, followed by electricity, did not always take place. Until the widespread adoption of electricity, most mills remained reliant on a combination of two or more power sources, allowing a greater degree of flexibility in terms of their mode of operation and permitting the most cost-effective combination to be used.

Table 20
Power Sources of Selected Mills in the Region

<table>
<thead>
<tr>
<th></th>
<th>Longfords</th>
<th>Stanley</th>
<th>Dudbridge</th>
<th>Ebley</th>
<th>Dunkirk</th>
<th>Millend</th>
<th>Bonds</th>
<th>Wallbridge</th>
<th>St Marys</th>
<th>Brook-house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water wheels</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Water turbine</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Steam - beam</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Steam - horizontal</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(X)</td>
<td></td>
</tr>
<tr>
<td>Gas engine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(X)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity - site generated</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity - public supply</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>(X)</td>
<td>X</td>
<td>X</td>
<td>(X)</td>
<td>(X)</td>
</tr>
</tbody>
</table>

(X) Denotes post-woollen period
CHAPTER 7

TRANSMISSION OF POWER

Power distribution systems were minimal or non-existent where small hand or animal powered processes were utilised; even early fulling mills were generally driven directly by a simple tappet wheel. It was not until a multiplicity of processes came to be gathered together under one roof that power distribution systems became a critical aspect of production. In this situation, a number of individual processes and/or machines were powered by a centralised source of power, namely water or steam, or a combination of both. From here on, transmission systems increased in importance and complexity and were expected to deliver power to all appropriate parts of the mill in a safe, efficient and reliable manner.

Power transmission in early fulling mills was a relatively straightforward matter; the stocks were raised and lowered by means of variants of simple tappet wheels, turned directly by the water wheel. Initially, this was the only powered process in the chain of cloth manufacture however, later, especially in the Stroud region, teazle gigs were also driven by water power. At this point, power transmission began to increase in complexity as the necessity of driving several separate machines from a single source of power became a necessity. There was still the option of using a dedicated wheel for each individual piece of machinery and in some cases, this was the solution adopted. Fairbairn comments:

"At this point mills were improved and enlarged...what is surprising, the engineers and millwrights of those days appear to have had no idea of the advantages derivable from large water-wheels, but contended themselves with additional wheels to meet the demand of additional work. On the occasion, every pair of fulling stocks had their separate water-wheels and these were multiplied according to the demands or necessities of the trade". (Fairbairn, 1865: 110).

This system was adopted widely; at Baylis's Upper Mill in Painswick, a separate internal water wheel was used for each function, hence two sets of fulling stocks were driven directly off the central wheel shaft, one each side of the wheel, the cloth washer by a second and the gig mill directly by a third.

There was a clear limit to how far this technique could be extrapolated; Baylis's was probably as far as this could practically be taken. It became impractical to continue increasing the number of individual wheels for each additional application. The only alternative was to drive multiple units via a transmission system of some sorts.
Advances in the development of power transmission systems were not limited to the woollen industry and significant developments were taking place some years before such activity took place in the trade; particularly in the area of silk throwing, important developments occurred during the earlier part of the 18th century. The necessarily complicated steps involved resulted in systems capable of driving a multiplicity of units. Of particular note were the development of early powered systems as adopted in Cotchett’s Mill (c1704) and Lombe’s Mill (1721) on the banks of the River Derwent in Derby. The systems used in these innovative enterprises must have provided considerable operating experience on which later developments in other branches of the textile trades were based. By the mid 18th century, mechanical systems were in use in a group of silk mills in East Cheshire (Calladine & Fricker, 1993: 24). Retrospectively, Rees’ Cyclopaedia (1819) describes the evolution of such power transmission systems developed for winding, reeling, etc. in the silk trade (Entry for ‘Silk’. vXXXII). It makes particular reference to Lombe’s Mill, amongst others. Further details are given by Calladine (1993; 82-99).

Categories of Power Transmission

Transmission of power from the centralised power source(s) can be viewed effectively as comprising two major segments. The primary transmission can be considered as the means of transmitting the power from the water wheels or steam engine to the different floors of the mill (or possibly adjacent buildings) whereas the secondary transmission constitutes the passing of this power within these areas, down to individual units such as spinning machines, carding engines and power looms. With few exceptions, in all woollen regions, the initial system adopted for primary power transmission centred around the use of vertical and horizontal wooden shafts. Generally, upright wooden shafts took the power from the water wheel(s) and/or steam engine, to the upper floors of the mill, or into
adjacent structures. As subsequent developments increased the power available from water wheels and steam engines, so mills began to increase in size, primarily upwards. By the late 18th century, some mills had reached a height of seven storeys (Markus, 1993: 266) although this was predominantly in the North. In the West of England, structures were generally more modest although a few of the Stroud mills, such as the original Lodgemore Mill, did attain six storeys. In some locations, mills also increased significantly in length (although their width remained the same) achieved through placing the water wheel(s) in the centre as opposed to the traditional location, at one end. This enabled horizontal drive shafts to be run in both directions, to the ends of the mill. Hence, although mill lengths now reached up to 100 metres or more, maximum shaft lengths remained at 40-45 metres. At points along the horizontal shaft, bevel gears took the drive to the upper floors via vertical shafts.

This means of primary power distribution was generally associated with newly built mills; in the Stroud valley mills, and many others in the West, the earlier systems was often retained. Here, transmission tended to be based on that of the traditional corn mill, whereby a cogged pit wheel, carried on the main axle of the water wheel, engaged with a smaller bevel gear mounted on an upright drive shaft. This carried the drive to the upper floors. As many Stroud valley mills had been based around extended or partially rebuilt structures of earlier periods (as opposed to completely new builds) it was general practice to stick with this relatively simple tried-and-tested system.

In the Stroud region, in relatively few cases were water wheels re-sited to a central location. As alluded to already, the typical Stroud business was considerably smaller than that of, for instance, Yorkshire. In few cases were mills built on a scale to match the North. The result was that manufacturers often retained adapted buildings in which the water wheels remained in or near their original locations although clearly there were exceptions. At Millbottom Mill in the Horsley Valley,
there is clear evidence of the location of the earlier (probably undershot) water wheel in the basement of the present structure. Although the position of the water wheel moved some distance to the end wall of the new building, this relocation was associated with the construction of a new mill pond and the adoption of a more efficient overshot wheel. However, this serves to re-emphasise the point that existing mills were frequently at least partially absorbed into later replacement structures.

Apart from the financial constrictions, substantial rebuilds were often precluded at many mill sites as a result of the local topography and their cramped nature. Other surrounding features often hemmed in the existing buildings. In addition, there was intense development along most watercourses ensuring that effectively all suitable, and less than suitable, sites were utilised. Thus many of the mills based around earlier structures retained their water wheels in less than ideal offset positions. This may not have been such a drawback as it might appear as physically, most mills in the region were much smaller than in Yorkshire, hence the lengths of shafts required were much more modest. The length of wooden shafts was limited by the extent of their torsional resistance; in many Stroud locations, this limiting factor may not have been reached as both lengths of shaft and the power they were required to carry, was generally much less than in the North. This undoubtedly played a part in the continuing use of this apparently antiquated system, long after more advanced methods of power transmission had been adopted widely elsewhere.

The Development of Iron Drive Shafts

In all textile mill areas, original upright drive shafts were made of wood reinforced with iron hoops. However, these were supplanted by cast or wrought iron, as advances were made in manufacturing techniques. Both forms of iron shaft found wide acceptance in textile mills. Such shafts required to be strong but also needed to be resistant to twisting or torsion. These problems were well known to the likes of Fairbairn. As a proponent of iron shafting, he ensured that it was used widely in any projects that he was involved with. The advantages in terms of strength can be gauged from the following table:

<table>
<thead>
<tr>
<th>Material</th>
<th>Strength (lbs)</th>
<th>Modulus of Torsion (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast iron</td>
<td>2548</td>
<td>−951,600</td>
</tr>
<tr>
<td>Wrought iron</td>
<td>2050</td>
<td>−1,775,000</td>
</tr>
<tr>
<td>Teak</td>
<td>820</td>
<td>−27,300</td>
</tr>
<tr>
<td>Oak</td>
<td>400</td>
<td>20,000</td>
</tr>
<tr>
<td>Ash</td>
<td>675</td>
<td>20,300</td>
</tr>
<tr>
<td>Pitch pine</td>
<td>544</td>
<td>14,750</td>
</tr>
</tbody>
</table>

(Fairbairn quoting Barlow's experiments)
(Notes: Standardised samples used for comparison of strength; Modulus of torsion as a measure of resistance to twisting).

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One of the first notable examples of the use of iron shafts was in Rennie's London Albion Mills of 1784-5. Although this innovative corn mill was short-lived, it demonstrated the supremacy of iron shafting over wood. The adoption of iron shafts resulted in a significantly greater degree of freedom of mill design. As a result of iron's greater torsional resistance, it now became possible to manufacture longer shafts and textile mills increased in both height and length. From the 1770s on, iron played an increasingly important role in this respect and gradually, wood gave way to iron for this aspect of power transmission. Not only was iron stronger, it was now easier to produce much longer runs of shafting, manufactured to closer tolerances; this helped reduce problems of alignment and vibration. Of smaller diameter than wooden equivalents of corresponding strength, the reduction in overall weight was a useful spin-off. In addition, iron gears could be attached and centralised on the shaft with relative ease, whereas centralisation of gears on a wooden shaft could be a time consuming business involving the use of tapered wedges packed between the gear and the shaft. Similarly, an iron shaft was easier to support in bearings along its length, unlike wooden shafts which invariably ran less true. Examples of methods to link shafts are shown below on Figure 47. In the event of failure, an iron shaft was appreciably easier to replace, an added bonus in reducing mill downtime. In many of the integrated Yorkshire woollen mills, the primary drive shaft ran underneath the mill's ground floor, located in suitable tunnels from which the power was transmitted via bevel gears, to upright shafts at the appropriate points. This particular arrangement of primary transmission was not found in any of the Stroud mills.

This is not to infer that all workmanship was up to that of the likes of Rennie and Fairbairn, and the latter when referring to early shafting noted that:

"at the beginning of the [19th] century, mills were geared with ponderous shafts...generally of cast iron, square and badly coupled".

Although not adopted widely in Britain, there was an alternative to the upright shaft, that of drive via flat leather belts or straps. This system was ubiquitous for secondary power transmission in Britain, however it was used for primary transmission in many US cotton mills of the period. The use of belt drive for these purposes was rarely countenanced by British millwrights who considered that its advantages were greatly outweighed by its disadvantages, namely, higher power losses through increased friction, slippage over the pulleys and frequency of repair. In addition, in order to cope with the substantial amounts of power required, belts often needed to be up to 3 feet in width. Occasional examples of belt drive occur in Britain but not in large textile mills. For instance, the water-powered Moelwyn fulling mill at Tanygisiau, Merioneth, took its drive via leather belting (Parkinson, 1985: 42-43) although clearly here, power transmission requirements were minuscule compared to a large textile mill.
Although such belt drive systems were suitable for a relatively simple, low powered fulling mill, from the following table it becomes clear how cumbersome such systems could become where high horse power was involved:

Table 22

<table>
<thead>
<tr>
<th>Horsepower</th>
<th>Belt width (ins) - 7 ft diameter main pulley</th>
<th>Belt width (ins) - 10 ft diameter main pulley</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>5.1</td>
<td>3.6</td>
</tr>
<tr>
<td>20</td>
<td>10.2</td>
<td>7.2</td>
</tr>
<tr>
<td>40</td>
<td>20.0</td>
<td>14.0</td>
</tr>
<tr>
<td>60</td>
<td>30.0</td>
<td>21.0</td>
</tr>
<tr>
<td>80</td>
<td>41.0</td>
<td>28.0</td>
</tr>
<tr>
<td>100</td>
<td>51.0</td>
<td>36.0</td>
</tr>
</tbody>
</table>

(After Fairbairn, 1865: 4)

Large belt drive systems found favour in some US mills as, interestingly, did round ropes of catgut
or hemp, running in grooved pulleys. The latter system was to make its presence felt in Britain’s textile industries later in the 19th century.

**Power Transmission in the Stroud Mills**

Overall, the characteristic flat belt drive was the predominant method of secondary power transmission adopted in the Stroud valleys although as in Yorkshire and elsewhere, primary transmission from the water wheel or steam engine was often by means of a substantial main vertical drive shaft passing through each floor of the mill. Appropriately located bevel gears took the drive off at each floor level, usually transferring it to line shafting and thence, to individual machines. In some cases such as Churchend Mill, the main shafts were inside the building, whereas at others, it ran up an outside wall of the main building. Examples of the latter include Meadow Mill, Eastington (Pers. Comm. Mr J Ireland, former employee) and possibly Bonds Mill in Stonehouse. Further afield, the original fulling house at Cam Mills also used an external shaft (Pers. Comm. Mr R Palser, Cam Mills Ltd). Not surprisingly, considerable amounts of power were dissipated through the multitude of frictional losses encountered. Fairbairn noted that in some instances, the power required to keep such upright shafts in motion sometimes outweighed that of the machinery that it drove (Fairbairn, 1865: 72). Despite this, the use of vertical drive shafts remained fairly widespread and was to be found in mills of varying size throughout the Stroud valleys. When the modest sized Pitts and Freames Mills were offered for lease in 1820, the particulars mentioned:

"...two stocks and a gig mill with an upright shaft and a large drum to drive the machinery in the said mill [Pitts]". (Tann, 1967: 279).

Likewise, the lease for Freames Mill included:

"an upright shaft and two large drums to drive the machinery in the mill loft and also one other drum in the next loft and also others in the shearing loft". (ibid. 230).

The drums mentioned appear to have consisted of wooden cylinders which operated as very wide belt wheels, allowing a number of belts to be taken off from the same point. The only known survivor of this system remains in Daunceys Mill, Uley. This is driven via iron/wooden gears by an internal water wheel of ~ 12 ft diameter and 5 ft width, featuring wooden axles and shafts. Cloth manufacture ended here around 1840 and the mill was turned over to saw milling. It is not possible to ascertain whether the drum is associated with woollen manufacture at the site although this seems the most likely explanation.
The use of such drums to allow power to be transferred to individual machines was also encountered in Wiltshire. Although such surviving transmission systems are rare, one is also preserved as part of the Esgair Moel fulling mill which forms part of the National Museum of Wales at St Fagans. Here, like at Daunceys Mill, a wooden belt drum is driven by an iron spur gear, transmitting power to machines on the upper floor.

Figure 43. Transmission system, Daunceys Mill, Uley

Figure 44. Esgair Moel Mill, St Fagans

One drawback with this type of power transmission system, especially in large manufactories, was that they:

"blocked up the rooms of the mill with large drums and pulleys, obstructing the light, which in factories is a consideration of very great importance" (Fairbairn, 1865: 72).
Although there is little evidence remaining, this system was probably fairly common throughout the West of England woollen districts, although technological advances made in power transmission systems invariably obliterated what went before (Rogers, 1986: Plate p72).

Some variants of the drum drive system were of iron as opposed to wooden construction. Certainly, in some of the earlier cotton spinning mills of the Manchester region, iron drums formed part of the main vertical shaft(s), belts transferring the drive to individual machines (Williams & Farnie, 1992: Plate p70). This appears to have been a relatively common form of secondary power transmission in many mills of the period and on the lower floors of the building, machines were sometimes driven in such a fashion from vertical shafts. On the upper floors, drive relied on overhead line shafting. This combination was fairly widespread in the Manchester region by the late 19th century (ibid. 89).

In the Stroud region, the grandiose Stanley Mill also made use of the vertical shaft principle. Here, the stocks were situated as normal on the ground floor and driven directly. Three of the four upper floors were powered by means of vertical shafts that passed through the brick vaulting via iron castings. The shafts were composed of staggered individual sections on each floor. Secondary power was distributed by the ubiquitous line shafting, supported by intricate cast iron columns and arches. In the central arcades, there was provision for three sets of shafting (Falconer, 1993: 22).

![Figure 45. Stanley Mill interior. 1985.](image)

Initially, power was provided by means of water wheels however alterations were made to the system when a 40hp Boulton & Watt engine was added. This was installed in a detached engine house, the drive shaft crossing the yard and entering the building through an aperture in the north wall. It then passed up the inside of the wall (ibid. 24).
There are indications that some manufacturers were willing to go to the additional expense of bringing in expertise from outside the immediate Stroud region. In the case of Churchend Mill, apart from George Haden, Boulton & Watt's engineer responsible for overseeing engine assembly and installation on site, there are indications that for some aspects of power transmission systems, the Hicks family were relying on a Manchester-based engineer of some repute, Mr T C Hewes. There are several references in the Boulton & Watt order books relating to various mill modernisations by the Hicks; these include "mill by Mr Hewes" and "millwork by Mr Hewes" (Boulton & Watt order books. Pers. Comm. P Bassett. Birmingham Library Services). Hewes was considered an eminent engineering millwright of the time, one of some national importance although how he became involved with the Hicks' mill projects remains obscure. Possibly he was recommended by Boulton & Watt or the Hicks may even have sought him out directly as a result of his reputation. As mentioned earlier, Fairbairn credited Hewes with significant developments with suspension water wheels c1810-1820, a period that immediately pre-dates his work at Churchend (c1822). Hewes may have been involved in improving the water power system at the mill although the mention of "millwork" would seem to imply that he was also involved with the power transmission system adopted. His involvement may reflect the wealth and status of the Hicks family in that they were in a financial position to bring in such an accomplished engineer. At the time, the Hicks were known to have been investing heavily in their mills.

The foregoing may have been a relatively isolated instance as the manufacture and installation of both primary and secondary transmission systems seems to have been largely the prerogative of predominantly local suppliers although it is possible that during the earlier part of the 19th century, access to appropriate expertise in the region may have been lacking at times. Certainly, by the second half of the century, there is every indication that power transmission systems were being produced, installed and maintained by a number of local millwrights and engineers.

Clearly, the weight of a vertical shaft system could be considerable, whether predominantly of iron or wood. This, plus the weight of the associated iron gears, bearing and supports necessitated a strong supporting structure and this usually comprised an end wall or a suitably strengthened internal wall; this was sometimes known as the "gearing wall". In some mills, the vertical shaft was located in a slot or duct within the wall, whilst in others, it intruded into the work space. In the Stroud region, generally the shaft appears to have been of the latter variety, often probably a legacy of the reuse of existing buildings. To accommodate the weight of the shaft, large masonry blocks were often used to provide support for its base section. This area was the one where the greatest stresses were imposed as much of the overall weight of the shaft was concentrated in this one spot.

Consequently, the design of the foot bearing often taxed the skills of the millwright. Not only was
it was essential that the bearing was of appropriate materials and of sufficient size, it was crucial that regular lubrication was maintained in order to avoid the bearing running hot. Where mills had been built in an ordered logical fashion, the vertical shaft(s) was generally located close to the building’s centreline, however with the piecemeal development that characterised the Stroud woollen industry, there seems to have been no hard and fast rule as to its location. Often, a corner of the building seems to have been used, possibly because of its greater strength.

As the Stroud mills grew larger and became increasingly mechanised, so power transmission systems became more complex. Sophisticated systems for transferring power to different parts of the mill were becoming commonplace and power was carried to every corner of the increasingly large and complex mill structures then in use. In some areas, shafting utilised bevel gears or other devices to reach particular areas, although straight runs of shafting were used wherever practical. Whenever it was required to transmit power through 90°, the most commonly encountered solution was the use of iron bevel gears. Although universal joints were also available, they found little favour with millwrights in Britain who considered them to be more troublesome than tried-and-trusted gears.

From the advent of powered machinery, there came the necessity of developing a mechanism for isolating it from the power source. In the industry’s infancy, where each machine had its own dedicated water wheel, this was not such a problem. However, when multiple units were driven by a single power source, an effective way to stop an individual machine was clearly required. Numerous solutions to physically removing the drive belt were developed during the 19th century. For instance, locally, H J H King developed a range of clutches that could be inserted into the shafting, allowing machines to be taken out of production without the need to uncouple the drive from the shafting. One type utilised an expanding/contracting band around a driven drum, much in the same way that the windshaft brake wheel of a windmill operates. There were many other novel designs produced (Figure 46).

Similarly, further complications occurred as combinations of water and steam power were adopted by mill owners and here again, Kings produced clutch mechanisms to accommodate such power source combinations.
Thus, power transmission systems inevitably became increasingly complex as the number of machines per mill increased and the overall power requirements rose. When John Ferrabee bought Hope Mills in 1843, the inventory for just one small section included:

"143 ft of drum shafting, round and square from 2 inches to 2 1/2 inches in diameter...shafts and gearing for driving stocks either by water wheel or steam engine" (Tann, 1967: 179-180).

Nearby, in 1846, Ham Mills was described as having three water wheels with iron shafts and arms and an upright shaft leading to the floor above containing the stocks and gigs (ibid. 171).

Despite the obvious disadvantages associated with the vertical shaft drive, it was a long time in dying. In the Stroud region, it outlived the introduction of rope drive elsewhere but even in the North, there were instances of the system surviving up to at least the turn of the 20th century. The last known vertical shaft system in use in the North was at Nile Mill, Chedderton, in 1899 (Wiliams & Farnie, 1992: Plate on p116).
Figure 47. Methods used for coupling and disengaging shaft drives (after Rees and Fairbairn)
Rope Drive

Predominantly during the last quarter of the 19th century, the ubiquitous vertical shaft drive began to be replaced by the more efficient rope drive system in some textile mills. By the close of the century, it had become the most widely used form of primary power transmission system being used in British textile mills. Its success lay in the development of the pliable long-lasting cotton rope, probably developed in the mid 1870s and introduced into Yorkshire mills a few years later (Giles & Goodall, 1992: 160) although as noted earlier, a type of rope drive was in use in some American cotton mills as early as the mid 19th century. From this time on, the rope drive usually formed the heart of the primary power transmission system in newly constructed or rebuilt mills. Associated with the widespread uptake of the rope drive was the increasing adoption of the horizontal steam engine as a replacement for the traditional beam engine. The combination of horizontal engine and rope drive became the norm for the textile industry, especially in the North. Now, the large flywheel of the engine, often referred to as the rope drum, doubled as the primary drive wheel and carried up to 60 individual grooves intended to take the various ropes, although around half this number was more usual. Ropes engaged with corresponding pulleys on the ends of single line shafts on the upper floors. From these, belts often took the power to adjacent shafts.

Clearly, as confirmed by the widespread uptake of the system, rope drive had significant advantages over earlier systems of primary power transmission. Perhaps the greatest from the manufacturer’s point of view was that it was both simpler than the often-complex vertical shaft drive, and effectively resulted in an increase in power available as a result of the greatly reduced frictional losses resulting from a host of shafts, gears and bearings associated with shaft drive. In addition, a broken vertical shaft could result in the total loss of power to a complete floor or even an entire mill, whereas a broken rope meant the loss of drive to perhaps no more than a single line shaft. Added bonuses included quieter running as well as increased safety for the operatives as the main transmission system no longer intruded into the work space but was now housed inside a separate rope race.

As a consequence, rope drive was adopted widely although it made little impact in the Stroud valleys. There were a few odd exceptions: at Playne’s Longfords site, to the east of the 1858 building, an additional structure was subsequently added. On the upper floors three sets of transverse sets of line shafting were accommodated, the surviving wall-mounted bearing boxes indicating that the central shaft was the largest, suggesting that this supplied the power to the two outer shafts. The central shaft was subsequently driven by an electric motor via a small rope race (RCHME Longfords Mill report and information supplied by I Mackintosh, Stroud Textiles Group).

Apart from the Longford’s application, only a few other mills appear to have adopted this form of
transmission. In 1896, P C Evans of Brimscombe Mills placed an order with H J H Kings, engineers of Nailsworth, for a rope flywheel of 7 ft diameter, grooved to take three 1.5 inch diameter ropes. In the same year, they also ordered a 3 ft 3 inch diameter flywheel to accommodate the same configuration (GRO. Kings Order Book No 1). By implication, rope drive was in use in their woollen mill. Kings also supplied a rope drive to New Mills of Tubbs & Lewis of Kingswood, near Wotton. In 1905, they supplied a horizontal engine with a 10 ft diameter rope drum designed to take six 1.25 inch diameter ropes. The foregoing are the only known examples of rope drive used in woollen mills in the Stroud valleys and the south of Gloucestershire. A few other examples were to be found being used by some of the industries that replaced woollen cloth manufacture. These included Toadsmoor Mill during its flock manufacturing period (Information supplied by Dr R Wilson). In addition, in 1908, Perkins & Marmont of Woodchester ordered a horizontal compound Corliss condensing engine with a rope flywheel grooved to accept six 1.25 inch diameter ropes. This was probably supplied to Frogmarsh Mill which was then in use for pin manufacture. The surviving c1870 160hp Tangye engine installed second hand in St Marys Mill also sports a rope pulley flywheel however, only two or three rope drives were taken off to drive saw benches during the mill’s period as a walking stick manufactory.

It is interesting to note that in 1901, Kings also supplied a compound engine, rope pulleys and shafts to Southern & Nephew of Manchester (GRO. Kings Order Book No 1). In this region, rope drive had been in widespread use for three or four decades; it can only be assumed that King’s bid must have been very competitive in order to compete with local suppliers.

As with the Stroud region, the rope drive system appears only relatively rarely in other parts of the West although isolated examples occur in woollen mills, such as the steam and water-powered Coldharbour Mill at Uffculme in Devon.

Secondary Power Transmission

In the case of the Stroud valley woollen mills, in terms of secondary transmission, the overhead line shaft reigned supreme. More often than not, this was suspended from wooden joists and/or supported in wall mounted iron bearing boxes. However, as the use of cast iron columns became more widespread throughout the industry, it became increasingly common for these to carry cast-on bolting faces, support flanges or brackets, designed to carry line shafting. This technique became increasingly common from the mid 19th century onwards (RCHME Buildings Report - Longfords Mill, 1858 mill; also examples in Giles & Goodall, 1992). Certainly, in mills of the Yorkshire and Greater Manchester areas, iron columns were used widely for this purpose although in the Stroud area, this remained something of a rarity and with a few exceptions such as Stanley Mill, iron columns were used solely...
for supporting the upper floors. The 1858 mill building of the Longfords complex was typical in this respect; both upper floors were supported by means of iron columns however the longitudinal line shafts were suspended by means of hangers from wooden beams. On the ground floor, two rows of line shafting were used, installed outside the existing rows of iron columns, the latter once again, merely supporting the upper floors (RCHME Building Report - Longfords, 1858 mill). Various other buildings throughout the complex were similarly equipped.

The use of iron columns suitably modified to carry line shafting was fairly unusual throughout much of the West of England clothing districts especially during the earlier part of the 19th century, although it does crop up in some of the larger, later mills. In Bradford-on-Avon, Wiltshire, one of the main buildings of the Greenland Mill site used such a system. Here, a two-storey 19th century stone-built building used gently tapering iron columns cast locally by H Martin of Bradford, to support the upper floor. About 14 feet in height, the upper 2-3 ft was rectangular, the mounting faces pierced by two mounting holes intended to carry line shafting. The upper floor was much shallower in depth and was supported by similar iron columns although shorter and lacking the mounting faces, an indication that the upper floor was probably not powered. A further smaller single-storey building on the site also used similar columns with mounting faces, although of smaller height and diameter.

By the last decade of the 19th century, there is evidence to suggest that the use of iron columns designed to carry line shafting was at last having some impact on the remaining Stroud woollen mills. However, overall, such use is likely to have been fairly minimal as by now, cloth manufacture had contracted to a greatly reduced number of sites. The large Dudbridge Mills complex was typical in this respect and as in earlier days, used simple iron columns merely as support for traditional wooden joists and flooring (Industrial Gloucester, 1904: Plate p27) but also utilised some columns equipped with brackets supporting line shafting. These were used in a number of areas of the mill, including the finishing room.
An interesting variant was to be found in the weaving shed for here, short iron "columns" (about half ceiling height) were positioned at the rear of each loom, carrying the necessary line shafting (ibid. Plate p26). Dudbridge Mills had been largely destroyed by fire and much of the site had been rebuilt in 1891. Thus, it seems that during the rebuilding, the opportunity had been taken to adopt what was perhaps considered state-of-the-art technology through the use of columns specifically designed to carry shafting. Had the mill not been rebuilt, it is likely that the earlier systems of supporting line shafting would have been retained.

![Figure 49. Columns by H Martin of Bradford](image1)

Figure 49. Columns by H Martin of Bradford

![Figure 50. Weaving Shed, Dudbridge Mills](image2)

Figure 50. Weaving Shed, Dudbridge Mills

![Finishing Room, Dudbridge Mills](image3)

Finishing Room, Dudbridge Mills

Generally, in Gloucestershire mills, even when water power gave way to steam or a combination of the two, and subsequently to other forms of power, line shafting continued to play an important role in some manufactories well into the 20th century. In other districts such as Yorkshire and Manchester, electric motors powering individual machines found favour, however in the Stroud area, even though electricity largely usurped water and steam, its role was often in the form of a central power source, line shafting continuing to take the drive to individual machines. Even up to and beyond the 1930s, several of the biggest and most successful mills in the district still used overhead line shafting in both
their spinning and weaving departments (for instance, Lodgemore and Longfords Mills). Indeed, up to 1989, although overhead shafting had been replaced, Stanley Mill still relied on flat belt drives from electric motors to power spinning mules. Similarly, overhead line shafting carried on in use in some of the largest of the surviving Wiltshire mills and as in Stroud, provided the power to an assortment of machines including spinning machines, looms, cloth washers, milling machines and cutters well into the 1930s and beyond. Even now, the mechanics shop at Stanley Mill is entirely powered by an overhead line shaft, driven by electric motor.

Despite its longevity, overhead belt drive was not without its problems. Even when clutches had been developed and were readily available from local suppliers, some mills carried on using the tried-and-trusted systems such as fast and loose pulleys. This is not to infer that these systems were trouble-free and accidents inevitably happened. For instance, the Gloucester Journal reported that:

"William Bassett, a middle aged man... a worker at Dark Mills, Brimscombe, was instantly killed in a terrible manner on Wednesday afternoon. He was in the act of removing a belt from one wheel on the shaft above...when he was caught by his apron and carried into the mechanism before his workmate could get the water wheel stopped. The poor fellow’s neck and legs were broken". (GJ. 6 January 1892).

Similarly, some years earlier in 1858, the weaver-poet Jeptha Young of Kings Stanley commemorated Elijah Watts’ demise through such a fatal accident at Stanley Mills:

"...that morning in the power loom shed
He ventured much too far
Until a strap [drive belt] got him round his leg
And dragged him round the bar..."

(Quoted by Hawker, 1945).
Local Manufacture of Drive Belts/Straps

It is hardly surprising that with such a large and varied market for leather drive belts in the mills and factories of the region, leather belting came to be manufactured locally. The major supplier in the Stroud region appears to have been Sampson & Co of Stroud who advertised a range of "patent leather driving belts, mill bands and straps". Their manufacturing methods were quite novel and in order to overcome the drawback of numerous joins, and hence potential weak spots, in the length of the belt, cut their leather spirally from the hide. This enabled them to manufacture belts of up to 100 feet or more in length "without a single cross joint". The belts thus produced were considered to be far stronger than common leather belting even though the price was claimed to be comparable. Leather was prepared on the company's premises, using exclusively the best oak tanned leather, the intention being to produce belts of the highest strength with the lightest weight. Sampson's belts were apparently highly regarded and testimonials from contented customers noted that in some cases, belts had been running continuously for over six years without repairs (Morris & Co. Dir. Glos, 1867: 55).

In another case, a 12 inch wide belt, over 80 ft in length:

"was put to use in Sheffield...for rolling steel, and, severe as this test is, the Band is working most satisfactorily up to the present time and is doing the work of one a third more weight, which was constantly breaking" (ibid).

Apart from being spirally cut, belts were also joined using a novel method that was claimed to prevent the jump ("so objectionable") arising from the old way of lapping.

Thus, apart from use within the locale, Sampson's belting was being used in industrial locations throughout Bath, Bristol, Bideford, Birmingham, Burton-on-Trent, Derby, Gloucester, Leicester, Manchester, Nottingham, Plymouth, Reading, Shaftesbury, Wilts, Sheffield, and many other places.

In later years, belting was produced by at least one Gloucester-based company: Merrylees, Pugh & Co. manufactured drive belting from bakta, cotton, hair and rubber from their St Nicholas Works in the City. Likewise, belting of an unspecified nature was made by The British Belting & Asbestos Co. at the Prospect Works in Dursley (Kellys. Dir. Glos, 1939: 451). No doubt some of the markets remained of a local nature and although by now, the overall number of industrial sites had reduced in number, they had increased in their complexity.
LEATHER DRIVING BELTS,
MILL BANDS, & STRAP
MANUFACTURERS,
STROUD.

THESE Belts are cut spirally from the hide, and the two edges firmly sewn together; thus securing lengths of fifty or one hundred feet without a single cross joint. They are far stronger than the common leather Bands; they run more evenly over the pulleys, and save the loss of time caused by mending cross joints, whilst the price is scarcely more than that of the old-fashioned pieced ones.

The Double Belts are made on the same principle as the single ones, and are put together with best American Pegs, which take much of the wear off the leather. For heavy work these are the very best Driving Bands manufactured—some of them have been running continuously for the past six years without repairs. A twelve-inch Belt, over 90 feet in length, was put to work in Sheffield some months ago for rolling steel, and, severe as this test is, the Band is working most satisfactorily up to the present time, and is doing the work of one a third more weight, which was constantly breaking.

The Manufacturers of this Belt use nothing but the best Oak Bark Tanned Leather, and **curry on their own premises**, as one great object is to produce the greatest strength with the least possible weight. Their new mode of uniting the ends of Bands is another great recommendation, as it prevents the jump (so objectionable) arising from the old way of lapping.

The Patent Belts only require a trial to convince machine owners of their superiority over the old-fashioned cross joints.

Price List and Testimonials forwarded on application.

Sampson and Co.'s **LUBRICATION PASTE** or LEATHER **PRESERVER**, for Driving Bands, Harness, Leather Hose, &c., &c., in Tins, 1½ lb., 1s. 9d.; 3lbs., 3s. 3d.; 6lbs., 6s.
Power transmission - summary

In many of the Yorkshire woollen mills, primary power transmission essentially went through three specific phases. Initially, vertical shaft drive took power to upper mill floors; from the 1860s, this was superseded increasingly by rope drive. This system was in turn replaced by group electric drive and individual electric motors driving single machines. With the mills of the Stroud region, the transitional phase of rope drive rarely appeared and where it did, was usually associated with the post-woollen industries. Primary power transmission continued to rely, to a much later date than Yorkshire, on vertical shaft drives. By the time the rope drive was being applied to the expanding woollen cloth mills of Yorkshire, much of the Stroud industry was in decline, hence was in no position to invest in radically new technology. Smaller mills were closing and where the industry continued to prosper, it was in a small number of larger highly mechanised mills. The large mills of Yorkshire did not have equivalents in the Stroud valleys and even in the bigger mills such as Stanley, Ebley, Longfords, Fromehall and Bonds, rope drive was conspicuous by its absence. As such, it forms yet another reminder of how conservative many of the Stroud manufacturers were, in much the same way that many carried on relying partly or even wholly on water power when their peers elsewhere had been entirely steam powered for decades. Those Stroud mills that did carry on working appear to have gone directly from vertical shaft drive to electric motors, although the latter often drove a clutch of individual machines via the traditional overhead line shafting, a system referred to as group drive (for example, Lodgemore and Longfords Mills).

Thus, developments in power transmission systems lagged some way behind those of many mills in the North. Although similar systems based on the use of vertical drive shafts were in place in both the North and the West from the end of the 18th century, from the middle of the 19th century, further developments saw major northern manufacturers switching to the more convenient rope drive. In contrast, the indications are that technology around Stroud stagnated, with the traditional vertical drive only being supplanted when electricity became easily available. In most cases, this post-dated the manufacture of woollen cloth in the region. Only a few of the successor industries warranted the use of rope drive and where it was adopted, systems were inevitably much simpler than those adopted in northern mills. For instance, the rope drive installed at St Marys Mill consisted of no more than two or three drives to saw benches, typical of the type of setup then encountered.
CHAPTER 8

FACTORS INFLUENCING THE EVOLUTION AND CONSTRUCTION OF MILL BUILDINGS

Consideration has already been given to the impact of power source and power transmission on the construction of textile mills. In this section, other factors which played a part in the gradual evolution of the mill are examined. Although local circumstances influenced such development, overall, a number of factors that were common to all woollen areas were responsible for shaping the buildings that became characteristic of the industry. These major influences were:

- Changes in the organisation of the industry
- The influence of new processing machinery and manufacturing techniques
- The limitations imposed by the materials of construction available and the effect of advancing structural technology (examined in the following section)

Over the course of the woollen industry's history, a number of distinct types of structure evolved intended to house the manufacturing processes. These altered and developed as a result of evolutionary changes that occurred for a variety of reasons, some organisational and others as a result of technological advances. Throughout the history of the woollen cloth industry, several common threads ran through the woollen districts, and during some periods, similar buildings were to be found in all major manufacturing areas. At other times, significant differences became apparent, as local circumstances dictated that the industry should develop in different ways. These differences were reflected in the bricks and mortar that housed the industry. Particularly during the period spanning the late 18th-early 19th century, the scale and layout of the textile mill changed radically; the reasons behind this are explored in the following section.

Buildings Associated with the Domestic-based System

The earliest structural form adopted was clearly based on the domestic building. From the earliest times, cloth was produced within the dwelling, primarily to meet the occupier's own requirements. Generally, these requirements were so modest that little, if any, structural reorganisation of the dwelling was necessary. Carding, spinning and weaving were all hand-based and could be accommodated without recourse to alterations to the fabric of the building.
Particularly from the 17th century, capitalism began to influence increasingly the way in which parts of the industry was organised. This led ultimately to notable differences in how the woollen districts of the West and the North were operated. In the West, much of the industry came under the control of a relatively small number of major clothiers, men who controlled the trade in their locale and organised the various stages of manufacture, most of which were reliant entirely on out-workers scattered throughout surrounding villages. The major clothier in the West often controlled hundreds of such workers who carried out carding, spinning and weaving in their respective cottages, usually operating as independent workers, although sometimes working for several masters. This type of manufacture was frequently carried on in cottages that apart from perhaps turning over a room to house the loom(s), remained essentially unaltered from its purely domestic state. Where several looms were installed, it was usual for one to be operated by the master of the house, with further looms worked by a journeyman, often in the same room of the cottage. The cottage-based weaver was to remain a recurring feature throughout virtually every region of the country, surviving in a few places up to the latter part of the 19th century.

In its early phase, the Gloucestershire woollen industry was characterised by a combination of out-workers cottages, some with small attached workshops, and fulling mills plus their associated clothiers houses. Generally, structural alterations to cottages necessary to accommodate industrial use appear to have been few although in some of the clothing villages around Stroud there is evidence to suggest that a modicum of alteration sometimes took place. In some cottages a room was set aside for industrial use and often, taking-in doors survive on upper floors. Such cottages were found in locations such as Chalford, Nailsworth, Eastcombe, Painswick and France Lynch. These villages are often characterised by a jumble of predominantly 18th century stone-built cottages and houses, built in an unregulated fashion, some on common or waste land. In the case of Eastcombe, many of the weavers cottages were built just below the plateau of what was Bisley Common, in order to give some protection from the prevailing winds. (Lambert & Shipman, 1984: 13-14). Such wholesale encroachment of the edges of commons was not uncommon and Thirsk notes that workers, not unnaturally:

"settled themselves where there is the best stock, the largest commons or wastes to build cottages...In 1670, it was estimated that squatters on waste were increasing daily" (Thirsk, 1981: 211).

Thus, squatter settlements grew in the Stroud region, built of limestone dug on or near the spot. Occasionally, small groups of workers were gathered together in one place and there is evidence to suggest that in a few locations around the Stroud region, spinners were brought together in "spinning houses". In 1725, William Capel of Capels Mill in Stroud, was sending wool to be spun at such an establishment in Presbury, near Cheltenham (PRO. Prob 3/24/100; cited by Loosley, 1993: 2).
Similarly, in 1773, Edward Clutterbuck noted that:

"My cousin went this morning to the spinning house in Caudle Green, near Miserden" (Hawker, 1945: 63).

However, the cottage remained the predominant form of out-workers accommodation and it was noted that locally, the industrial space within the cottage was generally referred to as The [work] Shop:

"To this day, some of the older people refer to their living room as The Shop. One cottage in Chalford Hill has the traditional spinning and weaving sign, a wheel, carved in the stone on each side of the doorway with the date 1767 above it. The present occupier of the cottage remembers that it had a low stone bench running round the walls inside the kitchen on which the sacks of wool were kept and where, it is thought, the women sat to spin" (Gloucestershire Community Council. I Remember... 1977: 24).

Similarly, a house nearby has a carved stone device resembling a spinning wheel above the door, plus the date 1712 and the initials "T M"; these refer to Thomas Matthews, clothier of Bisley (Rudd, 1937: 32).

Certainly, by the latter part of the 18th century, spinning and weaving was no longer totally confined to the cottage and spinning and loom shops were to be found amongst the weavers cottages forming the squatter settlements. For example, in Chalford Hill, a late 18th century, 2-storey, stone-built loom shop, lit by numerous windows survives (Pers. Comm. Dr N J Paterson). It stands adjacent to what was presumably a minor clothier’s house, complete with taking-in door at the upper level. He apparently had his own out-workforce but took his cloth to be fulled in one of the mills along the valley bottom. Similarly, an industrial wing survives, attached to domestic accommodation that formed part of the Arundell Mill site near Stroud (ibid). In other cases, other parts of existing cottages were pressed into service and at Rockstowes Mill, Uley, it is suggested that the attic space of several cottages on the site housed hand-operated jennies. (Tann, 1967: 133). There must have been many similar situations although, inevitably, little physical evidence remains.

The use of the loom shop increased and by 1806, they were to be found in the clothing districts of Alderley, Wotton-under-Edge, Dursley and Stonehouse; the latter was the largest with 23 looms. As the advantages of collecting looms together became increasingly apparent, it became clear that not all local clothiers had anticipated this trend. In 1802, the Dursley clothier, John Wallington, commented ruefully that:
"We have lately been under the necessity of building an entire new place but we did not make the provision for a single loom" (PP 1802-3. vii. 299).

Not all loom shops were mill-based and c1818, Samuel Clutterbuck of St Marys Mills bought two cottages in Skaits Hill, which he turned into loom shops (GRO. D1815). There were a number of similar enterprises set up at other points around the district. Inevitably, such structures needed to be well lit, and some may have utilised tall weavers-type windows, although evidence for these is lacking. A range of long windows at Frogmarsh Mill, inserted into what appears to have originally formed a 17th century dwelling, may be associated with this phase.

Mill-based loom shops took a variety of forms. At Beards Mill in Leonard Stanley, a detached 3-storey loom shop was built around the beginning of the 19th century and although well lit, most windows were of the conventional small-paned variety. At Millend Mill in Eastington, hand looms were housed in a substantial 2-storey wing added to the existing carding, spinning and fulling mill. The new wing was brick-built wing and lit by ranks of iron-framed windows. The new wing remained of the traditional narrow form and continued to be mirrored by similar constructions at mills, such as Meadow Mill, nearby.
At Dunkirk Mills, a 5-storey, cruciform block plus attic, housing hand looms, was also added. (Giles, 1993: 29). Thus, detached buildings or attached wings (often tall and narrow) appeared increasingly at mill sites. Their scale and rate of adoption varied between locations, doubtless sometimes influenced by the degree of local opposition to the process of relocating the out-worker from his cottage to the mill.

Particularly during the 17th and 18th centuries, as the industry evolved, some weavers expanded their operations by constructing small weaving sheds attached to their cottages, generally housing one or two looms; occasionally, up to six might be encountered. Where the dwelling was of suitable size and configuration, as an alternative to housing looms in a room or shed, an upper floor or attic might be turned over to weaving. Particularly where links with agriculture still remained, it was not uncommon to find weaver/farmers converting barns or other structures to house hand looms or some other stage of manufacture. (Giles & Goodall, 1992: 19). Thus, extended/altered dwellings or related buildings came to house several stages of manufacture in many woollen districts.

In some regions such as Yorkshire, it became increasingly common for not only workers cottages, but also clothiers houses to be attached to some form of workshop. Here, organisation of the industry was somewhat different to that in the West where much remained in the hands of substantial capitalist clothiers. Throughout many areas of the North, much of the industry comprised minor clothiers who
wove cloth in, and operated from their own homes; the dwelling formed the centre of the business and as a result of its dual role as dwelling and workshop, often incorporated the characteristic tall "weavers windows", designed to illuminate work rooms incorporated into the house.

There were many occasions where the dividing line between dwelling and workspace became blurred and the transition from wholly domestic-based weaving to the factory proper was characterised by a transitional phase where some structures contained both domestic and industrial spaces. The enlarged cottage or farmstead housing a collection of hand looms became increasingly common, however, even relatively late in the 19th century, such dual purpose buildings were still being constructed. For instance, some segments of the Welsh woollen industry were housed in such buildings. In Union Street, Penygloffda, Newtown, a row of tiny two-room houses were built between 1835-41, surmounted by one long room housing flannel looms. In the same street, a further row of eleven houses formed the lower part of a factory built 1830-33 by a local flannel manufacturer. Over these, were two floors of factory space housing looms, etc. and a roof loft used for storing materials. Separate access was provided to the factory space. (Lowe, 1977: 24-25). Similar examples were also to be found in all of the woollen districts, for instance, at Linthwaite and Golcar (built c1820-40) in Yorkshire. (Giles & Goodall, 1992: 20). Such combinations were common to all major woollen areas during this transitional phase, combining workers housing with industrial space containing various types and stages of manufacture. The fact that in some instances, a shared work room extended over a number of separate dwellings suggests that a particular manufacturer had been instrumental in the original construction.

In parts of the West of England, it was usual for a clothier's business to be centred on his fulling mill, with other stages of manufacture contracted out to cottage-based workers. Notably in Gloucestershire, the clothier almost invariably lived close to his fulling mill and although perhaps the attic of his dwelling might form a secure cloth store, his house was not generally used for manufacturing purposes. In contrast, in for instance, the Upper Calder Valley, clothiers houses usually incorporated a workshop at one end. Similarly, in urban centres such as Halifax and Leeds, merchants houses frequently had workshops at the rear of the premises (ibid, 77).

**The Appearance of the Loom Shop**

Up to the early part of the 19th century, the majority of hand loom weaving remained cottage-based although even in earlier centuries, it was not unknown for a small number of hand looms to be gathered together under one roof. With a few notable exceptions such as William Stumpe of Malmesbury, who bought Malmesbury Abbey and installed numerous weavers therein (Ramsay, 1943: 31), and the wealthy Gloucester-based clothier and capper, Thomas Bell, who set up his home and a
substantial business in the old Black Friars (VCH. iv. Plate 42), cottage-based weaving remained predominantly the norm until well into the 18th century or beyond, although increasingly, from the beginning of the 19th century, the trend towards the gathering together of hand looms into dedicated loom shops was underway. Some were found in association with existing mill sites whilst others remained tied to domestic accommodation. Such arrangements were encountered throughout the country's clothing districts.

Figure 55. The former Dominican friary, Blackfriars, Gloucester. Home and workshops of Thomas Bell.

In some regions, especially where the links between agriculture and cloth manufacture were still strong, it was not uncommon to encounter part of a farm set aside for communal spinning. Thus, spinning galleries were to be found in parts of the North; examples included Boon Craig in Cumbria, Towend Barn at Troutbeck (possibly dated c.1666) and Yew Tree Farm at Kendal (Hughes, 1985: plates p172-3 and pp174-5). It became increasingly common to find the kitchens of traditional farmhouses in the Pennines converted for weaving and an extension added to accommodate household activities. (Trinder, 1987: 17) and by the early part of the 18th century, the loomshop of the Pennine region with its traditional weavers windows had already evolved. (ibid). In the West Riding, from the early 18th century, there was the tendency towards the growth of squares of cottages or "folds"; these often filled in plots of land attached to single cottages. Such folds were frequently part-agricultural and part-weaving in nature.
In the West, arrangements for weaving under supervision often took the form of detached shops associated with clothiers’ houses; such a surviving example is the "Wool Loft" of 1726 in Nailsworth (Giles, 1993: 28). Giles notes that most loomshops built outside mill complexes date from the 1830s onwards although in the Stroud region, a number of examples apparently of the later 18th century survive in the former squatter settlements such as Chalford Hill as well as along the lower Frome. By the beginning of the 19th century, a handful of Gloucestershire mills had collections of hand looms, some housed in specially built structures. In 1802, there were reputedly no weaving shops in Gloucestershire (Tann, 1967: 51) although as noted, some were certainly in use during the latter part of the 18th century. However, much hand loom weaving remained centred on out-workers situated in cottages, often-scattered throughout the district. In Yorkshire, small loom shops proliferated, especially from the late 18th-early 19th centuries. As well as in the new mills themselves, these were housed in a variety of situations including cellars, attics, plus attached and detached buildings (Giles & Goodall, 1992: 19). Unlike rural Gloucestershire, in Yorkshire, some loomshops were situated in urban locations where a variety of accommodation was more readily available. Thus, urban-based weaving was more widespread in the North where it was not uncommon to find terraces of cottages with loom shops on the top floors, characterised by distinctive weavers windows, a form seemingly limited largely to the Yorkshire and occasionally, parts of the Welsh woollen districts. However, they were also associated with the lace districts of the East Midlands and indeed, Tewkesbury in Gloucestershire.

Up to the 18th century, apart from workshops, the fulling mill remained the sole "industrial building" associated with the trade. In the West, capital for their construction was often provided by the wealthy clothier. In the North, where capitalism made slower headway into the region, the average clothier operated on a much smaller scale and it was to the public fulling mill that he turned. In Yorkshire, by the second half of the 18th century, the woollen industry was being served by more than a hundred specialist fulling mills, along with a number of raising mills involved in the finishing of cloth. Otherwise, production remained either house or workshop-based and reliant largely on hand power (Giles & Goodall, 1992: 78).

Thus, before the late 18th century, the Western clothing districts were characterised by combination of water-powered fulling mill, clothiers house, out-workers cottages (often indistinguishable from ordinary dwellings), plus a relatively small number of buildings used for communal spinning or weaving. In contrast, much of the industry in the North remained firmly rooted in the cottage, the urban workshop and the public fulling mill, the latter comprising the sole powered stage of production.
The Dawn of the Factory Era - the Effects of Machinery on the Development of the Mill

Generally, the fulling mill fulfilled a single function, namely housing the fulling stocks. It was generally constructed in such a way as to make difficult the accommodation of further stages of manufacture. As the initial designs of machinery for carding and spinning became increasingly available, appropriate accommodation became a requirement. As such machines were generally not large and required only hand power for their operation, it was sometimes feasible to house these within existing work spaces. Thus, for instance, hand-worked carding engines and jennies could be accommodated in a variety of ways, ranging from existing workshops to parts of cottages already partially utilised for industrial purposes. Care was taken to ensure that these areas were well lit, probably the only additional requirement, and relatively little reorganisation of the internal structure of such buildings was necessary.

As the development of machinery progressed further, its introduction had a profound impact on the industry at large, and both in the West and the North, carding and spinning machinery was adopted increasingly after c1770. In Yorkshire, hundreds of new mills were set up, driven largely by animal and water power. Much of this period of mill building occurred between 1770-1800, a period that also witnessed increasing activity in the West. Around Stroud, this ushered in the "Great Rebuild", a time when most local mills were rebuilt or extended; between c1790-1825, there were few that were not substantially altered and enlarged. The situation was similar in many other parts of the West. Many mills were built or rebuilt by individuals or partnerships already active in woollen cloth manufacture and as such, they merely represented the mechanised arm of the business. In other respects, production continued to be carried out by workers using hand power, often still in their homes. Apart from mills operated by individuals or families, alongside its public fulling mills, Yorkshire also had other public mills which carried out scribbling and carding for the multitude of minor clothiers of the region. Especially from the 1770s onwards, public mechanised scribbling and carding mills assumed an important role in the industry although this type of arrangement was rarely encountered in the West. In Yorkshire during the period 1770-1825, the majority of mills specialised in just one or two stages of production (Giles & Goodall, 1992: 79); it was a similar situation in the West. Thus initially, in most cases, a single stage of manufacture was carried out however, in Gloucestershire, the fulling mill often combined the dual function of fulling and gig mill.

It was wholly logical and inevitable that in time, further mechanised stages would be added, the result being the development of buildings housing two or three manufacturing steps; Gloucestershire was already some way down this road with its fulling/gig mills. As the number of processes increased, what is sometimes referred to as the "proto-factory" came into being, a building in which several processes were centralised into a single larger manufacturing unit. This was typified by a systematic
grouping of machinery. For instance, at Mill House Mill, Sowerby, the mill carried out scribbling, carding and fulling for the family owners, however weaving continued to be carried out by out-workers, some of whom lived up to 13 miles away (ibid. 79). Similarly, Cocking Steps Mill housed mechanical scribbling, carding, slubbing, milling and finishing, whereas all of the company's spinning, burling and picking continued to be carried out in the "servants own houses" (ibid). Although much manufacture was still carried out by out-workers, the trend towards collecting various groups of workers together at a central location was gathering pace. In Yorkshire, centralised work spaces were created for carders, spinners, weavers, etc., some housed in small shops remote from mill sites, and others working in buildings put up adjacent or attached to existing scribbling and fulling mills. The range of scale of such shops was wide, extending from domestic-scale buildings to much larger structures. At Gott's Bean Ing Mills, a 3-storey wing was added c1779, housing spinning rooms of ~35 ft width (ibid. 18).

When mill building began in earnest towards the latter part of the 18th century, as was the case with Gott's mill, these inevitably took the form of tall, narrow structures, often of up to six storeys. Some woollen mills of this period housed a combination of powered fulling, carding and spinning processes, the remainder of the building being used for wool preparation, storage, etc. Usual practice dictated that fulling stocks were located on the lowest storey, adjacent to the water wheel(s), with most of the other stages of manufacture housed on the upper floors where better natural lighting was available.

The overall width of such early mill buildings was constrained by the construction techniques available at the time and generally, was limited to the loading capacity of the timber beams used to support floors and to a lesser extent, roofs. Thus, the limit imposed by the overall length available and the strength of the beam used resulted in mill buildings that were often a single room deep and generally restricted to a maximum width of 28-30 ft. This limitation was similar for all early woollen mills, irrespective of their location. In Yorkshire, the widest mill was reputedly of ~28ft, with many others being less. For instance, when Hebble Mill, Halifax, was put up for sale, the particulars noted the various structures that comprised the site included a 3-storey building of 28 ft width, three rooms of 24 ft width, a 4-storey warehouse of 24 ft width, a dyehouse and a similar building 18 ft wide. The only exception were two rooms of 36ft width, although these may have been of later date and/or supported internally by columns (Leeds Intelligencer 13 August 1804). The narrow widths of textile mills is graphically demonstrated by the dimensions of Arkwright-type mills listed in the Colquhoun Census (Chapman, 1981-2: 5-26). This confirms that mill widths fell predominantly between 24-33 feet, a situation that was common throughout the textile industry at the time.

In the West of England, the situation was similar. Wherever increased floor space was required, apart from the addition of extra buildings, it was common for additional floors to be added and mills often
increased vertically as opposed to horizontally, sometimes reaching a height of seven storeys. In the Gloucestershire region, heights of up to 5-6 stories were not uncommon, although as with other woollen areas, there were also many mills of 3-4 stories.

Wherever the location, predominantly, mills were built using local materials and building traditions. Thus, in many parts of the West, mills were constructed using techniques scaled up accordingly from those used for the construction of domestic structures, with materials coming largely from the locality. Tried-and-trusted techniques were retained, with builders being primarily local men (often millwrights) and architects in the accepted sense of the word, being notable by their absence (aspects of design and construction are examined in greater depth in the following section). Consequently, in many respects, early mills were of similar form wherever their location. Thus, in Gloucestershire and Wiltshire, tall narrow, multi-storey mills built of local limestone were common. In the North, mills were dimensionally similar although depending on their situation, local granite and sandstone took the place of limestone. Irrespective of location, the governing factor was the restricted width resulting from the practical limitations imposed by available materials and the level of development of structural technology.

As further developments of manufacturing machinery continued to be made, the industry was driven
further from the cottage and the workshop and closer to the mill. For instance, as the number of spindles of the typical jenny increased dramatically, the hand-powered 48 spindle "domestic" machine gave way to the water-powered 240 spindle mule. Clearly, this stage now required a significantly greater work space as well as access to a power source. This development clearly had a significant effect on the internal organisation of the mill as much greater floor space was required. Efforts during the early part of the 19th century saw the further development of the mule and between 1825-30, Richard Roberts developed the first fully acting unit, spindles now increasing from perhaps 400, to 1500 or more. It became common practice for two machines to be placed back to back. The movement of each carriage now took between 6-7 feet, a great increase over earlier systems, the result being that in order to accommodate the newer designs of mule, mill widths doubled or even trebled. The effect on the development of the mill became apparent in the transition from the tall, narrow buildings that had characterised the industry up to this point, to squarer, squatter blocks of much greater width. These changes occurred throughout the country's woollen districts and examples of the transition were to be found in the shape of, for instance, Abbey Mills in Bradford-on-Avon, Wiltshire. Here, in 1875, the tall structures that had comprised the mill up to this time, were joined and eventually supplanted by a new square block of considerable size, designed to house new machinery, just one example of many.
In order to accommodate the new requirements imposed by increasingly bulky machinery, several constructional techniques were developed to allow for the construction of this wider type of building. Clearly, a way was required to overcome the width limitations imposed by the strength of unsupported timber beams and this was tackled initially in one of two ways. The most apparent and widely used technique was the adoption of upright columns of timber or iron supporting floor joists at mid point, a technique that was to be found in all woollen districts. An alternative, although one that was not so widely encountered, was the adoption of the trussed wooden beam. Here, the beam was supported about its central point through the action of angled, stressed iron rods set into the wall at either end. This had the effect of supporting the beam about its mid point, hence allowing for a greater span and load-bearing capacity, without the intrusion of upright supports. This technique was probably utilised in at least a few of the mills in the Stroud valleys although the sole survivor in a woollen mill is the c1820 block of St Marys Mill, Chalford, where upper floors are supported by such trussed beams. In terms of span, St Marys Mill was probably near the limit attainable using such techniques. The only other confirmed local example was the large Severn Corn Mill at Sharpness.

Effectively, in order to increase the span to a greater extent, the use of columns was the only way forward, and these, initially of wood but increasingly of iron, were used widely. Depending on the particular application, several rows of columns were sometimes used. Upper storeys usually required fewer columns, of smaller dimensions, as the loading per unit area decreased proportionally (see later section on the Impact of Iron and Fire-Proofing Techniques).
The Introduction of the Loom Shed

The gradual development and refinement of the power loom to the point that it became suitable for the manufacture of woollen cloth was destined to have a significant effect on the layout of many mill sites. By the 1830s, the number of power looms was increasing and with their installation came a new set of problems. Apart from requiring access to a power supply, power looms created such vibration that frequently, they were only safe on the ground floor of the mill (Markus, 1993: 275). Initially, the practice of installing power looms in unsuitable, adapted buildings was relatively common, although the drawbacks were obvious. The logical place for them to be sited was either on the ground floor of the mill or better still, in a specifically designed single-storey structure. By this means, it was possible to overcome the problems associated with the high levels of vibration and considerable weight associated with a multiplicity of power looms. Thus, the loom shed was born.

The loom shed consisted of a series of small pitched roofs, glazed on the steeper north facing side, a development credited to Fairbairn. He had certainly been active as a proponent of the shed-type structure, and was fully convinced of the advantages it bestowed. He noted that:

"It was chiefly adopted for power-weaving and contained many advantages in having the machines on the ground floor...it is difficult to estimate the advantages of this description of building for manufacturing purposes; they are, however, considerable, and where land can be had moderately cheap, it is found superior in many respects, particularly as regards light...". (Fairbairn, 1865: 115-116).

Looms in the shed were arranged in such a way that the maximum light available was directed onto the cloth being woven. From the time of its first introduction, the characteristic north-light saw-tooth profile of the loom shed was to remain essentially unchanged throughout the lifetime of the textile industry. The first use of the loom shed dated to c1820 when small sheds were added to cotton spinning mills in the Manchester area (Williams & Farnie, 1992: 76). Here, they rapidly confirmed their effectiveness and increasing numbers were built during this decade.

The single-storey loom shed proved its worth and throughout the country, at many of the major manufacturing sites, sheds were added. Despite their obvious advantages, the single-storey loom shed was not adopted universally throughout the textile industry. In some situations (predominantly silk and tape manufacture) power looms continued to be housed in purpose-built multi-storey buildings (Giles, 1993: 27) although in both cotton and woollen manufacture, the shed was adopted widely.

In Gloucestershire, as elsewhere, the appearance of the power loom was to have an influence on the
size and configuration of local mills. Initially, a number of manufacturers, unconvinced of their reliability and performance, installed one or two looms as an experiment. There was generally little problem in physically installing such a small number of looms although as their number subsequently increased, so the requirements placed on the mill's structure began to change. Power looms had a number of requirements which could present problems not previously encountered by manufacturers. Clearly, a power source was needed, more often on upper floors of the mill.

In some cases this was already in place through earlier requirements of powering carding and spinning machinery. However, in others, new vertical drive shafts required installation. Typically, these drove overhead line shafting via bevel gears, with individual drive belts to each loom. Power looms could require a significant amount of power and this too, sometimes led to problems. At Ham Mills, the installation of power looms resulted in significant alterations being made to the Frome, wrought in an attempt to improve flow and to extract more power from the three existing water wheels. Despite these efforts, within a short period, steam power, with all the attendant structural additions and costs this entailed, had been added to cope with the increased load generated by the looms.

From this stage on, substantial increases in the size of many of the local mills became apparent as power looms imposed different requirements on the layout and construction of the buildings. Not only was power necessary in all relevant areas, but buildings had to be substantial enough to cope with a greater weight loading per unit area as well as increased vibration and other mechanical stresses. Where looms were accommodated in a new building, specifically built for the purpose, the necessary reinforcement could be provided, however, where they were installed in an old building, problems could sometimes arise. Such was the case with Days Mill in Nailsworth; here, the old building proved to be incapable of handling the stresses imposed by the newly installed power looms on the upper floors. The ultimate solution involved the construction of the first purpose-built loom shed in the Nailsworth area (Davies MS. c1980). The first loom shed appeared in the Stroud valleys c1830 (VCH. ii. 193) and it was noted that:

"about the year 1830, the master-weavers began to be displaced by the manufacturers fitting up weavers sheds near their mills, in order to serve greater regularity and better work". (Marling, 1913: 315-333).
In order to reduce the complexities of power transmission in loom sheds, they tended to be somewhat wider than the adjoining mill, this configuration helping to reduce overall shaft lengths. Normally, a single input from the water wheel or steam engine was sufficient to power the ranks of line shafting that took the drive to individual machines. In some instances, power was transmitted via shafts running under the floor of the shed, although the overhead line shaft appears to have been the most widely used means of power transmission. Thus, power was easier to transmit and frictional losses much reduced, compared with multi-storey buildings dependent on vertical shaft systems. Although a single direct shaft drive was the usual means of providing power to the shed, in later years, there were examples of vertical rope drive taking the power directly to individual line shafts (eg. Cromer Ring Mill, Middleton. Williams & Farnie, 1992: plate on p41, from Textile Mercury, 1905: 367). Such systems were never encountered in the Gloucestershire mills and it seems doubtful if any loom sheds in the West were powered in such a fashion.

A major added bonus to manufacturers adopting the loom shed was that as a result of the predominant use of natural daylight (as opposed to artificial lighting), insurance premiums were reduced significantly. In fact, in some cases the risks of fire were judged to be so minimal that sheds were not insured at all (Williams & Farnie, 1992: 42). As a result, wherever economically justifiable and where land was available for expansion, the loom shed continued to supplant the multi-storey building.

The use of the shed-type structure became widespread in textile mills throughout the Greater Manchester and Yorkshire regions, and in the West, they also became an increasingly important addition to many mills. However, in the Stroud region, mills sometimes occupied cramped sites, this restricting expansion outwards, and similarly, some of the town-based mills of Wiltshire were also hemmed in by existing buildings. Particularly in the latter, existing multi-storey structures continued in use for weaving, although overall, the loom shed had a significant impact on the industry in the region. Consequently, where possible, sheds were added to mills, especially during the 1860s and 70s (Rogers, 1986: 55) rather later than many Gloucestershire mills. Notable examples included sheds added to the existing narrow 6-storey Greenland Mill at Bradford-on-Avon, and that added to the squatter 4-storey Studley Mill in Trowbridge (ibid. 114).

Despite the undoubted advantages that this type of structure provided, a power loom shop was not always a pleasant place to work and a graphic description of conditions in a large loom shop was given in 1851:

"... where the weaving takes place, the appearance is certainly more astonishing than anything else presented by these establishments...[rows of looms] each one a distinct and complete piece of
mechanism, are seen to be arranged in parallel rows, over an immense space of ground, having passages between the rows. Each loom is between three and four feet high, and perhaps five or six wide; and they are all so placed that one female can attend two looms. Every loom receives its moving-power from mechanism near the ceiling, where shafts and wheels present almost as complex an assemblage as the looms beneath them. These shafts are connected with the main-shafts of the steam engine or of the water wheels, so as to receive their moving-power from thence.

The noise created by so many machines, each consisting of a great number of distinct moving parts and each producing what would in an ordinary-sized shop be considered a pretty vigorous din, is so stunning and confounding, that a stranger is almost utterly impossible to hear a person speak to him, even close at his elbow". (Anon. The Illustrated Exhibitor, Great Exhibition, 1851: 285).

Despite this drawback, the loom shed was set to remain one of the most important innovations encountered in the development of the fabric of the textile mill during the 19th century, one which still continues to be adopted for a variety of industrial purposes.

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**Summary**

The preceding variants of manufacturing structures eventually ushered in the factory, a building characterised by the adoption of largely automated machinery, invariably using a power source(s) based on water, steam or a combination of the two. Unlike the proto-factory, which did not necessarily rely on these forms of power, the factory was always driven in such a fashion. Wherever possible, machinery installed was grouped in such a way as to allow for the logical progression of woollen cloth from one stage to the next. Where older structures had been adapted to new purposes, this ideal was not always achievable. Where a new structure was built, it was possible to arrange production machinery in a wholly logical fashion, however this was precluded at some of the jumbled and haphazard mill sites found in the West. Thus, tall narrow buildings of the earlier form, struggled to contain increasingly bulky machinery. The result was that cloth, in various stages of completion, was still carried manually from floor to floor, building to building, or even mill to mill! The days of this type of arrangement were numbered and in the face of changing markets, shrinking profit margins and competition from elsewhere, it was little surprise that cloth manufacture became increasingly centred in a handful of sites characterised by enlarged buildings with a higher degree of integration.

Of crucial importance to the operation of the factory was the availability of power 24 hours a day, thus allowing for round the clock operations when necessary. In most regions, this was supplied by steam although in others, this was used in combination with water power. The investments involved in the
purchase of such power, plus the mill’s machinery, entailed a substantial financial commitment by the mill owner who clearly wished to profit from his actions. In a time when competition constantly ate away at profit margins, the obvious course of action was to increase output in order to maintain profitability, assuming the markets were in a position to accommodate this. Hence, the logical layout of machinery and production flow patterns were of great significance. To allow for 24 hour working, provision had to be made for adequate power to be made available; where manufacturers still relied heavily on water power, this inevitably led to seasonal shortages, short time working and missed delivery dates.

Thus, depending on the period in question, woollen cloth manufacture came to be housed in a series of building types as it moved gradually from the domestic to the factory system. Initially, manufacture was characterised by a combination of the cottage/workshop and the fulling mill, although gradually, it also came to be carried out in extended cottages or small workshops dedicated to a particular stages of manufacture, such as carding and spinning. Gradually, these processes moved to the mill, specially built to accommodate them. Apart from fulling (and in Gloucestershire, gigging), all stages remained unpowered until the latter part of the 18th century, when carding and spinning mills began to appear. Automation continued and by the 1830s, the power loom was being adopted increasingly, housed in both multi-storey shops and loom sheds; the latter came to be adopted widely throughout the woollen regions.

As the industry continued to evolve throughout the 19th century, there was an increasing trend of rationalisation and concentration to fewer, more highly integrated/automated mills. In some instances, such sites comprised all-new structures and in others, assortments of buildings of different type and age. To some extent, geography dictated the form that this took, with many of the West of England’s mill sites consisting of the latter.

The Development of the Mill in the Stroud Region - The Start of the Great Rebuild

The increasing adoption of mill-based shops was but one feature of the changes that were occurring to the industry at an accelerating rate and the period between c1790-1825 witnessed the rebuilding/enlarging of many existing mills, plus the construction of a number of others, intended to house the newly-mechanised carding and spinning processes. Much of this activity took place on sites already occupied by existing fulling mills, initially taking the form of tall, narrow, multi-storey buildings; the structural technology of the time ensured that buildings inevitably took this form and local examples abounded. For instance, when George Haden, Boulton & Watt’s agent, surveyed the Churchend Mill site in 1822 in readiness for the installation of a steam engine, he noted the narrow
width of one of the existing two main buildings:

“This is an old building of the average breadth of about 16 feet, the walls are 3 or 4 thicknesses, from 14 inches to 2 feet” (Boulton & Watt Collection. Pf 474).

He noted that the other (newer) main block was somewhat wider at ~24 ft in width and that even this relatively small increase had allowed this modest building to house two gigs running off one waterwheel, stocks off another, and an upright drive shaft off a third. Squeezed into the confines of the older narrow building were two waterwheels driving gigs and stocks.

Churchend Mill typified much the industry in the region, in as much as sites were rarely levelled and rebuilt completely anew; the majority tended to grow with the passage of time, new additions being made as business dictated it.

Thus, generally, the degree of integration remained low, a characteristic that was to stay with much of the industry until its eventual contraction to a handful of sites later in the 19th century. Even at this late date, baskets of bobbins were still being carried via cinder paths through the meadows, between Churchend spinning mill for subsequent weaving at Meadow and Bonds Mills. Likewise, finished cloth was then transported in a similar way to Beards Mill for dyeing. Such arrangements could not hope to survive indefinitely in the face of increasing centralisation of production in fully integrated mills and it was essentially the last gasp of the old system. Despite its inefficiencies, such systems allowed a substantial amount of business to be carried on without recourse to the construction of wholly new, and expensive, integrated woollen mills, of which the Stroud valleys had few.

Thus, for much of the 19th century, with a single exception (Stanley Mill) mills in the region retained
the tall, narrow form. When New Mills at Kingswood (Fig 63) was built c1810, using predominantly brick and timber, it took this traditional configuration despite the fact that alternative constructional techniques were now available as evidenced by the totally different construction of Stanley Mill, built within a few years.

Stanley Mill's iron-framed main block was much wider than that previously encountered in the region and was to remain the sole example of this type of constructional technique for the remainder of the industry's life in Gloucestershire. Most major components of the Stanley site were built essentially at the same time, such an arrangement clearly allowing for a much higher degree of integration and logical layout of processes, unlike the majority of mills in the region. Many of these tended to comprise perhaps a single main block, often with a mixture of additional wings or allied buildings housing different stages of manufacture. There was little attempt to adopt the lessons learned from Stanley Mill and only where an existing mill of the earlier form had been burnt down, was there any real attempt to produce a mill site that was wholly logical in its layout and construction. Thus, following their destruction by fire, the Lodgemore and Dudbridge mill sites were rebuilt taking at least some of these factors into account; at Lodgemore, squat, square brick-built buildings replaced their tall, narrow predecessors whereas Dudbridge adopted many single storey shed-type structures. Both techniques allowed for a greatly increased level of integration. However, old traditions died hard in the region and as late as 1875, Stonehouse Upper Mill was built on the site on its burnt down predecessor, taking the tall, narrow form of earlier days. There was still no pretence at adopting fire-proofing techniques and Stanley Mill was to remain the sole exponent of this technology in the region.
Effects of New Machinery on Gloucestershire Mills

The introduction of newly-developed machinery, although initially relatively small, clearly imposed a requirement for the provision of suitable accommodation. During this transitional phase, early machines were housed in an assortment of structures. In 1795, at Howards Mill in Dursley, the second floor of the main block housed two billies, one carding engine and a scribbling machine. On the third floor were two billies, two carding engines, whilst in the attic were three billies plus and equal number of carding engines. Three ancillary workshops also housed two further jennies, two billies and five carding engines on various upper floors (Tann, 1967: 126). Thus, at many mill sites, such processes continued to be located in an assortment of buildings, although at others, they were accommodated more logically in newly-built blocks or wings.

As spinning machinery was developed further, the relatively small jenny gradually gave way to variants of the mule. Clearly, much greater space was required although the squatter, squarer buildings that came to be associated with the process remained relatively uncommon in the region, and Gloucestershire manufacturers continued to compromise between efficiency and costs.

As noted earlier, the loom shed's initial appearance in the Stroud region came c1830 (VCH. ii. 193) and gradually, its advantages became apparent to most of the major manufacturers. A combination of well-lit floor space, easy power distribution and reduced problems associated with weight and vibration convinced many that this was the appropriate location for their power looms. By the end of the 19th century, looms sheds were in use at such mills as Days (Nailsworth), Longfords, Lightpill, Stanley, Bonds and Stonehouse Upper and Lower, Merretts, Staffords, Ham, Abbey and New (Kingswood), Cam, Dudbridge and Bliss Mill sites. Few if any were to be found on the Painswick Stream, Slad Brook, or in the Toadsmoor and Uley areas, the majority being situated at the larger manufactories along the Frome itself.

As noted above (The Introduction of the Loom Shed) the shed became an increasingly important building and in a number of instances, manufacturers went to great lengths to construct one. At some Stroud valley sites, land was at a premium, the Longfords site being a prime example of this. Having endured operations in old buildings for many years, in order to reduce problems of limited structural stability, vibration and the threat of fire, in c1910, a new loom shed was built. As space was so limited, the only solution was to build over one of the existing mill ponds. On the advice of Robert Stotesbury, engineer and architect of Stonehouse, ferro-concrete piles (18" x 12" square) with iron-shod pointed ends, were constructed. These were moulded on site then allowed to dry for 1-2 weeks after which a steam-driven pile driver drove them into the bed of the mill pond, until firmly embedded into the lias clay. Onto these, reinforced concrete beams were fixed, overlaid with 3 inches of
concrete. The 160ft x 85ft brick-built shed was then built onto this substantial base. Even when all of the looms had been installed, there was no vibration evident (Playne, 1952: 47-48). The Playnes achieved their aim, despite the considerable effort and cost; such were the advantages associated with the shed-type structure. The Playnes, like many other local manufacturers, had been painfully aware of the problems created in attempting to house modern machinery and processes in old buildings and noted that:

"c1910, the old 4-storey building was no longer considered safe for the modern heavy and quick running machinery. Workshops were low, scarcely more than 10 feet high, and the floors, moreover, were so saturated with oil and caked grease that had a fire occurred during working hours, those who were in the upper storeys of the old mill might have had some difficulty in escaping" [something of an understatement!] (ibid: 46).

Despite the drawbacks associated with the reuse of earlier less-than-satisfactory buildings, at Gloucestershire mill sites, cloth manufacture was carried on in a bewildering assortment of buildings of various ages, shapes and sizes. This type of arrangement sometimes survived until the cessation of cloth manufacture at the site, such lack of integration and logical layout of processing stages probably hastening the demise of the particular manufacturer. However, this was not always the case as evidenced by the fact that the firm of Apperley-Curtis, ranked as one of the most profitable and prestigious cloth manufacturers in the region, succumbed in the 1930s. Much of their manufacture had been carried out in buildings rebuilt along logical lines following a fire in the 1890s - even this failed to save them from their eventual demise. In contrast, Playnes' Longford Mill carried on working up to the early 1990s, housed in an assortment of multi- and single-storey buildings, dating from the 17th-20th centuries. Business fortunes could be influenced greatly by the structures housing the processes, although clearly, this was not the only factor in the complex equation.

Figure 64. The jumble of buildings forming the Longfords Mill site.
Builders, Designers and Architects

Although early mills were simple in design and construction, with the passage of time, many mill sites came to be reused repeatedly, and gradually the structures became more permanent in nature. Stone was used widely for many mills, especially those built along the Stroud valleys. As a result, the contribution of the mason increased. Together, using the same techniques being adopted widely for the construction of the characteristic dwellings of the region, masons and carpenters built simple, functional buildings, perfectly suited to the scope and scale of the industry at the time. Many of these were small fulling mills, although a number were either corn or corn/fulling mills. As well as the mason's contribution increasing, that of the blacksmith also rose as the content of iron parts used in the mills multiplied; initially, these were limited largely to wrought pieces used in areas of particular stress. Most of the mills thus built were roofed in the traditional local manner, using stone tiles pegged to the roof timbers. Such were the normal building practices being used in the Stroud and other areas at the time.

Not surprisingly, no such structures survive in anything like their original form, having been replaced or integrated into newer buildings. In Gloucestershire, only the outer shells of a few early fulling mills are extant, two of note being the stone-built Dursley Mill, possibly dating from the late 17th century and Grindstone Mill, in the Ozleworth Bottom.
Here, the mason clearly played the major role, still basing his techniques and ideas on experience gained in the building of domestic structures. This becomes apparent in the stone mullioned windows and drip mouldings, identical with those found on houses of the period. By the 17th century, the term "millwright" was becoming more common and increasingly, his contribution to such projects extended beyond the provision of water wheel and equipment, now sometimes encompassing some input to the fabric of the building itself.

Invariably, little mention is made of the men who actually built such early mills. For this type of structure, an "architect", in the accepted sense, was not involved. Local builders, possibly working in conjunction with a millwright, simply used the same materials and styles of construction that they had been using for centuries - there was no reason for them to do otherwise. Indeed, there was little opportunity for the use of different materials. The lack of a coherent transport system inevitably forced the use of materials close at hand. In this case, locally quarried stone, locally grown wood and later, bricks made on the spot or near at hand.

Most local mills were increased substantially in size during the latter 18th and early 19th centuries and during this period, the simple structures of the preceding years were increasingly swept away or absorbed into the fabric of the new mill. Now, at least for some of the wealthiest of the Stroud clothiers, appearance began to count for much more, and a number of grandiose structures came into being. For instance, in 1766, the clothier Thomas Baylis built an impressive and ornate manufactory and house situated on the outskirts of Stroud, known as New Mills. The Slad Brook provided the power. Fisher describes it thus (Fisher, 1986: 216 + plate p276):

"A large dwelling house was erected by Mr Thomas Baylis, the owner of the mills and a considerable adjoining estate. The edifice, when completed, consisted of a central line one hundred and twenty feet long, and of a wing sixty eight feet long, proceeding from each end at a right angle with it - the north end including the mill ... [it was built in] a uniform style of imposing appearance".

He goes on to comment that it stood, with a lawn before it, on an artificially raised foundation 1779 that filled the bottom of the narrow (Slad) valley from side to side. The property passed onto Daniel Baylis, Thomas' son, and both the house and the mill were extended even further in later years.
This mill and its attached dwelling house serves as an illustration of the wealth that the local cloth trade had generated for a number of individuals, men who were prepared to invest their wealth in building schemes of such scale. Even with a project of this magnitude, the designer and builder(s) remain unknown. It might be expected that to be associated with such a grand edifice would ensure at least some measure of long-lasting repute, however, this has not proved to be the case and the persons involved remain obscure. Such is the situation with the designers and builders of many of the large country houses and mansions that dot the region, hence the chances of determining the individuals engaged in mill-based projects remain slim.

Such anonymity was a country-wide phenomenon. Like Stroud, as the Wiltshire and Somerset woollen industries grew, innumerable buildings sprang up to meet the increasing requirements. And, like Stroud, little is known of the designers or builders, especially pre-1825. In much of the region, there was little expansion between 1825 and the 1860s/70s, the latter ushering squatter, squarer mills. However, even at this later date, precious little is known of the mill designers and builders of Gloucestershire, Wiltshire or Somerset. Up to this transition to "machinery mills", in the time-honoured tradition, the builder and/or millwright presumably supplied much of the design (Rogers, 1976: 49) and although the uniformity of design of some of the Wiltshire mills could be attributable to the same men, once again like Stroud, it is equally likely that it was simply a result of the propagation of a style of building that had proved itself over several centuries and was now accepted as the norm. Only occasionally do details of the designer/builder emerge and these help to throw light on the type of individuals involved. For instance, at Angel Mill in Westbury (built 1801) the builder was William Grant, described as a carpenter, undertaker and builder (ibid. 224). This combination of occupations was not uncommon in many rural and semi-rural regions and survived in some areas up to the Edwardian period and beyond. In the Stroud region, the Clutterbuck family of Eastington were such an example, turning their hands to building a mill extension as easily as making a coffin. The Clutterbucks were typical of many village-based builders of the time, capable of undertaking virtually any form of building work. The repertoire of such firms could be surprisingly large; for example, the Eastcombe-based building firm of Henry Hook worked on well over a hundred buildings, from churches to mills, Lionel Hook also repairing machinery in the latter (Lambert & Shipman, 1984: 32).

Further north, the mysterious nature of the mill builder/designer continues, with little or nothing being known about the individuals responsible for mill design and construction, especially during the pre-1825 period (Williams & Farnie, 1992: 50).
Up to the latter part of the 18th century, manufacturers still relied heavily on the input of the builder and the millwright for the overall design and construction of his mill although doubtless there were also occasions where the mill owner himself assumed a greater role in this process. In some cases, an architect or designer of some sort was consulted although even here, the owner may have supervised directly the design and construction phases or at the very least, assisted in these procedures. An individual master craftsman was sometimes hired to act as the focus of the project, acting as supervisor to the works, although on occasions, the mill owner himself fulfilled this role, hiring appropriate workers directly and supervising the day-to-day operations on the site. In this respect, the role of the architect/designer may have been minimal, the owner taking on much of the work himself. Such was the situation with Benjamin Gott and Bean Ing Mills (Jones, 1985: 46). In contrast, a number of mill owners were actually proficient engineers. For instance, William Strutt (son of Jedediah) was responsible for the design of a 6-storey fire-proof mill, built in Derby in 1792-3, and one of the Belper mills in 1803-4 (Trinder, 1987: 105). There is no direct evidence that Gloucestershire mill owners were so intimately engaged in the design of their mills, although this was doubtless sometimes the case.

The known builders/architects operating in Gloucestershire on any significant scale during the 18th century were few in number. In fact, in the region, much of the building of any description was carried out by men who considered themselves primarily builders, millwrights and/or masons and who had little or no formal training in design. Only a few were known beyond their own locality and of these, the Strongs of Taynton were probably the best known, having been involved in the building of St Pauls Cathedral (Kingsley, 1980: 138-141). Although the major mill building phase in the region came some time later and there is no direct evidence to suggest that they were active in mill-related work, it seems plausible that some of the activities of later generations may have been in this sphere. Building/rebuilding of local mills would have formed an important and lucrative market at the time.

Apart from the Strongs, another likely candidate was Anthony Keck, who from the 1760s, operated as a mason/architect/builder, based in the village of Kings Stanley. In the case of Keck, there is no doubt that he carried out a number of commissions for the prosperous Stroud mill owners, including Sir George Paul of Rodborough (ibid). Over fifty buildings have been attributed to Keck and there are doubtless others not identified. Of these, only a handful can be described as prestigious country house projects and although, once again, there is little evidence to link him directly with mill-related work, it seems perfectly plausible that he was involved, considering that his base of operations was effectively in the heart of the Stroud woollen industry.

Although Keck cannot be tied directly to a particular mill project, his mode of operation helps to shed some light onto the way in which builders/architects/masons carried out their business at the time.
On accepting a commission, a team of craftsmen was assembled. These may have been employed directly although it appears that in many cases, labourers, carpenters and blacksmiths were recruited from the immediate neighbourhood of the job in question. On occasion, Keck advertised in the local press, such as the Gloucester Journal, for appropriate craftsmen. These were the procedures adopted for the construction of dwellings and there is no reason to think that they would have been significantly different for mill-based jobs. Doubtless many of the smaller scale mill-related works were organised and supervised by a single builder or mason who gathered together a small core of craftsmen, subcontracting a section of work to each. They in turn sourced and provided the appropriate labour. The builder instigating the work doubtless also fulfilled a supervisory role, much in the same way that his more illustrious peers, such as Keck, did.

In this respect, there is little to suggest that such organisation differed significantly from other cloth-making districts, at least prior to the 19th century, although clearly there were some exceptions, predominantly in the North. Here, during the latter part of the century, a number of individuals and companies grew up specialising specifically in textile mill design and construction, the scale of many manufacturing businesses offering such opportunities. These were notable by their absence in the West, characterised by its modest scale of operation. In this case, piecemeal addition and alteration was more the order of the day. Clearly, such modest requirements could be met largely by local craftsmen, men who were of little consequence beyond their immediate locality. Their relatively humble status perhaps goes some way to explaining their anonymity.

Occasionally, we are fortunate enough to know at least the name of the builder involved as, for example, Millend Mill in Eastington, and this allows a rare glimpse of how such building projects were organised in Gloucestershire. In this case, the wealthy clothier Henry Hicks, in 1818, brought in a Mr Blackwell of Brimscombe as the master builder (EM. July 1894). Materials for the mill’s rebuild consisted of stone brought down the Stroudwater Canal from the Brimscombe quarry, and Welsh slates, also conveyed by water. The workforce consisted of a core number of craftsmen who were employed directly by Blackwell, with labourers and less skilled artisans gathered from the villages surrounding the work site. Within a few years, the mason and craftsmen has been supplanted and brick was used to further extend the mill as stone became increasingly replaced as the prime building material. Increasingly, the master craftsmen were usurped by local builders, such as the Clutterbucks, doubtless working to a schedule and budget.
The fact that Blackwell is identifiable with a specific mill is unusual as most builders remain obscure. However, perhaps more surprising is the lack of information of the builders and designers of the large factory mills of the valleys. Clearly, in some instances, a designer or architect must have had an input. By now some of the buildings had become too large and complex to be constructed using the time honoured methods, although in some instances, constructional techniques appear to have been simply extrapolated from those of earlier predecessors. Designers with at least a rudimentary knowledge of the greatly increased stresses involved in such constructions must have been involved although they remain frustratingly anonymous. Despite this, there are indications that some of the mills of the valleys may have been built by the same individuals. Although speculative, there are similarities in certain areas of construction that point to the same hands being involved. For instance, the design of windows of a number of mills show similar details (Moir, 1957: 241). This cannot be taken as a firm indication however, as a strong tradition of local architecture was maintained over many centuries in the valleys; quite possibly, such similarities were no more than experience and local preference being passed on from one generation of builders to the next.

Predominantly in the North, during the latter part of the 19th century, even when an architect was employed, he was often constrained within a carefully calculated budget. It became increasingly common for mill owners and investors to calculate an appropriate rate of return on their investment based on, for instance, a specified number of spindles. From this, the requirements in terms of power and floor space were deduced. The architect was then instructed to design the mill to meet the necessary requirements but within the budget specified. Thus, the predominant feature was the internal layout of the machinery to allow for maximum production, as opposed to the external appearance. As a consequence, the degree of freedom for the architect was often minimal and this led inevitably
to many mills taking on a similar (often fairly stark) appearance (Jones, 1985: 159). In this way, the money-men held sway over the architect. This development ran counter to the design changes encouraged by Fairbairn from the late 1820s onwards (Fairbairn, 1865: 113-114). As Fairbairn noted:

"the large profits...enabled proprietors to build mills, some of colossal dimensions. At first, these mills were square brick buildings, without any pretensions to architectural form...this description of building with bare walls was for many years the distinguishing feature of a [cotton] mill and for a long period they continued to be the same form throughout all parts of the country" (Fairbairn, 1865: 113-114; also Jones, 1985: 33-34).

Fairbairn's comments were doubtless correct for many of the mills in the North, a region he was most familiar with. In the West, many of the buildings were generally significantly different in both form and appearance and although many lacked any serious attempt at architectural pretensions, they blended more harmoniously with their surroundings due largely to their more modest scale, vernacular construction and use of traditional building materials. Even after a century or more, some northern mills still appear alien to their surroundings, although others have become an accepted part of the local architecture and landscape.

Although internal mill layout remained of primary importance, Fairbairn's attempts at improving the starkly functional appearance of many northern mills resulted in at least some owners adopting his ideas although clearly, as markets became more difficult, the exterior appears to have assumed lesser importance. However, there were occasions where such a tight rein was not kept on the purse strings and the architect was given greater latitude; this may have been where a particular mill owner was trying to outshine a neighbouring mill. Here, the mill was viewed as a three-dimensional advertisement for the business, as well as a highly visible symbol of the commercial stature of the owner. Generally, the architect of many such later 19th century projects are known, however in the West, the situation remained less clear and whereas owners and tenants are often known, the men directly responsible for their construction remain largely obscure. As Falconer (Architects Journal. 1935) points out:

"In few cases can the identity of designer, master builder or men employed be established".

Even in the case of the uniquely structured fireproof Stanley Mill, at Ryeford, the identity of the designer remains unresolved. Speculation as to his identity has even included John Rennie (Falconer, 1993: 80). Falconer agrees, however, that the matter remains open to debate.

Thus over several centuries, mills throughout the woollen districts were designed and built by a
number of eclectic individuals. From the ranks of local masons, millwrights and carpenters emerged a number designer/builders, still largely parochial in nature. In many cases an individual sourced and organised other craftsmen and labour from the immediate area. Such workers were usually still firmly rooted in the techniques and styles associated with domestic-based structures and this was apparent in the type and scale of the mills that they were responsible for. Up to the 19th century, mills were built/rebuilt primarily by local men, whether in the West or the Northern clothing districts. However, as the 19th century progressed, there was a divergence of organisation and the North witnessed the appearance of a number of specialist mill designer/architects who concentrated their efforts primarily in the development of the large mills so characteristic of the region. In the West, the situation was somewhat different as by now, mill development was largely restricted to piecemeal alteration or extensions, a task that was generally well within the capabilities of local builders. Essentially, by the close of the 19th century, mill building had all but finished in the West, whereas it was set to continue unabated for some time in the North, providing opportunities for mill designers that were denied them in the fading woollen districts of the West. In the Northern towns, mills were designed by specialists such as Woodham; Bradshaw, Gas & Hope; Pott, Son & Hennings; and Stott & Sons (Jones, 1985: 12, 220-221). In contrast, in Gloucestershire, the likes of the village-based Clutterbucks and Blackwells continued to add to local mill sites in a piecemeal fashion, much as their predecessors had done for several centuries before them.

Influences on the Design of Gloucestershire Woollen Mills

To a large extent, the architectural style adopted was dependent both on date and location. Generally, up to the first part of the 19th century, relatively little attention was paid to a mill’s exterior appearance. It was, after all, an industrial building and what went on inside was of greater importance to the owner. It was only later that mill owners began to take on board architectural themes, some gleaned from the English country house and others from some of the most notable public buildings within Europe and beyond. Thus, in terms of overall visual impact, there were several factors that helped decide the form adopted. In some cases, no doubt this impinged on the way in which the particular master wished to be viewed by his peers, the local populous and obviously, potential customers. It also depended on his personal circumstances. In parts of several textile districts at different times, industrial buildings were constructed with designs based on a variety of themes including Greek, Gothic Revival, and Italianate, as well as what came to be known as High Victorian Gothic. Often, the mill came to fulfil a secondary role, acting as a three-dimensional advertisement for the business. Thus, architectural flourishes became more common and mill names were emblazoned across buildings and chimney stacks.
Adoption of a particular style was by no means uniform and in reality, considerable differences between the appearance of mill buildings continued to exist in all areas. During the same periods, widely differing styles co-existed. For instance, when Union Mill (Manchester) was built between 1818-20, it comprised a strictly functional, unadorned brick-built structure, whereas during the same period, mills modelled on Palladian ideas continued to be constructed throughout the major textile districts. In contrast to Union Mill’s austere appearance, the Palladian-inspired mills often exhibited central pedimented sections, clocks, bell cupolas and Venetian windows set in regular patterns. Even though there were considerable differences between these two mill types, the gap was set to widen further with the subsequent appearance of a number of "themed" mills. Such an example was Temple Mills in Leeds, built between 1838-40, where the Egyptian movement gained a relatively isolated hold. The mill offices resembled an ancient temple, the main chimney was in the shape of an obelisk and the spinning shed was dominated by a row of huge columns featuring papyrus leaf capitals (Jones, 1985: 102).

Perhaps the most notable visual reminder of themed mills was that of the Italianate school, one of the best known being Salt’s mill at Saltaire, built between 1851-3. This huge mill featured a southern facade packed with rectangular and radially-headed windows. In addition, two Italianate towers flanked the main entrance; these housed two pairs of condensing beam engines, steam being fed from boilers placed underground a short distance in front of the mill (Fairbairn, 1871: 235). The detached main stack was some 250 ft in height and resembled a large campanile. Although Saltaire was perhaps the pinnacle of Italianate design, many other mills also adopted the theme, including Dean Clough Mills in Halifax and Black Dyke Mills (1857) in Akroydon, the latter including an Italianate tower and exterior features.

The other style of architecture associated with the mid-late 19th century was the Gothic revival and although used widely for churches, public buildings and domestic structures, it only found limited expression in a handful of mill buildings. One of the few notable examples was the Anglo-Scotian Mill of 1871, built in Beeston. Here, the red brick mill was castellated and featured lancet windows and turrets. However, this was one of the few mills to take up the Gothic theme, although Gothic-styled windows sometimes cropped up on otherwise traditional designs.

Thus, several architectural styles came into use for textile mills. However, the vast majority of this
activity was centred in the North where businesses were considerably larger than in the West and thus, opportunities for bold architectural statements were greater. Here, as with the other textile districts, the final form adopted could reflect not only the owner's preferences, but possibly also local traditions of building and constructional materials. In other cases, both ideas and materials were alien to the region. The increasing improvements in transport systems during this period made it easier to move materials economically over long distances, hence many 19th century mills could use bricks made hundreds of miles away and timber imported from overseas. This increased range of materials allowed for a greater degree of expression in brick and stone than had hitherto been possible and a number of owners and architects took advantage of this. The result was a range of industrial buildings of widely differing characteristics. At times, one particular style was in fashion, at others, something completely different. However, there was a great overlap in terms of period, and various types of mill coexisted for lengthy periods. Whatever the style, all needed to meet the major criteria imposed by the layout and procedures of textile manufacture.

**Appearance of Gloucestershire Mills**

In general terms, mill buildings in the Stroud region fell into three categories. The first was modelled on the traditional domestic architecture of the area, based on the Cotswold-styled gabled structure. The design and structure of these was simply an extrapolation of the same techniques adopted for the construction of domestic buildings, used in the region for centuries. Even large mills tended to incorporate domestic-styled and -scaled features (e.g., types of window and door openings) and to predominantly make use of local limestone for the construction of both walls and frequently roofing. As such, apart from their scale, many mill buildings resembled existing dwellings. The second category comprised, for a period during the latter part of the 18th and early part of the 19th centuries, the pedimented "Palladian" style. This was followed by the third category, consisting of a number of brick-built mills, displaying varying degrees of architectural merit. In terms of dates, there was considerable overlap between these phases and all types coexisted for a lengthy period.

Up to the turn of the 19th century, most of the mills throughout the region owed much of their appearance to the traditional building techniques and materials of the region. For instance, Baylis's Upper (fulling and gig) Mill was of a moderate size although most of its features reflected the domestic architecture of the region; the door and 2- and 3-mullioned window openings were precisely the same as those gracing many of the houses of the district. In fact, the scale and appearance of the mill was not unlike a country house of the time. As with virtually all domestic structures in the area, stone was used for the mill's construction, doubtless sourced locally from the Painswick quarries.
Similarly, Dauncey’s Mill in Uley clearly demonstrates the similarities born out of tradition between domestic and mill buildings of the period. In this case, it is difficult to differentiate between the domestic and industrial parts of the L-shaped building. Once again, traditional local materials and techniques were used in the build, the mill section exhibiting precisely the same scale and type of window and door openings as the mill house itself. The water-powered section of the mill is of two storeys and retains an early breastshot wheel of \( \sim 12 \) ft diameter and 5 ft width. At its height, the mill housed the regular Gloucestershire combination of fulling stocks and gig mill, with a variety of auxiliary buildings dotted around the site. As such, the mill serves as a useful visual reminder of the scale and nature of many of the local mills of the 17th and 18th centuries. The extrapolation of traditional local domestic-based architecture to the mill is fully apparent.

Instances where the line between domestic and industrial buildings became blurred are not unknown in the region. During the demolition of Wallbridge Mill in 1964, a number of domestic features from the 17th and/or 18th centuries were uncovered. A former employee of Howard & Powell, the last operators of the mill, recalled that:

"the building where I worked was once a gentleman’s house; the walls were a yard thick (with thick beams) built of Cotswold stone. The plaque on the outside of the wall said 1646. There was a very large fireplace in the fuller mill where the cook was said to have been burnt to death...". (Pers. Comm. Mr W J Lawrence. 1986).

The existence of domestic features within the mill suggests strongly that at some point, at least part of the structure had been in domestic occupation. Possibly the clothier had taken up residence in part of his mill; alternatively, as suggested, a domestic structure may have formed the core of what later
became a cloth mill. There is evidence to suggest that this was not a particularly uncommon occurrence, with clothiers living either in part of, or certainly adjacent to their mills. In this particular case, the industrial part of the structure came to dominate however, this was not always the case and occasionally, the domestic part was the greater. A particularly notable example of the integration of a clothier's house with his mill was to be found in the shape of New Mill, built by the wealthy Baylis clothier family, in the Slad Valley (see also above, p257). As the Gloucester Journal described it (GJ. 11 April 1768), the entire structure was E-shaped in plan, consisting of a long main block, central porch and flanking wings, one of which housed the mill. It was also noted that decorative classical details were used throughout. At this date, power requirements were probably limited solely to the fulling process, hence the industrial component of the site was relatively small compared with the domestic section. Nevertheless, indications are that the mill was built to the same standards as the residence, care being taken to ensure complete harmony between the two (Fisher, 1986: 216-217; also VCH. xi. 128 + Plate p176). As such, New Mill provides an example of great care being taken with the overall appearance of an industrial building and although its appearance could hardly be described as extravagant, it was apparent that consideration was given to both its integration into the whole structure and its overall visual impact.

Even in later years, when substantial rebuilding was being carried out to many of the existing mills in the region, this traditional style was still adopted in some cases. For instance, the substantial Dunkirk Mills near Nailsworth, comprised four main blocks dated between 1798 and 1855. A 5-storey cruciform-shaped extension was added in 1827, housing hand looms. Here, matching materials and styling were used, the new section being built in the traditional gabled style, allowing it to harmonise with the remainder of the mill. Whether this was a result of careful planning and design or simply good fortune is not known.

Although a number of Gloucestershire mills reached a considerable size, many still retained a strong link with local traditions. During the period of the Great Rebuild (c1790-1825), requirements for adequate floor space were met through the continuing use of local building traditions. Thus, buildings tended to increase in height (rather than width) but as a result of the limited construction techniques available, often remained a single room deep. This gave rise to tall, narrow multi-storey mills, characteristic of the period and included mills built on a relatively modest scale, such as the 3-storey section of Days Mill in Nailsworth, to parts of Lightpill Mill which were of 5 storeys; good quality masonry was the hallmark of much of the latter. During this period, stone continued to be used for most major mill building projects. In terms of quality of stonework, this varied from neatly laid but fairly coarse stone blocks (eg. Avening and Langford Mills) to dressed masonry of the highest order; many fell in between. At this time, only in a few isolated cases did brick replace stone as the main building material. With the exception of the unique Stanley Mill, the most notable example was that
of New Mills at Kingswood, this attractive brick-built mill being built c1810. As with its stone-built peers, the mill was tall and only one room in depth.

Many of the area’s largest surviving mills date from this period. Such was the case with Ebley Mill, one of the grandest in the region, built simply from local stone and roofed with slate. From a constructional point of view, there was little novelty in the design, the interior consisting of traditional timber floors and iron columns. However, there was still scope for embellishment and although the mill was built largely according to well established local traditions, its entire appearance was greatly enhanced by the addition during the 1860s of a replacement block featuring a chateau-styled tower housing the factory clock and bell, surmounted with ornamental ironwork. A decade or so later, the theme was picked up during the rebuild of Stonehouse Upper Mill, where a suitably scaled down version was used to grace the brick-built mill.
As the 19th century progressed, mill form began to alter in order to accommodate the changing requirements being placed upon it. Gradually, the traditional tall narrow structures gave way to squarer, squatter buildings. Such was the case with new part of Ebley Mill, the replacement block being added to the front, based on a design by the architect G F Bodley. The new form was clearly apparent and although traditional stone was used for the construction, the shape of the building was significantly different to those structures already standing. This resulted in significant differences in power transmission arrangements and accommodation of the machinery. In terms of textile mills, this was the shape of the future, such designs increasingly supplanting the tall, many-storeyed blocks of earlier days. The theme was taken up in all the woollen districts, rectangular blocks of large open floor plans being built in both the West and the North. Thus, Ebley's new block was similar to a number of woollen mills of similar scale being built in Wiltshire. In the latter, the tall narrow buildings of, for instance, Avon Mill in Malmesbury, were increasingly replaced with structures that looked almost identical to the new block at Ebley Mill; for example, similar buildings were to be found in the shape of Abbey Mills in Bradford-on-Avon and Studley Mill and Ashton Mills in Trowbridge.

**Pedimented ("Palladian") Mills**

Much of the influence for this style of mill building was derived from the work of the 16th century Italian architect Andrea Palladio who was credited with popularising the architectural style that came to bear his name, Palladianism. From his work came the re-emergence of the pedimented portico, characterised by a shallow triangular gable supported, at least on non-industrial buildings, by columns. Palladianism came to dominate the English architectural movement in the 18th century not only for public buildings and grand houses, but also for a range of industrial structures. The idea of the centrally located pedimented section was adopted widely for mills, although this was generally used in a somewhat simplified form befitting such a structure. Nevertheless, the adoption of this Palladian feature effectively transformed what may otherwise have been a simple box-like building, acting as it did as a suitably grand central focus, often the location for the mill's main entrance and housing the factory clock and time bell.

Its popularity for mills was widespread and examples were built from the 18th century onwards in all major textile areas. Buildings of a similar style, in an array of shapes and sizes were to be found in the form of silk mills in East Cheshire, woollen mills in Yorkshire, cotton mills in the Manchester region and woollen mills in Wiltshire. Examples in the latter region included the 4-storey Courts Mill in Trowbridge with its 3-bay pediment, the 4-storey Angel Mill at Westbury with a 4-bay pediment housing a clock, Home Mill at Trowbridge, where the factory name was displayed on the face of the pediment, and the famous 6-storey factory at Staverton, where the pediment was 5 bays in width and
carried a clock in the front face (Rogers, 1986: 91, 94, 96).

Interestingly, this was the one form of outside influence that was actually taken up by some mill owners in the Stroud valleys, the combination of local stone, coupled with Palladian features resulting in some of the most aesthetically pleasing mills of the region. Although many were large by local standards, they were often smaller than their counterparts elsewhere; this did not detract from the effectiveness of the design as the smaller scale often resulted in more effective overall proportions. Notable examples of mills built in this style in the Stroud region included the 5-story Woodchester Mill, with its central pediment of four bays in width, Days, Fromehall, Millbottom, and Brimscombe Lower Mills, plus the large 13-bay Nailsworth Mills. The latter had a pronounced central section and pediment, some 4 bays in width. A variation on the theme was to be found at Hope Mills, Brimscombe. This 7-bay rectangular building had no central pediment but was patterned along similar lines, and capped with a decorative cupola. Millbottom Mill survives as an interesting example; here, it appears that its was never completely finished and was probably intended to have an additional storey. Possibly the owner underestimated the expense of the works and at a time of deepening recession in the cloth trade, the money simply ran out! Ironically, much of the work left undone at the time was being carried out by the new owners from the mid 1980s onwards.

![Figure 73. Nailsworth Mills, showing pedimented main block.](image)

Regrettably, few of these mills have survived, most having been demolished or burnt down during the latter part of the 19th or first half of the 20th centuries. For example, Woodchester Mill, one of the most attractive in the region, was burnt down in a spectacular blaze in 1938.
19th Century Brick-built Mills

This group was typified largely by the functional brick-built structures that were, with the exception of Stanley Mill and New Mills, Kingswood, put up predominantly from the middle of the 19th century onwards. Visually, many of the brick-built mills of the period were characterised by their blandness. For instance, Lewiston Mill at the foot of the Toadsmoor Valley was built in 1856 of plain red brick and radially headed cast iron windows, materials that were perfectly in keeping with the period but lacking in visual impact. The main 1856 building and the extension put up in 1864 were plain, squat and strictly functional in appearance despite the addition of a loading tower (VCH. xi. 130). Similarly, the surviving late 19th century blocks of Griffins Mill, although not totally unattractive, show little attempt at architectural pretensions, being constructed simply of plain red brick with iron windows. However, one block features a modest pediment that formerly housed the clock, helping to break up the expanse of plain brick. Most other brick mills or additional buildings added to existing sites during the period were of a similar nature.

One of the most striking mills of the Stroud region making use of brick for its construction were the buildings that replaced the original Lodgemore Mill. This was devastated by fire in 1871 and replaced a few years later with a distinctive structure in red brick with blue pilasters and voussoirs, featuring bands of yellow brick above the second floor windows. It was designed by local engineer, James Ferrabee. The original mill had been a traditionally-built building of 4, 5 and 6 storeys. However, the new structure broke completely with tradition as the old style of building was swept completely away. The new mill comprised rectangular 3-storey blocks with iron-framed windows and had nothing in common with its predecessor. It was strictly functional in appearance and looked completely alien to the area; gone were the traditional minor flourishes and fenestration that sometimes embellished earlier structures, functionality was the name of the game. The only other mill to follow in the footsteps of Lodgemore was Merretts Mill. This was partly rebuilt in 1887 using red and blue bricks in a similar style, and followed by a further extension in 1894.

Thus, Lodgemore Mill’s main concession to ornamentation was through the use of coloured bricks, a technique that was also explored in other manufacturing districts. For instance, the Gidlow Works in Wigan were built of red brick, decorated in a variety of ways with blue and white Staffordshire bricks. This included coloured panels, relieving arches, string courses and decorative motifs set into the walls (Williams & Farnie, 1992: 34). The use of coloured bricks in this way impinged little on the Stroud mills, Lodgemore being the prime, and effectively unique, example.

Perhaps, fortuitously, the appearance of Lodgemore and Merretts Mills failed to set a trend for other local mill rebuilds although by now, these were becoming rarer as the industry continued to contract,
and although newer materials and styles were adopted, the end results were somewhat more pleasing on the eye. A case in point was Stonehouse Upper Mills, burnt down in 1847 but not rebuilt until 1875 (Tann, 1967: 148; Also SDC Urbed Report. 3). Although constructed from machine-made brick, this substantial manufactory benefited from pleasing proportions and was topped with a Welsh-slated Mansard roof. The latter was a rarity in the area and only a few other examples such as the 2-storey Howards Mill in Dursley were known (Sutton, 1991: 61). In addition, a cupola and chateau-inspired tower (similar in concept to Ebley Mill’s) was added, housing a number of carved stone and brick details and surmounted with ornamental ironwork. Overall, a much needed reaction to Ferrabee’s functional Lodgemore Mills.

Occasionally, interesting combinations of brick and stone were used, one of the most unusual being the "piered building" which straddles the 5 wheel culverts at Stanley Mill. Here, narrow stone pillars (some 18 inches square) have been infilled with brick panels and windows; there is the possibility that these have replaced wooden louvres suggesting a former drying house. The building is narrow with floors carried by single timber spans supported by central wooden columns. According to tried-and-trusted engineering principles and the laws of physics, such a construction should not be standing, but stand it does, an interesting legacy of the early 19th century. This interesting building was examined in some detail by Stratton & Trinder (1988) and Falconer; the latter cites comments by Schinkel, a Prussian architect, who describes various building types encountered during a journey through England, Scotland and Paris in 1826. A number of detailed drawings (of various scales) also formed part of the RCHME survey carried out at the site in 1987 (copies provided by the mill owner, Mr M Griffith). The pierced building remains in commercial use.

The use of stone features to embellish brick-built mills was not uncommon and their use in this manner frequently elevated the overall appearance. Often for purely practical reasons, stone details were found in the shape of lintels over door and window openings. A more ornate feature survives as part of the former Dudbridge Mill, where a finely carved stone panel commemorates the building’s opening by Lord Bathurst in 1910 (Fig 76). Apart from well executed lettering, other carved features include the traditional sheep, a reminder of wool’s importance to the area. Similarly, on the upper facade of Cam Mills, a large carved stone panel bearing the company name left the visitor in no doubt as to his whereabouts. At various other local sites, stone was employed for a variety of decorative features, including quoins, string courses, circular and arched windows, and in a number of forms around mill main entrances, no doubt intended to enhance the image of wealth, solidity and stability associated with the particular business.
In a similar fashion, during the later 19th century, a few mills were embellished through the use of brick or terracotta details. These usually celebrated the name of the mill or more often the occupation of a particular owner. For instance, Charles Hooper’s presence was made known at Bonds Mill through the large initial "H" embossed onto the outer wall of one of the site’s most visible structures, the 1887 "Jubilee" building, completed in the year of Victoria’s jubilee. Similarly, but on a more modest scale, parts of New Mills, Kingswood, were graced with terracotta shields proclaiming "T L & Co. 1895", celebrating the date of the opening of Tubbs & Lewis’ new weaving shed. It is conceivable that the terracotta components could have originated at the Stonehouse Brick & Tile Company who were noted for the manufacture of a variety of ornamental terracotta goods. Occasionally, this material was used for date stones however in the majority of cases, these continued to be made of stone. Most simply carried the date however in a few cases, further ornamentation was added. As interesting example is located in a surviving section of Nailsworth Mills, where a date of 1814 is accompanied by a carved sheep.

Terracotta detailing remained a comparative rarity in the Stroud area, although it found greater expression elsewhere. A number of mills in Yorkshire, mainly of the late Victorian and Edwardian
periods made use of terracotta motifs, notable examples including Swan Lane No 3 Mill in Bolton, which carried terracotta swans around the main entrance and the parapets, and Pear New Mills, where terracotta pears adorned the corner turrets and engine house (Giles & Goodall, 1992: 125,126).

In the case of New Mills, Kingswood, the appearance of what was essentially a gigantic brick box was greatly enhanced through the addition of a stair tower, located slightly off centre, on the front wall. Clearly, although a strictly functional addition, care was taken to make it an attractive feature; the top of the tower featured an ogee design and housed a large ornamental clock. The careful placing of the tower helped to maintain the overall symmetry of the building and to break up what would have otherwise have been a huge expanse of windows. Even the rain water down pipes were carefully positioned such that the overall balance of the building was not affected. In addition, ornate rectangular ‘turrets’ graced the 1895 weaving shed, capped with steeply sided slate roofs and ornamental ironwork (Industrial Gloucester, 1904: 23). Similarly, at Stonehouse Upper Mill, a centrally placed tower housed a staircase as well as the mill’s main entrance at the second floor level.

Thus, the use of a tower in a suitable location could greatly enhance the appearance of what may have been a visually uninteresting building. It could have a significant visual impact and many large Victorian and Edwardian textile mills of the North were graced with suitably embellished towers. Often, their addition helped to overcome some of the austere appearance of a building that may have comprised a large cube, featuring acres of unadorned brickwork. Even if the main mill block itself was relatively plain, the tower usually carried some embellishment or had been constructed to reflect a particular architectural style. Mansard roofs were common, sometimes incorporating conservative Italianate features. In other cases, the tower was lit by a succession of decorative or radially-headed windows. Often, finials of varying types were added and the brickwork of the tower itself enlivened through the use of patterned panels of matching or contrasting brick. Thus, the appearance of many of the northern textile mills was enhanced with a stair tower, a feature that was both strictly functional and yet, often highly decorated. Notable examples included Beehive Mill in Bolton, Bolton Union Mill No 2, Laburnum Mill in Leigh, and Barnfield Mill in Tyldesley (Williams & Farnie, 1992: Plates 30,32,33,99,123).

In a similar way, towers surmounted by water tanks supplying sprinkler systems, although essentially functional, were sometimes suitably decorated. At Dudbridge Mill, the water tank sits atop a tower of red and blue brick, suitably embellished with gothic-style windows, bell, clock and ornamental iron work. At Cam Mills, the water tank was carried by a brick-built tower added to an earlier multi-storey block (regrettably demolished in 1995); the tower also housed a clock on each face and was lit with radially-headed iron windows. Further examples survive at sites such as Stanley Mill, where the tank is carried on a brick tower pierced with radially headed windows surrounded by decorative stone.
dressings. Interestingly, at the Lodgemore site, two towers survive; one consists of a later brick-built tower that forms part of the main site, whilst the second consists of a detached built tower of ashlar blocks, featuring Italianate windows, some distance up the valley side - presumably this was to increase the water pressure available. Such water arrangements were to be found exclusively at the larger sites.

Loading towers were also used on a number of local mills. Here, the tower was generally located at a corner of the structure, allowing for loading arrangements at each level but avoiding their intrusion into the work spaces. This useful arrangement was used in a number of the West’s 19th century mills, examples including Studley Mill in Trowbridge and locally, Lewiston Mill in the Toadsmoor Valley.

Hence, in terms of a mill’s appearance, the use of a tower could help to create a central focus and change completely the appearance of what were often, simple rectangular brick-built boxes. Although primarily functional, this type of architectural statement was not adopted widely in the Stroud region although examples abounded in the North. Doubtless rising costs and an increasingly difficult marketplace left little room for such individual flourishes in the former.

Clearly, the overall appearance of Gloucestershire mills was also influenced by the assortment of allied buildings that inevitably surrounded the main block(s). Such buildings housed an assortment of processes and often comprised a combination of single and multi-storey structures, some adapted from earlier uses and others newly built. Indications of the types of structures can be gauged from the variety of processes that they housed, as noted by Partridge (1975) and in greater detail by Mayhew who visited Lodgemore and Fromehall Mills during the 1860s; he commented on both processes and the buildings that made up the site.

Clearly, the spectrum of buildings found at individual sites varied, however, as dyeing comprised such an important aspect of the Stroud trade, dye houses were found at many mill sites. For instance, at Churchend Mills, the dye house was of a single storey, ~7'10" to the beams. It housed two vats of 4' in depth. These were originally heated by coal fires and later by steam. In a typical day, five ends of cloth could be dyed (note in Boulton & Watt pf.434). Where dyeing came to be the speciality of a particular master, significantly more space might be required. Thus, John Hawker built up his large dye works at Dudbridge, housed in a number of former cloth mill buildings. These housed 17 vats, capable of dyeing up to 42 ends of cloth in a day. Thus, dye houses varied widely in size and scale.
and shared many common features throughout the textile trades (a Gloucestershire example was reported by Pountney & Beddow in 1976). However, in the West of England, one particular type of building existed that was not found outside the region. This was the tall, round wool drying towers found in locations in the Stroud valleys and parts of Wiltshire. These early variants were exclusive to the region and were not found in the northern textile areas. The operation and configuration of these interesting buildings has been reported widely (eg. Ponting, 1967; Haine, 1981; Rogers, 1986; Wilson, 1989; Mills & Riemer, 1989; and Falconer, 1993). Wilson's report includes a visual reconstruction based on notes from Partridge (1975). These round towers were gradually supplanted by more rectangular structures and long, narrow stoves.

Summary

Thus, the appearance of mills in Gloucestershire changed with time, developing through a number of distinct stages. Initially, small fulling mills were built, reflecting closely the scale and appearance of domestic buildings. For example, Dursley Mill was constructed from the same materials, was characterised by similar architectural features, and was of a similar scale to the adjoining clothier's house. Those mills which occasionally strayed from this norm, such as New Mills in the Slad Valley, still strongly exhibited the domestic influence.

From the latter part of the 18th century, mills increased in size in order to house an increasing number of mechanised stages of manufacture. Most of these buildings were essentially enlarged versions of what had gone before, still heavily reliant on long-established styles and techniques. Although mills were now on a much larger scale than their predecessors, they were still strongly influenced by the traditional techniques, often reflected in door and window openings of domestic scale. Although some reached a considerable size, their exterior appearance remained essentially unadorned apart from perhaps, the necessary factory clock and bell, sometimes housed in a cupola. In many cases, this form of mill building was to survive until the effective end of cloth manufacture in the region, although frequently, additional buildings or wings came to clutter the site.

An alternative to the "traditional" type of mill adopted by some mill owners was the pedimented Palladian style, and this was used for a number of the region's most striking mills, built from the latter part of the 18th and early part of the 19th centuries. As with the more traditionally styled mills, pedimented mills varied widely in scale. The adoption of this architectural style did not supplant the earlier type of mill as both co-existed for a lengthy period. Indeed, some pedimented mills pre-date others based on the traditional gabled style.

However, the gradual contraction of the Gloucestershire woollen industry effectively precluded the opportunity for the adoption of some of the later and more flamboyant architectural themes and developments (eg. Italianate, Gothic, etc) in mill buildings to be found predominantly in the North.
In Gloucestershire, as the 19th century progressed, mill building increasingly reflected the inevitable changes that were taking place in the marketplace. Bricks systematically replaced stone as the main building material. With the exception of a few mills dating from the first quarter of the 19th century, (such as New Mills at Kingswood and Stanley Mill) most date from the second half of the century. These brick-built mills tend to reflect a more functional appearance and although not wholly unattractive, were relatively plain, unadorned structures. Where the appearance was enlivened, this tended to take the form of raised or coloured brick features, sometimes in conjunction with stone features such as quoins. Apart from a few major rebuilds, such as Dudbridge Mills, the latter part of the century witnessed few mill building projects of any scale. Where expansion did take place, buildings were almost inevitably of brick. By and large, developments in Wiltshire mirrored what was happening in Gloucestershire. In parts of the North, the evolution of textile mills continued for a further half a century or more, and the traditional designs of building were increasingly replaced with mills, some of massive proportions; some were plain and unadorned whilst others were heavily embellished. In Gloucestershire, these influences had little or no impact on the appearance of the local mills. Essentially, in terms of mill design and appearance, the end of the road had been reached some time before the start of the 20th century.

**Construction of Gloucestershire Mills**

**Materials of Construction**

The materials used in mill construction varied throughout the history of the Gloucestershire woollen industry, much as they did in other woollen districts. For walls, timber, stone and brick were used; floors were almost inevitably of timber, and roofs were of stone tiles or latterly, slate - much depended on what was available locally. With one notable exception (Stanley Mill) the use of iron for constructional purposes within the region was limited. Hence, the degree of use of a particular type of building material was influenced by the location, and considerable differences in materials and building techniques later emerged between the different regions.

Prior to the 19th century, materials used in a mill’s construction were dependent largely on its location and almost inevitably, local materials predominated in its build. Early mills (predominantly small corn and fulling mills) throughout Gloucestershire were simply constructed from local wood, doubtless with thatch for roofing material. Particularly in the Middle Ages, timber was used extensively for mill construction. The range was diverse and included apple, crab apple, hornbeam, ash, elm, oak and whitethorn. Great care was taken in its selection, different woods being favoured for specific areas. For instance, one mill used elm for roofing timbers, oak for supporting timbers, apple and servis for gears, elm for wheel trough, oak for supporting posts, and elm, oak and ash for wheel sections (GCL.T1865). The fact that such structures had a finite life and would eventually decay becomes
apparent from records that regularly mention rebuilds or repairs. Gradually, these simple all-wooden structures gave way to those built from more durable materials.

The majority of the mills built in the Stroud valleys themselves were built of local limestone. Examples of this type were numerous, many still surviving. Stone was often quarried locally, thus minimising problems of transport which for many years, formed a major headache in the region. As a result, mills built in Chalford used stone quarried in the vicinity, and the same was true in other towns and villages including Nailsworth, Minchinhampton, Slad and Painswick. It was noted in the case of the latter, that the former cloth mill later occupied by W H Cole's pin works had been:

"constructed of stone taken from the hills nearby" (Industrial Gloucester, 1904: 18).

However, not all building materials were sourced locally and with the opening of the Stroudwater Canal in 1779, opportunities for the use of materials from farther afield increased. For instance, a significant proportion of the materials for the construction of Stanley Mill, including some ironwork and specialised brickwork, was delivered to the nearby Ryeford Wharf although the remainder must have come from more local sources (Stratton & Trinder, 1988). Similarly, when Meadow Mill at Eastington (Fig 62) was constructed c1810, stone, timber, bricks and slates were unloaded near to Court Orchard Lock and transported to the site by means of a small tramway, built specifically for the purpose (EM. July 1884). In addition, 1826 saw the arrival of a 30 hp Boulton & Watt steam engine by the same means.

Where local materials predominated in a build, in particular, it was the use of local limestone that enabled mills and associated buildings such as clothier's houses to blend so harmoniously with existing settlements. Travellers during the 18th and 19th centuries sang the praises of the region's industry commenting that the mills appeared to have sprung from the rock itself. In fact, to this day, perhaps the greatest compliment paid is that travellers frequently fail to realise that they have passed through a region formerly characterised by intense industrial activity. Although the vast majority of mills used building materials sourced locally, there were occasions where, for specific reasons, stone and timber were transported for some distance. At Walk Mill, on the Little Avon near Kingswood, sales particulars recorded that:

"the buildings are of stone...principally covered with slate and stone tiles...the foundations exposed to water are built with weather stone from [Minchin] Hampton Common." (Tann, 1967: 91-92. Quoting sales particulars of 1839).

The technique of using stone for the lower courses was widespread and apart from the numerous examples in the Gloucestershire woollen districts, its use as a damp course was to be found in many areas including mills in East Cheshire (Calladine & Fricker, 1993: 45-46).
Moving downstream towards the Vale of Gloucester, a subtle change occurred, as stone gave way to locally produced brick. For some of the mills along the lower Frome, stone was something of an expensive luxury and bricks made from clays dug and fired near at hand sufficed. Later, at many other locations throughout the valleys, where smaller stone-built mills were rebuilt or enlarged, the rebuild sometimes retained the existing stone footings and lower courses, the new structure being built from brick. In a number of cases, stone-built remnants of earlier mills survive as part of a later structure.

Small brick yards were numerous, making use of suitable seams of clay. Bricks were made from locally dug clays at a number of sites in and around Stroud itself and Stonehouse, from clay deposits around Doverow, Dudbridge and Rodborough. Some small settlements along the lower Frome also had their own brick yard, producing bricks made from local clays, predominantly for local use. Eastington was typical in this respect, having a small yard that relied on the use of clay dug within the parish, processed in a single horse-operated pug mill, and fired in clamps on the spot (Keys, 1953: 7). However, one of the most productive brick works was situated at Frampton on Severn, near the Frome’s outfall into the Severn. For almost a century, distinctive bricks were made here from Severn clays. Their fascinating range of colours and textures goes some way to excusing their poor performance in terms of their permeability to water, problems of spalling and general lack of mechanical strength. Despite these drawbacks, there was little opportunity to obtain supplies from further afield, such were the limitations of the rudimentary transport system at the time. Frampton bricks were used for a number mills along the lower Frome including those at Frampton itself, Eastington and possibly Stonehouse. Further upstream, bricks were used in part of Bonds Mill, produced from clay probably dug and fired on the spot. These differ significantly from Frampton bricks in their colouring and their general ability to survive the effects of the elements, a clear indication of the varying chemical makeup of the local clay deposits. Certainly, bricks were made in profusion by the Stonehouse Brick and Tile Works and Jefferies and Sons, both making use of the clay deposits of Doverow Hill, near Stonehouse. The bricks produced were renowned for their superior properties compared to the products of many of the local yards that they ultimately supplanted, and many thousands were put to use during periods of expansion in the local cloth industry. Many were exported to other regions of Britain and even overseas.

Gradually, brick began to replace stone, even in areas traditionally associated with stone-built mills. When Hallidays Mill in Chalford, a mill site since c1710, was partially rebuilt during the 19th century, red brick was used (GRO. MF339/5). Cost and speed of erection were clearly now the primary objectives. Although bricks had become fashionable for use in some locations and circumstances, there is no evidence to suggest that their increasing use around the region was as a consequence of this.

Although bricks became increasingly important and were used widely for mills and related buildings, there were instances where the owner was prepared to pay the increased costs associated with the use
of stone. This may have been his way of making a bold architectural statement or of enhancing his perceived personal status in the area. Whatever the reasons, this led to a number of interesting results. At Beards Mill, the already substantial brick-built mill owners house standing adjacent to the mill, was extended c.1820 by Josiah Parsons, a mason formerly of Portsmouth but who at the time, was resident in nearby Cress Green (EM. July 1894). He was responsible for the addition of an extensive new section, featuring Palladian details and built of dressed stone, added to the front of the house. Here, status and appearance clearly outweighed the greater cost. In addition, a new detached building was added to the mill complex around the same time, latterly known as the "Menders House", although originally built to house hand looms. The building still survives and consists of a single large room on each of the three floors. The front face consists of well dressed blocks of stone, however this conceals interior walls of jumbled rubble stone and brick. In fact, the back wall of the building was built entirely of brick, presumably because this was not directly visible. Interestingly, whereas the other three walls are filled with large windows, this wall is entirely devoid of them, probably as it overlooked the garden of the Beard family home. This was not the only instance of mill owners trying to outdo each other in terms of status, and there are apocryphal tales of cloth mills being built with wings or blocks that remained empty or even lacking floors, although from the outside at least, they appeared to be completely functional, such was the reputed vanity of a number of individuals active in the cloth trade at the time (Hadfield, 1973: 194-5).

As well as mill rebuilds, there were innumerable instances where additional buildings or extensions were added to sites and frequently, stone-built mills were extended with brick. A prime example of this is Millend Mill in Eastington. Built in 1818 by Henry Hicks on the site of an earlier fulling mill, it formed a simply proportioned single block of four floors plus attics. Architectural pretensions were few, the simple stone building being designed and built to house fulling stocks on the ground floor, with carding, spinning and other hand processes and storage on the upper floors. However, within a few years of its completion, a large brick-built wing had been added to house hand looms. No attempt was made to match the mill’s original materials of construction; such compromises were to occur increasingly as profit margins began to fall and competition increased. In the region, additional buildings or wings became increasingly functional in appearance and form.

In Nailsworth, an interesting combination of materials was utilised for the construction of the new loom shed at Days Mill where an effort was made to give some interest and harmony to a structure, often viewed as strictly utilitarian. The windows benefitted from decorated surrounds and the ends of the building were built from bricks produced at Dudbridge. The main walls were made in the traditional manner using dressed local stone. Overall, considerable care was taken in the appearance of what was essentially an add-on to the main mill. (Davis MS. 1982).

Thus, mill buildings in the region were initially all stone-built, passed through a transitionary phase where combinations of stone and brick were used, and latterly, entirely of brick. Irrespective of the outer shell’s construction, internally, there was little variation and almost invariably, timber was used
for many of the mills interior features.

The Significance of Timber

Timber played a vital role in mill building, irrespective of the geographical location. As with the materials used to construct the walls, at least up to the turn of the 19th century, wherever possible, supplies tended to be based on local resources. Different timbers were utilised for specific purposes although local availability clearly played a part in the selection process. Up to the latter part of the 18th century, oak continued to be used wherever available. In Gloucestershire, some southern parts of the county were heavily wooded and there is thus every reason to assume that oak was sourced locally. It was used in a number of structural locations, being utilised for joists, floorboards, roofing timbers and upright supports. It could prove a good selling point as the 1839 sales particulars, when referring to two substantial multi-story buildings of Walk Mill on the Little Avon proclaimed:

"...nearly all the principal timbers, joists and roofs are of English oak".

By this time, the use of oak for such purposes had diminished significantly as a direct result of difficulties in obtaining adequate supplies. The primary source of timber for Gloucestershire was the Forest of Dean, however much of this had long been earmarked specifically for shipbuilding by the Navy. Where available, oak was in fairly widespread use during the 18th century. For instance, hewn oak was still used in the roofing structures of a number of surviving mills in the Cheshire region, being utilised for such components as king post trusses (Calladine & Fricker, 1993: 47). However, its use was set to diminish as the shortage became more general. Although indigenous oak appears to have been preferred by mill builders, imported varieties were also sometimes available, coming from throughout Europe and beyond. Of these, American Oak (mainly White Oak) was one of the most sought after on account of its properties of strength and durability; in most respects it was similar to English Oak.

Amongst the other indigenous timbers available in Gloucestershire, elm was probably of the greatest importance. Like oak, elm was used widely for joists, floorboards and lintels. Its characteristics also made it useful in damp situations and it found use for such items as launders, sluice gates and water wheel buckets. Although not impervious to water, an equilibrium was set up whereby the level absorbed remained fairly constant; it was this property that ensured that many canal boats were built with elm bottoms. In reality, there were five main elm variants used for a variety of construction-based purposes. The combination of availability, strength across the grain and durability in wet/damp situations ensured that it was used widely.

Other woods including ash and particularly beech, grew in profusion in parts of the Stroud valleys however there is no evidence that these were ever used for structural purposes in significant amounts. Beech was of limited use for building and engineering purposes on account of its tendency to rot
rapidly in damp conditions. In addition, it contained "juices that corrode[d] iron fastenings" (Notes on Building Construction. iii, 1887: 376).

By far and away the greatest source of structural timber used in Gloucestershire mills during the 19th century were deals of pine or fir variants, imported mainly from overseas. A bewildering array of pine variants was available, supplied in an assortment of forms ranging from whole trunks to pre-sawn planking. It was generally accepted that several types were of particular importance for building purposes; these appear to have been chiefly of American and Baltic origin. Of the former, pitch pine from the Southern States' ports of Savannah, Darien and Pensacola were highly regarded for building purposes. Pitch pine was used extensively for heavy timber structures that required great strength and durability. Frequently imported in the form of sawn logs some 11-18 inches square, lengths of individual sections ranged between 20-80 feet in length, more than adequate for most mill building projects (ibid. 365-383).

From the 18th century, imported timber poured into Gloucester, initially to the Quay and other riverside points, and latterly, the Docks and a series of large canal-side timber yards. Even before the opening of the Gloucester-Sharpness Canal in 1827, substantial amounts of timber were being imported by the forefathers of what later became Price, Walker & Co, one of the largest timber importers in the country. Originally founded in 1736, the company brought in a wide range of timber to their large mill built adjacent to the canal. Supplies came from Russia, Norway, Sweden, Canada and ports along the Danube and Black Sea. In addition, an extensive trade in pitch pine was supplied from the Gulf of Mexico and North America, with oak coming from Germany (Industrial Gloucester, 1904: 32-34). There can be little doubt that much of the timber used in local mills during most of the 19th century came from this source. Others also active in the timber importation trade included Nicks & Co, also located alongside the canal, and Webb & Spring of Ryeford, near Stonehouse.

Thus, in the face of such massive imports, local supplies of wood paled into insignificance. As noted, wood was often imported in the form of whole trunks although long sawn boards and similar bulkier profiles, eminently suitable for large building projects such as mills, were also shipped in. Many of the main timbers in surviving mills in the area came from this source. Imported pine was not limited to the Gloucestershire area, being supplied to many regions. Such was its importance that its use became almost mandatory in some cases. When Bollin Mill, Macclesfield, was being built (1826) the building materials were specified by the indentures of lease:

"...and the floor and roof of timber, to be good sound oak or foreign deal timber" (Calladine & Fricker, 1993: 45-46).

As oak was almost certain to be unavailable in sufficient quantities, deal was almost inevitably the preferred choice. Its relative softness compared to oak also made sawing and woodworking easier. On the other hand, it was certainly more combustible than hard oak. However, the general scarcity
of oak meant that with few exceptions, these types of imported timbers largely supplanted indigenous species. Their widespread use continued throughout Gloucestershire, up to the cessation of mill building in the region. In this respect, the area was little different to other woollen districts in the West of England. Indeed, even though iron-framed fireproof mills were in use in parts of the North, even late into the 19th century, substantial mills continued to be built using imported timber of the pine variety.

Apart from its use for joists and floors, the traditional wooden column was not entirely without its proponents and for a time, was not entirely usurped by its iron brother. In the case of the latter, concern was voiced as to the stability of iron columns in the event of fire. The possibility of sudden catastrophic failure, leading to total collapse during the course of a fire, was intimated. In contrast, under some conditions, large timber columns tended to burn only slowly, the rate of burning being retarded by the layer of ash that formed on the outer skin; there was some evidence to support this theory. For instance, in Millend Mill, blackened timber uprights are still in situ, having survived a serious fire some 70 years ago.

Such "slow-burn" characteristics were associated with the use of heavy timber for floors as well as columns, and the system was adopted by some American mill builders in the 1820s, although this development came too late for mill building in the Stroud valleys.

Thus, from the earliest days of mill building in the region, timber remained a crucially important constructional material. It was used almost exclusively for internal fittings such as floors, columns and roofing timbers and later, in an era when iron increasingly replaced wood for such purposes in other regions, its use in the Stroud region remained undiminished.

The Impact of Iron and Fireproofing Techniques on Gloucestershire Mills

The introduction of fire-proofing technology in textile mills has received considerable (and overdue) attention in recent years. In 1993, Falconer reviewed the major technologies adopted with respect to textile mills (Falconer, 1993: 11-26). Geographically, the area covered was wide however, only a single Gloucestershire mill fell into this category. Inevitably, this was Stanley Mill, also examined a few years earlier by Stratton & Trinder (1988). What is inescapable from these works and other studies is that at the time of its construction, Stanley Mill was unique in the Gloucestershire woollen district. Despite the clear advantages demonstrable to manufacturers who had seen innumerable local mills reduced to ashes, the techniques employed in Stanley Mill failed to set a trend and the mill remained an anomaly in the otherwise conservative Gloucestershire woollen district. Considering the precedent set by the mill’s construction, it is perhaps surprising that over the ensuing century and a half, not a single other local mill was built using any fire-proofing techniques apart from the adoption of the ubiquitous cast iron column.
The use of iron columns in the region (usually cast in local foundries) to support upper floors was widespread. Iron possessed a number of advantages in this respect as it was virtually maintenance-free, capable of carrying line shafting brackets where necessary, and provided at least some degree of protection in the case of fire. In addition, iron columns occupied less space than an equivalent timber column of comparable carrying capacity, a useful bonus where the ground floor often housed a combination of water wheels, fulling stocks, gig mills and in some cases, cloth washers. The primary function of the iron column was purely mechanical its main use being simply to provide support to the upper floors. The 1858 Longfords mill was one of many local examples; it had traditional wooden floors with transverse beams, supported by three rows of cast iron columns; the central row was thicker and supported the single row of columns on the upper floor and the roof's valley gutter (RCHME buildings Report. Longfords. 1858 mill). Such use of columns allowed for the construction of buildings of much greater width although on occasions, columns were inserted in existing mills, not necessarily to support a wider span but to carry the increased weight resulting from the installation of heavy machinery. At Ebley Mill, the "Long Mill" was of ~30 ft width, a distance that could have been spanned by unsupported timber joists. Here, secondary strengthening in the form of iron columns was inserted later in order to support increasingly heavy iron-framed machinery on the upper floors (Pers. Comm. Mr J Marshall). In 1862, a pedimented block at the front of the Ebley Mill complex was destroyed by fire and subsequently replaced by a block designed by the ecclesiastical architect George Frederick Bodley (VCH. x. 280). The new block was of five storeys and was larger than the building it replaced, requiring the support of rows of iron columns in its construction. In addition, the double roof span was framed with queen post trusses with a central valley gutter, again, supported by iron columns (Falconer, 1993: 77).

In some mills, a combination of iron and wooden columns continued to be used; the six-storey Kimmins (flour) Mill at Dudbridge, built 1849, used eight cast iron columns (6ft 5 inches tall) and a number of timber uprights (13 inches square) to support the upper floors (SDC Urbed Report, 1986: 8). Despite the ready availability of iron columns, wooden uprights were not necessarily usurped; Millend Mill retained wooden uprights through several rebuilds and changes of use. Replacement timber uprights were installed as late as the 1920s. Irrespective of whether wooden or iron columns were used, mill buildings were now able to attain greatly increased widths compared to their predecessors, an increasing requirement in an industry where greater automation was to become a necessity for economic survival.
Falconer notes the great diversity of column encountered throughout Britain's textile mills, yet once again, in Gloucestershire, this was limited almost entirely to the simple cylindrical form, almost invariably bereft of ornamentation and usually, with no facility for carrying line shafting. Thus, throughout the history of the Gloucestershire woollen industry, local manufacturers studiously avoided any real attempt at fire-proofing their mills, undoubtedly as a result of cost considerations. Doubtless the additional costs estimated at \( \sim 25\% \) (Tann, 1970: 147; Also Falconer, 1993: 16) plus the manufacturers' cautious nature, inhibited its uptake in a period of increasingly difficult market conditions.

Despite the higher costs, fire-proofing was adopted with a vengeance in some regions, especially in the North. When Benjamin Gott built Bean Ing Mills in Leeds, precautions included the ingress of heating air only via apertures in the walls (fires being outside the building), a staircase of stone lit by gas, plus floors covered with sheet iron (Sun Fire Insurance Policy 975002. 1821). Other mill owners took similar precautions and when the cotton spinner Samuel Moore of Manchester built his mill, heating was limited to that provided by steam pipes. Wherever artificial light was used, this was enclosed in "glass lanthorns" (Sun Insurance Policy 973511. 1820). Few of these techniques impinged on the development of the mills in Gloucestershire which continued to be built in the traditional manner.

Whereas Gloucestershire limited its adoption of iron predominantly to columns, in other regions, the next logical step was taken in replacing timber beams with cast iron versions. Once again, in Gloucestershire mills, their use in main mill structures is entirely absent, iron beams only making a limited appearance in a few wool stoves.

The wider uptake of fire-proofing techniques particularly in the North, did not mean that even here, all textile mill structures were treated in a similar fashion, and throughout the 19th and into the 20th centuries, many multi-storey mills were built, as in Gloucestershire, using timber beams, joists and floors, supported by the ubiquitous cast iron column (Giles & Goodall, 1992: 64). In Yorkshire, often considered to be the heartland of the fire-proof woollen mill, large mills continued to be built in such a fashion (eg. Robinswood Mill, Keighley), however, the latter part of the 19th century really saw the last gasp of this combination of building techniques and materials and the region witnessed considerable changes in constructional techniques. Timber was finally and irrevocably displaced by constructions of concrete, steel, brick and iron. By the early 20th century, the latter represented the main constructional materials.

Even in non-fireproof mills, iron components sometimes served a variety of purely mechanical purposes and were to be found, used in conjunction with wooden joists and iron columns. For
instance, at Greenland Lower Mill in Bradford-on-Avon, this combination was further reinforced with L-shaped iron brackets that appear to have given additional support to the outer ends of the floor joists where set into the mill’s walls. Iron also found widespread use for reinforcing wall plates and tie rods, used to support outer walls. Similar arrangements were also found in some Gloucestershire mills.

The other area where cast iron made a major impact was in the shape of mill windows. Earlier designs had ranged from traditional stone mullions, to a variety of late rectangular variants. Depending on location, these were often of wood supported by flat wooden or stone lintels. The alternative was the use of brick or stone block relieving arches above the windows, and again, their use was widespread; in the Stroud region examples abounded and included Avening, Holcombe, Days, Egypt, Dyehouse, and many other mills. Light was at a premium for many parts of the cloth making chain, hence windows were made as large as practically possible. Frequently, individual panes were quite small, of the order of 3-4 inches square. As improvements were made to glass making techniques, these tended to get larger. Earlier windows were composed of a multitude of small panes, set in lead channels and supported with thin iron glazing bars.

The requirement for good lighting throughout all manufacturing areas of the mill was of paramount importance and its lack was one of the factors that had restricted the width of earlier mill buildings. Clearly, the amount of daylight reaching the central parts of the mill was dependent on the extent of the window space. However, there was an obvious limit on the window:wall ratio as the latter had to remain strong enough to withstand both loads and vibration set up by increasingly heavy machinery. By the later part of the 18th century, the maximum window area achievable amounted to ~15%. This effectively limited maximum width of the block to around 30 feet (Markus, 1993: 266). Increasingly effective use of iron windows, coupled with advancing structural techniques ensured that by the 1820s, ~30% was a realistic figure. Even this increase was not necessarily enough to ensure that the central sections of the mill were lit sufficiently by natural daylight and oil and gas lighting was installed where appropriate. Later, manufacturers switched increasingly to electric lighting as this significantly reduced the risks associated with the use of naked flames. For instance, by the 1890s, apart from a profusion of windows, Dunkirk Mills was lit by 500 x 16 candle power lamps, electricity being supplied by a dynamo powered by the water wheels and/or steam engine (Industrial Gloucester, 1904: 286).
However, for obvious reasons, wherever practicable, natural daylight had remained the preferred option as evidenced by the block added to Dunkirk Mills in 1827 to house hand looms. This was cruciform in shape in order to maximise daylight (see above. Fig 54). As the 19th century progressed, the use of strong iron windows became universal in virtually all mill building/enlarging projects.

The advent of cast iron opened up new horizons in this respect and the design of mill windows began to move away from the traditional forms adopted previously and in many areas, large iron windows, often with radial heads, were adopted. They were strong, essentially maintenance-free and came foundry-produced, complete with opening mechanisms where appropriate. Their use became widespread and examples were to be found throughout the Stroud region. At Stanley Mill, perhaps the pinnacle was reached. Here, hundreds of both flat and radially-headed iron windows filled the outside walls of the mill, making it more reminiscent of the large textile mills of the North. A type of compromise between the flat and radially-headed type of windows was also encountered in some mills of the area.

Thus, the adoption of iron components in Gloucestershire woollen mills had an impact in several areas. Although fire-proofing techniques were developed and used fairly widely in the North (Fig 81), their use in the West of England remained uncommon and in Gloucestershire, only a single iron-framed example was built. Although not primarily associated with fire-proofing, iron was adopted widely in the construction of Gloucestershire mills, generally in the shape of columns and windows. As such, the former influenced the form of the mill building, being utilised to allow an increase in the overall width of the structure. The latter influenced the mills’ appearance, allowing for greater freedom of expression at the design stage, as well as contributing to increased levels of natural light within the building.

Although there was virtually no takeup of fire-proofing techniques for mill construction in Gloucestershire, a handful of wool stoves were built along these lines. At Bourne Mill, the unusual early 19th century rectangular stove was originally built using a fireproof construction. Here, the floors, which comprised cast iron perforated plates, were supported by a framework of fish-bellied cast iron beams supported by iron columns (Pers. Comm. Dr N J Paterson). However, some of these works may have been associated with the stove’s later period of use for drying wood for walking stick manufacture (Mills, 1996: 35-41). Thus, even for stoves, the use of iron beams remained rare. The two other examples identified were at Rockstowes Mill, Uley, where sales particulars of 1823 mention a fireproof stove utilising an iron floor and roof (Tann, 1967: 133) and it seems reasonable to suppose that iron beams were incorporated into the design. The other example was unsurprisingly at Stanley Mill, where the stove featured ironwork cast by Ping & Fairweather of Gloucester. This comprised a single row of iron columns supporting cast iron spine beams running the full length of the building.
The beams supported cast iron fish-bellied beams which in turn carried the stone flag floors (Stratton & Trinder, 1988: 167).

Thus, apart from Stanley Mill and a handful of wool stoves, fire-proofing in Gloucestershire mills was notable by its absence.

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The End of Mill Building in Gloucestershire

What constituted the last complete mill to be built in the Stroud valleys? This is difficult to identify as in virtually all cases, mills evolved gradually over protracted periods of time. Often, what formed the main structure of a mill site incorporated parts or all of its predecessor in the construction. Parts of some surviving mills (eg. Griffins) date from the last quarter of the 19th century. However, 1875 saw two substantial projects undertaken in the shape of the new Stonehouse Upper and Lodgemore Mills. In the case of the former, this replaced a mill burnt down some four decades earlier and in some respects, remained very conservative in its design and construction. Like its predecessor, it remained relatively narrow and in an era predominated increasingly by steam, retained the use of two internal water wheels. Internally, things had not changed much from half a century earlier, with wooden joists and floors supported by simple cast iron columns bereft of line shafting mountings. Hence, there was no concession to fire-proofing or to the total replacement of water power as might be expected by this time. Even with this apparently "new" mill, a series of auxiliary brick and stone buildings that survived the earlier fire continued in use.

In the same year, construction of the new Lodgemore Mills was started. Here, there appears to have been little of its predecessor to retain, such was the extent of the fire, hence Lodgemore probably constitutes the last major mill building in the region. Other mills carried on evolving, with new buildings replacing or supplementing earlier ones. For instance, in 1887, a new red and blue brick structure was added to Merretts Mill, some elements of its design possibly owed to that of the new Lodgemore. Even here, within a few yards, buildings from the preceding two or three centuries remained in daily use, a situation encountered regularly in the valleys. Unlike, for instance, parts of Yorkshire, the "clean slate" approach was rarely encountered in the region.
Resume

Thus, not allowing for purely site-specific circumstances, there were a number of major factors that were universal in influencing the evolution of the mill. These were:

- effects of machinery
- alterations in the source of power
- improvements in the power distribution system
- advances in structural technology

Each advance in technology was usually accompanied by structural changes within the mills. As the size of spinning and carding machinery increased, so the requirement for floor space became greater. Existing mills were enlarged, depending on the particular location, upwards or outwards, on in some cases both. In many locations within the Stroud valleys, mill enlargement was constrained by topographical and other features such as water courses, roads, the Stroudwater and Thames & Severn Canals, and latterly, railway lines. Consequently, expansion in such cases tended to be upwards as opposed to outwards. As the valleys broadened out towards the Vale, the land became flatter and mills fewer in number, hence sites became much less constrained. Here, expansion tended to take the form of additional wings or buildings as opposed to extra storeys. Most of the mill sites along the lower Frome show this, some more so than others; the Meadow Mill site gained an additional wing and a number of detached buildings, as did Churchend, Millend, Bonds and both Stonehouse Upper and Lower Mills.
Enlargement of mill sites did not necessarily occur in a wholly logical manner. Whereas Dunkirk Mills grew relatively systematically through the addition of extra blocks added to the ends, others such as Longfords and Bonds Mills appear to have grown in a piecemeal and haphazard fashion, the former ultimately filling the valley floor with a jumble of over fifty separates buildings dating from the 17th to the 20th centuries. Thus, woollen manufacture in the Stroud region was typified by production carried out under a wide variety of conditions. There was little uniformity between sites, each often bearing little resemblance to even its immediate neighbour. In most cases, there appears to have been little will to, unlike Yorkshire, start afresh with new buildings (often fire-proofed) and processes and machinery organised in a logical fashion. Rather, almost to the end, manufacture was often carried out in cramped buildings ranging from 18th century multi-storey blocks, to spacious state-of-the-art single-storey shed-type structures. It was not uncommon for a site to encompass both. Unlike much of the North, there was little evidence of significant structural change or development beyond the latter part of the 19th century; even before this, the buildings themselves were generally simply-constructed and apparently, built to a budget. Despite their relatively unadorned, functional appearance, most survivors are of modest scale and have a stature and unimposing beauty that has enabled them to blend harmoniously with the landscape and local settlements. Whereas many northern mills dominate their surroundings, their humbler peers in Gloucestershire often enhance their immediate surroundings; they almost appear to have sprung from the rock, rather than been built by the hand of man - perhaps no finer compliment can be paid.
CHAPTER 9

DECLINE AND CONTRACTION OF THE GLOUCESTERSHIRE WOOLLEN INDUSTRY

In terms of sheer number of individual cloth mills operating in Gloucestershire, the peak was probably reached c1820. There was a general air of confidence in the trade, clothiers were prospering and workers were fully employed. In several parts of the county, census figures revealed significant increases (eg. Stroud and Kingswood) resulting largely from the flourishing state of the industry. It is difficult to gauge the full extent of the county's industry and the precise number of manufacturers at this time, as some operated in a very modest way and consequently, were not necessarily listed in directories of the period. There were at least 150 manufacturers although it is quite conceivable that the true figure was nearer 200 (Gell & Bradshaw Dir. Glos (1820) plus other sources). After this period, the industry started a gradual process of contraction and decline and throughout the next 150 years, this process continued although neither closures or contraction to fewer centres of production occurred in a linear manner.

During the early part of this period, the Gloucestershire industry generally remained in a healthy condition, in contrast with some other parts of the Western clothing districts. Writing in 1840, the Assistant Commissioner investigating the state of the handloom weavers in Wiltshire and Somerset commented that:

"In 1815, the trade began to stagnate. Since 1820 it has retrograded". (PP 1840. xxiii: 428. Report of A Austin).

Thus, it appears that the decline in Gloucestershire set in perhaps a decade later than in other parts of the West, however, by the time (1839) Miles prepared his report examining the county, the situation was similar and conditions were worsening.

Even though the Gloucestershire industry was justifiably famous for its scarlet and blue cloths used widely for the manufacture of military uniforms, the end of the Napoleonic Wars did not result in an immediate slump in the trade. In fact, Gloucestershire appears to have weathered the storm rather better than some other textile regions such as Yorkshire and east Cheshire; in the latter, the end of the war saw a dramatic reduction in demand from the Army, resulting in excess capacity and much hardship (Calladine & Fricker, 1993: 12). Gloucestershire was not as badly affected as might have been expected as a result of its heavy dependence on the home market. Even though the county exported much cloth, from the latter part of the 18th century, the home market had been of considerable importance (Rudder, 1779), thus the reduction in demand for military cloth had only a limited effect on the overall market. Indeed, many Gloucestershire manufacturers concentrated exclusively on the home market. However, the county did not escape entirely and a few areas that had concentrated more heavily in the supply of military cloths saw some distress. For instance, both
Bisley and Chalford saw much unemployment as a result in the sudden fall in demand (Mann, 1987: 155). Overall, the county did not suffer a significant slump and it was not until post-1825 that Gloucestershire, like much of the West in general, really began to decline (Ponting, 1971: 122).

The year following the great hand loom weavers strike in Gloucestershire (1825) was to see not only the county, but also Wiltshire and Somerset in severe difficulty. The crisis was worse in the latter two, with employment plummeting in places such Trowbridge (SJ. 15 May 1826) although parts of Gloucestershire were also badly affected.

In Gloucestershire, to certain extent, the fate of a particular manufacturer depended on where his mill was sited. Significant differences occurred in terms of long-term survival and profitability, greatly influenced by geographic location; businesses operating in the more outlying regions were generally, although not exclusively, the first to succumb. Thus, the numerous cloth mills powered by the Painswick Stream and its tributaries fell from their peak of 30+ mills, falling to ~4 by c1840. By the close of the decade, it was a mere 2 and by the end of the next decade, none of this formerly important string of mills remained in the cloth trade. The southern part of the county suffered similarly, as the once-prosperous clothing districts around Wotton and Kingswood went into terminal decline. At the beginning of the 19th century, over 30 mills were at work, however by c1840, this had fallen to ~20, and by the close of the decade, even this depressing figure had halved. Thereafter, the decline seemed to slow, although even the more competitive survivors from the earlier period gradually fell by the wayside; by the end of the century, only Millman, Hunt & Co. of Nind and Charfield Mills still survived (Industrial Gloucester, 1904: 25; Also Kellys Dir. Glos. 1919, 1935 and 1939).

In a similar manner, cloth mills in the Uley/Cam/Dursley area powered by the Ewelme/River Cam declined in number. The period 1825-30, generally a bad one for the West in general, saw a steady decline in the number of mills working. Parts of Wiltshire suffered similarly (Mann, 1987: 159) as mills closed throughout much of the region. By now, in all woollen counties of the West, the trend of increasing concentration into fewer locations, with the trade housed in mechanised mills, was accelerating, the marginal mills throughout the region beginning to fail in increasing numbers. In Uley, worse was to follow, where near the head of the watercourse stood Edward Sheppard’s large mill. This was to be a dramatic and unexpected failure in 1836, but was soon to be joined by others. If such a large, mechanised mill was unable to survive, what hope was there for the other smaller mills spread out along the valley leading down to Dursley and Cam. From a peak of 20+ mills operating at the turn of the 19th century, by 1830, only around 10 manufacturers were still working and some of these were fairly small concerns:
Table 23

Woollen Cloth Manufacturers - Uley, Dursley, Cam Area. 1830 (Source: Pigots Dir. 1830)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>George Adey &amp; Co</td>
<td>Uley</td>
</tr>
<tr>
<td>Nathaniel Iles Butler</td>
<td>Upper Cam</td>
</tr>
<tr>
<td>Joseph Tippetts Cam</td>
<td>Cam Mill</td>
</tr>
<tr>
<td>Comley &amp; Jones</td>
<td>Rockstowes Mill, Uley</td>
</tr>
<tr>
<td>George &amp; James Dauncey</td>
<td>Daunceys Mill, Uley</td>
</tr>
<tr>
<td>John B Foxwell</td>
<td>New Mills</td>
</tr>
<tr>
<td>George Harris &amp; Son</td>
<td>Lower Mills</td>
</tr>
<tr>
<td>Howard &amp; Son</td>
<td>Townsend Mill</td>
</tr>
<tr>
<td>Edward Sheppard &amp; Son</td>
<td>Uley and Halmore Mill</td>
</tr>
<tr>
<td>Charles &amp; George Vizard</td>
<td>Long St, Dursley</td>
</tr>
</tbody>
</table>

The numbers continued to fall at an alarming rate during the 1830s, and by the late 1840s, a mere two mills survived. Within a decade or so, Cam Mills remained as the sole survivor (through various restructurings and amalgamations, it remains one of the tiny number of cloth mills still working in the county today).

The depressed state of the local industry at this time was characterised by greatly reduced prices for cloth. It was estimated that prices for fine cloth had fallen by ~30% and for stripes, by 50% (Mann, 1987: 169). The fate of some of the more marginal mills was sealed. The only response to such a situation was to increase the output of cloth in order to compensate for the smaller profit margins, however this was beyond the means of many of the smaller Gloucestershire businesses. Thus, many of the first clothiers to fail in the Stroud region were generally those operating from smaller mills dotted along the Toadsmoor, Slad, Horsely, Nailsworth and Painswick Valleys. In the case of the latter, mills along the Painswick Stream were idle or were turned over to other uses as a result of their geographical remoteness which limited manufacturers’ access to canal and railway links. In addition, there was an inability/reluctance for expansion and/or the adoption of steam power. Most businesses were simply too small to compete with those in and around Stroud, many of which were becoming highly mechanised and equipped with steam power. Hawker also cites the hostility of the workers to the introduction of new machinery although in the case of the Painswick mills, this is likely to have been a relatively insignificant point (Hawker, 1945: 48-9). Similar situations were occurring with many of the smaller businesses throughout the region.

Further south, in the Wotton district, mills along the Ozleworth Bottom met a similar fate with Grindstone, Broadbridge, Penleys, Nowells and Hill Mills all closing in the 1820s-40s. Monks Mill was the only substantial mill along the stream and this too closed in 1869, when the occupier, unable to find a buyer for the mill, moved himself and his equipment to a more convenient location in
Stonehouse (SdJ. 28 March 1868). Such geographical isolation now became an increasingly important factor in a company's survival, with all of the above sites disadvantaged through their lack of easy access to either a canal, or more importantly, rail link. Most of the Ozlebrook mills were only accessible by lengthy tracks which were doubtless difficult to traverse in the Winter. Their isolation also decreased the possibility of easily obtaining coal supplies.

Apart from the isolation factor, the market had been changing and as profit margins fell, it became increasingly important for manufacturers to produce cloth in large quantities in order to survive. This necessitated full mechanisation with all of its attendant financial implications. Quite simply, many of the smaller mills were no longer in a position to compete, the result being the increasing centralisation of the majority of cloth manufacture to a mere handful of large, highly mechanised mills, mainly in and around Stroud.

Closures were not limited exclusively to the more outlying regions, as businesses continued to fail throughout the region. In 1829, the Gloucester Journal reported that:

"At this moment there are no less than seventy mills in the wool business in the West of England to be let" (GJ. 17 October 1829).

By c1840, the industry in Gloucestershire now comprised around 50 manufacturers of varying size, spread throughout the county (Table 24). Some areas such as Chalford and Wotton, had contracted to a significantly greater degree than, for instance, the Stonehouse/Eastington region. 1840 and the following year were universally bad for the industry in the West, although some of the Gloucestershire manufacturers managed to weather the storm better than others. In particular, the Marling family, with several family members active in a number of mills, appear to have escaped relatively unscathed. Other clothiers decided enough was enough and retired from the business before they were bankrupted. A number of Stroud clothiers took this route, as did others further south. In Bradford-on-Avon, a great reduction in the number of businesses occurred (D&WG. 21 September 1826). In 1820, 20 manufacturers were listed; this had fallen to 14 in 1833 and to a mere 5 in 1834. Of these, ~20 had been the result of bankruptcy, the remainder retiring (Mann, 1987: 172).

<table>
<thead>
<tr>
<th>Table 24 - Number of Gloucestershire Mills at Work. 1840</th>
</tr>
</thead>
<tbody>
<tr>
<td>District</td>
</tr>
<tr>
<td>Nailsworth</td>
</tr>
<tr>
<td>Chalford</td>
</tr>
<tr>
<td>Alderlev/Kingeswood</td>
</tr>
<tr>
<td>Wotton</td>
</tr>
<tr>
<td>Stroud</td>
</tr>
<tr>
<td>Dursley</td>
</tr>
<tr>
<td>Stonehouse/Eastington</td>
</tr>
<tr>
<td>TOTALS</td>
</tr>
</tbody>
</table>
During the period 1820-41, the number of mills at work in Gloucestershire fell from 137 to less than 80:

\[\text{Reduction in Gloucestershire Mills. 1820-41}\]

\[\begin{array}{cccccccc}
\text{Year} & 1820 & 1831 & 1835 & 1836 & 1838 & 1839 & 1841 \\
\text{Number of Mills} & 140 & 130 & 90 & 80 & 60 & 70 & 80 \\
\end{array}\]

(After PP 1840. xxiv: 363: and GJ. 15 January 1842)

During the period of the Gloucestershire failures of the 1830s and 40s, there was still sufficient attraction for newcomers to enter the trade, usually intent on revitalising the business, often taking over from a long-established manufacturer. In fact, during the preceding few decades, the majority of the clothiers who had been active in the trade in the early part of the century had gradually disappeared. By the 1840s, only a handful of families/individuals from the earlier period could still be identified as being active in the trade. This situation was true throughout the West's clothing districts. It was not always absolutely necessary for a newcomer to have substantial capital, and those with business acumen and sound judgement could make their way up without the need of a large sum of money. A prime example appears to have been Charles Hooper, who acquired the failed Hicks' business and prospered rapidly. In other cases, the newcomer simply became yet another added to the long list of bankrupts.

Even though the overall number of mills working continued to decline, the total output of cloth from the increasingly mechanised survivors remained essentially static. Clearly, the companies that had survived the earlier depressions were compensating by producing greater volumes of cloth. The situation was similar in Wiltshire and Somerset although at the same time, output from the Yorkshire mills continued to escalate (Tann, 1967: 61). The period between 1839-44 was one of great depression in the West and saw a steady decrease in the number of mills working in Wiltshire, plus short time working in many Gloucestershire mills, with 20 closing their doors for the last time. By the end of the decade, their ranks had been joined by a further 10 mills. In 1842, there had been ~80 businesses operating in Gloucestershire; by 1842, this had fallen to 42 (GJ. 15 January 1842). Nevertheless, the situation in Wiltshire during this period had been worse. By the middle of the century, in Gloucestershire, cloth making had all but ceased in formerly important centres such as Painswick, Uley, Dursley and Wotton. Most mills still working were spread out along the Frome and its major tributaries, plus a small cluster of mills around Kingswood. A further depression hit the industry in the West in 1847-8, but once again, Gloucestershire suffered less than Wiltshire, although
the Gloucestershire manufacturer A T Playne noted that there had been a gradual reduction in profits between 1836-48 (Mann, 1987: 196).

Clearly, significant changes had occurred in the industry during the last decade, with businesses failing, markets reducing and competition increasing. In 1839, Miles noted that during the previous eight years, four of the largest firms (including the Hicks Brothers and Edward Sheppard) in the county had failed and that of 137 cloth mills formerly at work, 58 had closed. In addition, both domestic and mill property had fallen in value by at least 30% (Miles, 1840: 362). The distress caused throughout the district was not evenly spread and some parts fared worse than others. Chalford had been particularly badly hit where of 41 cloths mills, only 15 were still working; even now, trade remained poor. Chalford had originally been an important supplier to the East India Company, however, from 1832, much of the manufacture formerly carried out for them migrated to Yorkshire.

The reduction in the overall number of mills working could not necessarily be taken as an indication that less trade was being carried on, as the introduction of steam power into the district had had the effect of increasing the concentration of the industry into a fewer number of sites, characterised by a higher degree of production and output. Similarly, the fall in the value of property did not necessarily reflect a diminution of trade, as outdoor weavers were now increasingly working in centralised loom shops at the mills, as opposed to a multitude of isolated cottages and small workshops. Clearly, this organisational change had impacted on property values.

A frequent cause for concern in the Gloucestershire trade was that, unlike Yorkshire, there was often insufficient capital in the trade to adequately fund new enterprises, enlarge mills, or develop new markets. By the end of the 1830s, the industry in parts of the Gloucestershire district was in a much decayed state. Chalford was in such a parlous state and it was noted that the "want of capital in Chalford has ruined the trade" (Miles, 1840: 364). Compounding the problem was the fact that the local manufacturers had a tendency to wait for a demand, and only then to prepare for its manufacture. In contrast, the comparatively booming state of Yorkshire was at least partially attributable to the higher levels of capital available and a greater tendency for speculation on the part of the manufacturers, unlike their conservative Gloucestershire peers. Many of the Yorkshire manufacturers either actively sought out new markets for their products or created new ones. The effect of insufficient capital was to be an increasingly important factor in the ensuing years, as profit margins continued to fall. Now, profits became more related to the quantity of cloth that could be produced as opposed merely to its quality. Many of the Gloucestershire manufacturers had insufficient capital to suitably modernise and enlarge their premises, necessary to increase output. If they did pursue such a programme, it often left them short of capital needed for any future contingency. In short, many were fully stretched financially so that when the inevitable downturn came in the market, they had no reserves left to tide them over. This goes some way to explaining the periodic upsurges in bankruptcies that occurred in the region.

It seems that some manufacturers had almost constant difficulties with their finances and at least some
of these could be attributable to their relationship between themselves and the London cloth factors, through whom they sold much of their cloth. For a long time, many manufacturers had had difficulty in assessing exactly how much profit they were actually making for a particular piece of cloth. Once manufacture was complete, cloth was sent to the factor's establishment where, length by length, it was perched and deductions made for every flaw or blemish. Hence, the manufacturer might have a certain price in mind when he despatched his cloth, although this might have reduced dramatically by the time he was actually paid. This, coupled with the inevitable delays caused through slow transport of cloth to the factors and the lengthy periods that any disputes could take to be resolved meant ongoing uncertainty over the extent of any profit made. These problems were by no means limited to the smaller manufacturers and in later years, a few of the larger Gloucestershire producers circumnavigated problems caused by the factors by setting up their own agencies in the capital and elsewhere. In response to Miles' questions, William Playne outlined some of the advantages of the larger manufacturer over his smaller brethren. He noted that, as his family did, the larger makers bought their own wool, thus saving the profit normally made by the broker and perhaps more importantly, had his own agency in London, thereby saving the profits of the factor. It also meant that any problems could be dealt with in-house, as opposed to being forced to deal with an outsider, perhaps more intent on maximising his own profit. Such arrangements were beyond the means of the smaller manufacturers who must have been kept in a condition of permanent suspense, awaiting the report and prices offered by the factor. In the light of such uncertainties over profit margins, the smaller makers usually responded in the predictable fashion of screwing down the wages of the workers, the largest outgoing on the balance sheet. Of these, out-workers, notably hand loom weavers, usually fared worst.

Such uncertainties over profits did not encourage, especially the smaller, manufacturers to indulge in expansion plans for their businesses. Such programmes clearly led to a greater output of cloth, however, ironically this in itself could have a further detrimental effect on the industry. As manufacturers invested in increasing amounts of machinery and ran their mills round the clock using a combination of water and steam power, at times, the markets for their products reached saturation point. Now, the output of cloth greatly exceeded that of earlier periods, a time that had been characterised by a situation where supply never exceeded demand and prices remained stable. The situation now faced by manufacturers was that in order to remain solvent, large volumes of cloth were needed and that "sales must be effected at any cost" (Miles, 1840: 358-9).

The effects of such competition were not all negative and manufacturers now had little choice but to become fully conversant with every detail of the manufacturing processes in the hope of wringing out improvements in production or quality of the cloth produced. Miles noted the change in manufacturers' attitudes that had become apparent since the advent of intense competition:

"...every method is now studied to improve the quality of the cloth... many of the manufacturers were comparatively ignorant of the skilful operations of the trade, and their knowledge did not keep pace with improvements of the times. This was not the case in Yorkshire...". (ibid. 362).
In short, Gloucestershire manufacturers were content to carry on producing the same products in the same ways that they had always done. Had competition not intensified to such a pitch, it seems likely that their businesses would have ultimately stagnated in the face of opposition from an industry in the North that was clearly continuing to develop further. Doubtless the shock of finding their way of life and livelihoods under threat shook many out of their condition of complacency and in the longer term, led to significant improvements in the production methods, quality and range of products.

By the middle of the century, throughout the West, the process of concentration to fewer sites was well under way and although the overall number of mills had fallen significantly, the number of workers employed in the industry had remained static or in some regions, actually risen. Despite this, in terms of its overall importance, production from the West's mills formed only a small part of the output of the country as a whole. Clearly, there were disparities and some localised parts of the industry continued to do better than others, however, the West had slipped farther behind Yorkshire. By 1850, the West could only boast ~ 9-10% of the spindles in use and 17% of the operatives in England and Wales. By contrast, Yorkshire had 68% of the spindles and 63% of the workers (Mann, 1987: 198). Even within the Gloucestershire woollen districts there were significant differences in fortunes and some areas continued to decline while others continued to profit. As the industry contracted further towards Stroud and the lower Frome region, some of the outer regions began to decline rapidly. The census figures clearly show the trend as in some of the more geographically remote areas, mills began to close and populations dwindle.

Table 25
Population Figures for Selected Woollen Manufacturing Areas of Gloucestershire

<table>
<thead>
<tr>
<th>Location</th>
<th>1821</th>
<th>1831</th>
<th>1841</th>
<th>1851</th>
<th>1861</th>
<th>1871</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uley</td>
<td>2655</td>
<td>2641</td>
<td>1713</td>
<td>1327</td>
<td>1230</td>
<td>1156</td>
</tr>
<tr>
<td>Eastington</td>
<td>1681</td>
<td>1770</td>
<td>1871</td>
<td>1886</td>
<td>1717</td>
<td>1685</td>
</tr>
<tr>
<td>Stonehouse</td>
<td>2126</td>
<td>2469</td>
<td>2711</td>
<td>2598</td>
<td>2614</td>
<td>2797</td>
</tr>
<tr>
<td>Wotton</td>
<td>5004</td>
<td>5482</td>
<td>4702</td>
<td>4224</td>
<td>3673</td>
<td>3651</td>
</tr>
</tbody>
</table>

Closures in Gloucestershire continued over the next two decades; ~ 8 mills closed during the 1850s-60s, and a further 10 during the 1870s although the early part of the decade had been a busy and productive period in the West. In 1871, the Trowbridge mills were hard at work and in Stroud it was hailed as:

"[a year] of commercial prosperity and industrial activity" (SdJ. 30 December 1871).

During this period, considerable expansion was noted in Gloucestershire, with the number of spindles increasing from ~ 41,000 in 1870, to 71,000 in 1874 (PP 1870. lxxi; and PP 1874. lxv). Some expansion was also evident in Wiltshire and Somerset. Trade remained good throughout much of the remainder of the decade but despite this, further closures were noted, worryingly, this time of a number of the larger, long-established manufacturers. Gloucestershire mills being offered for sale over
the next decade or so included Churches, Southfields, Vatch, Nailsworth, Holcombe, Days, Dunkirk, Woodchester and Staffords Mills. Similarly, Charfield Mill went out of use, as did a number of important mills in Wiltshire. Significantly, of these, few continued in woollen cloth manufacture. Closure of these businesses was not due entirely to failure, as death and retirements took their toll of manufacturers, although certainly, some of the Wiltshire closures were as a result of bankruptcy.

Throughout this period, considerable amounts of cloth continued to be manufactured, much of the quality being as high as ever. Gloucestershire manufacturers carried on winning medals and awards at international exhibitions including Paris (1867, 1885, 1889), Antwerp (1885), New Orleans (1885), Liverpool (1886), Brussels (1886), and London (1851, 1862, 1871, 1881, 1884). Despite the continued success with the traditional West of England cloths, for many years, there had been little attempt at diversification or development of newer products, something that would ultimately cost many of the West’s manufacturers dearly. One serious blow came in 1875, in the form of a change in fashion. The Gloucestershire manufacturers’ reluctance to change their long-established habits in order to meet this change becomes apparent from Hyett’s observation:

"Somewhere about the year...a taste for ribbed stuffs both for morning and evening wear arose, and before many years had passed, no one would wear anything else. The materials that became the fashion were only made in the north of England, and they could not be made in the West without the substitution in the mills of new machinery for old....many of the manufacturers in the Stroud valley, believing that the taste for ribbed stuffs was a passing fashion, shrunk from it, and their custom faded away". (Hyett, 1928: 105).

It was not only in the Stroud region that manufacturers were reluctant to change their ways as the situation was similar in much of Wiltshire. Such reluctance to change is perhaps understandable as many manufacturers considered that the newer cloths were merely a transitory fashion and that the taste for the traditional West of England materials would soon return. The traditional products were as good as they ever were but fashions aside, the real problem remained their high cost. In 1876, the Trowbridge Advertiser noted with some disquiet that:

"Trowbridge and its sister manufacturing towns have kept pace with every improvement but in the last year or two the demand for this class of high-priced cloth seems to be declining...the less durable, more fanciful and lower-priced class of cloth introduced by the Scotch manufacturers is depressing the West of England...where one piece of West of England is now sold, a hundred pieces of lower-priced fancy Scotch are recently purchased".

In 1878, a report in the Stroud Journal struck a similarly ominous note:

"The products of the West of England rank second to none in the world through few Englishmen can afford to wear them" (SdJ. 10 August 1878).
During the 1880s, despite this observation, times were fairly stable in the trade and some manufacturers continued to do well. Generally, production was now at a high levels due largely to the high degree of automation adopted by the fewer, but larger, firms. Fine cloths continued to be made in the West, but their cost compared to much of the output from Yorkshire remained high. The market for the West of England cloths was now limited to those who could afford to wear them. The result was that the industry was becoming increasingly affected by a lack of demand as customers turned elsewhere for their cloth. Competition with the West was not limited to Yorkshire as for several decades, tweeds produced in Scotland had been taking trade away from the traditional markets; Gloucestershire was not so badly affected by this although parts of Wiltshire certainly suffered. Although tweeds were less durable, they were cheaper (Mann, 1987: 214). In fact, a number of mills in the Stroud region prospered as a result of the fashion for tweeds and by c1850, Peghouse Mill was producing yarn for Scottish tweed makers (GI. 15 January 1848). As well as now having to compete with tweeds, other cloths continued to prosper at wool’s expense; post-1875, “fancy coatings” (a mixture of wool and worsted) were taking away traditional customers, mainly as they were ~25% cheaper than wool alone (ibid).

Needless to say, the overall number of workers employed in the West’s woollen industry continued to fall although there were pockets where employment had at least levelled off, due largely to the increased concentration of the trade in large, highly mechanised mills in fewer locations (eg. the Lower Frome area of Gloucestershire). In some areas of the county, employment levels appear to have peaked during the 1850s, whilst in others it came later. In some formerly important manufacturing areas, such as Wotton, there was a steady decline in both employment and population throughout much of the 19th century.

By 1890, a total of 6700 were still working in Wiltshire and Gloucestershire, although ~4000 were employed in the latter. In Yorkshire, some 87,000 were employed in the industry! (PP 1890. lxvii).

The determination of many of the Gloucestershire manufacturers to stick doggedly with their traditional range was ultimately to be their undoing. In 1904, an observer, when looking back over the previous few decades, summed up the situation:

"Their neglect of this new fashion was due, it must be admitted, to short-sightedness on the part of the Gloucestershire manufacturers, and, while they could not have been expected to foresee the vast extent of the approaching change in the cloth trade, they have certainly stuck to their methods of industry with somewhat unnecessary perseverance" (VCH. ii. 195).

The competition from elsewhere finally galvanised a few of the West's manufacturers into action and a number of experiments were carried out with worsteds. In Wiltshire, attempts appear to have been modest although in the Stroud region, several of the larger manufacturers pursued this with some vigour. In Stroud, by the 1880s, worsted manufacture by Marling & Co. was accounting for ~20% of their total output. In Brimscombe, P C Evans & Sons of Brimscombe Upper, Lower and Port
Mills, had also become involved in the business; apart from their manufacture of high grade woollens, it was noted that:

"...among the more important additions to the mills was the establishment of a worsted spinning plant, the only one of its kind in the neighbourhood" (Industrial Gloucester, 1904: 28).

At last, some signs of diversification began to appear in the region, although in reality, it had taken most manufacturers far too long to appreciate that their traditional markets were changing for good. In 1904, it was reported that Messrs. Davies & Sons of Stonehouse Upper and Lower Mills, were noted for their production of fine worsteds, "black, blue and mixtures". Apart from these, output comprised "vicunas, flannels, riding tweeds & Bedford cords, fine navy cloths, & doeskin, beavers, meltons, Venetians, Devons, scarlets, waterproof covert coatings, carriage and livery cloths. etc" (ibid. 25).

Despite the efforts of a handful of manufacturers to diversify, it was rather late in the day and mill closures continued. The 1890s saw the demise of a further 8 or so mills and by 1901, only 12 firms, occupying ~20 mills were still left in Gloucestershire (Tann, 1967: 69; Also SN. 12 January 1906). By this time, it was not uncommon for such manufacturers to occupy several mills, one, perhaps, housing just carding and spinning processes. Thus, when a business failed, more than one mill could be affected. As the Gloucestershire industry had continued to contract, so it had gravitated from mills along the upper reaches of the Frome, becoming increasingly concentrated in and around Nailsworth, Stroud itself, and along the lower Frome, in Stonehouse and Eastington.

Even with the many closures and contraction of the Gloucestershire industry, taken as a whole, the period between c1840-c1880 had generally been one of relative stability and prosperity, despite the inevitable ups and downs in the trade. West of England broadcloth remained fashionable for those who could afford it during this period and overall, the major manufacturers appeared to be making reasonable profits. However, underneath this apparent halcyon appearance, some manufacturers were struggling financially, often as a result of earlier depressions that had denuded their capital. In contrast, a few manufacturers, with sound business judgement, plus perhaps, a degree of good luck, had managed to accumulate considerable fortunes. By c1850, the company of Marling, Strachen & Co. of Stanley Mills were reputedly worth over £160,000. When operation of Stanley and Ebley Mills was combined and the two branches of the Marling family united in the business venture, this had risen to £176,000 (Moir, 1955. Also Mann, 1987: 206). And so, what remained of the industry moved into the 20th century (Table 26). By now, cloth manufacture in Gloucestershire was almost exclusively in the hands of ~20 manufacturers, some of whom were destined to survive longer than others.
Table 26
Major Manufacturers of the Gloucestershire Woollen Industry in the First Part of the 20th Century

<table>
<thead>
<tr>
<th>Company</th>
<th>1892</th>
<th>1904</th>
<th>1919</th>
<th>1923</th>
<th>1931</th>
<th>1935</th>
<th>1939</th>
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<tr>
<td>Apperley Curtis, Dudbridge</td>
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<td>Davies &amp; Sons, Stonehouse</td>
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<tr>
<td>P C Evans &amp; Sons, Brimscombe</td>
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<td>Charles Hooper &amp; Co. Stonehouse</td>
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<td>Howard &amp; Powell, Wallbridge</td>
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<tr>
<td>Hunt &amp; Winterbotham, Cam</td>
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<td>J Libby &amp; Co, New Mills, Stroud</td>
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<tr>
<td>Marling &amp; Co, Stanley and Ebley Mills</td>
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<tr>
<td>L Millman &amp; Co/S Long &amp; Co, Kingswood and Charfield</td>
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<tr>
<td>W Playne &amp; Co, Longfords</td>
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<tr>
<td>Alfred Ritchie &amp; Co, Ham Mills</td>
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<tr>
<td>Roberts, Jowlings &amp; Co, Lightpill Mill</td>
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<td>Thomas Smith, Bowbridge</td>
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<tr>
<td>Strachen &amp; Co, Lodgemore and Fromehall Mills</td>
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<tr>
<td>Northcott, Cartwright &amp; Co, Woodland (Peghouse) Mill</td>
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<tr>
<td>Humphreys &amp; Co, Woodland (Peghouse) Mill</td>
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<tr>
<td>Marling &amp; Evans, Brimscombe, Stanley and Ebley Mills</td>
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<td>X</td>
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<tr>
<td>Marling, Playne &amp; Co, Longfords Mill</td>
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<td>Millman, Hunt &amp; Co, Charfield</td>
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(Sources: Kellys and other Directories, 1892, 1919, 1923, 1931, 1935, 1939. Ind. Glos. 1904)

Mills were now fully mechanised, all being powered by steam, although water power continued to be used in some circumstances. The businesses now working produced substantial quantities of cloth from large mills such as Ebley, Stanley and Cam, the degree of integration generally being much higher than in earlier times. In one situation, a conglomerate of separate mills, as opposed to a single mill, was used. Such was the case with the Hooper empire which at its peak, encompassed five mills in three parishes, all specialised in a particular stage of manufacture but worked together as one. Similarly, Strachen & Co. split their production between Lodgemore and Fromehall Mills, separated by a few hundred yards. The traditional types of cloth continued to be the mainstay of the industry although for a time, worsteds did comprise an important segment of the trade, providing employment for a reasonable number of workers. It was noted that:
"Worsted cloth is now, however, being woven by a few [Gloucestershire manufacturers] with great success. The actual numbers employed in worsted manufacture is not clear...in 1891 they amounted to sixty-seven as compared with four in 1851, but the numbers must now [1907] be considerably greater". (VCH. ii. 195).

The observer went on to note that the manufacture of tweeds and other rough coatings in Gloucestershire was the most hopeful sign of all, as they were taken up by the more progressive of the cloth firms. Clearly viewing this as the way of the future for the Stroud industry, he referred to them as an "extraordinary and growing success".

A degree of stability marked the markets during the early part of the present century and compared with the attrition rate experienced throughout the West during several parts of the the 19th century, there followed a period of relative calm, at least in Gloucestershire. But even here, mills failed sporadically. In 1907, Roberts, Jowling & Co. of Lightpill Mill went bankrupt and around the same time, Charles Hooper shut down Churchend and Meadow Mills in Eastington. In Wiltshire, the decline also continued; in 1900, a solitary mill was left working in Bradford-on-Avon but by 1905, this too had gone. The last Melksham mill had shut down in 1899, there was only one survivor in Chippenham, and all of the formerly important mills of the Wylye Valley were silent (Ponting, 1971: 127-8, 132). All that was left of the once-busy Wiltshire industry was now centred around five mills in Trowbridge; clearly, Gloucestershire was faring somewhat better at this time. In terms of machinery, the West's surviving mills were generally up-to-date, with the likes of Salters and Palmer & Mackay's mills in Trowbridge (ibid. 128) plus the Gloucestershire mills of the Marlings, Playnes, Davies, Hunt & Winterbotham, Apperley-Curtis, Strachen & Co, and Charles Hooper all having kept abreast of developments.

Overall, apart from the two pockets of industry in Trowbridge and Stroud/Cam, the formerly great West of England cloth trade was essentially dead. By 1900, the West was now leagues behind the industry in Yorkshire and even that of Scotland. As the century progressed, the survivors dwindled further. By the 1920s, Davies & Sons had ceased manufacture at both Stonehouse Upper and Lower Mills, the Brimscombe Mill site was no longer in use and rationalisation had taken place in the south of the county, where Millman & Co. had abandoned Nind Mills in Kingswood, having earlier taken over Samuel Long’s business at Charfield. The 1930s saw the failure of two further manufacturers; unexpectedly, in 1933, the long-established and innovative company of Apperley-Curtis closed down the large Dudbridge Mill site, and Hooper's operations, which had contracted from five sites to Bonds Mill alone, finally closed down in 1934, having been run by three generations of the family. Thereafter followed a period where the handful of mills left continued to work steadily, the Second World War providing a useful boost to production. For instance, alongside producing large quantities of military and naval cloths, Cam Mills also manufactured a number of speciality lines such as felted
materials for munitions use. Ebley and Stanley Mills continued to be worked together, Ebley operating predominantly as Marling & Evan's spinning mill. In the 1960s, Howard & Powell’s Wallbridge Mill closed and was demolished and around the same time, Ebley Mill was also closed, the machinery being broken up for scrap, it having proved impossible to find a buyer. The company now concentrated its efforts entirely at Stanley Mill, however, following financial difficulties, the business became the subject of a management buyout. This merely delayed the inevitable and by c1990, cloth production had come to an end. Tragically, the list was joined by the Longfords Mill site a short time later.

And so, the West of England industry came almost to an end, crippled slowly through a combination of conservatism and a reluctance of many manufacturers to adapt to new fashions, coupled increasingly with competition from the North and elsewhere. At their best, the traditional cloths produced in the region were of excellent quality however, their manufacture involved many stages of production and necessarily entailed a high price. At the end of the day, the market for such high priced products, however good their quality, was set to wane in the face of competition from cheaper cloths such as tweeds and worsteds, produced in Scotland and Yorkshire, and alternative fabrics such as cotton.

During this protracted period of decline in the West, there were marked differences between and within regions. Thus, the once-prosperous Wiltshire industry gravitated almost exclusively to Trowbridge. In many ways, the decline of the Wiltshire industry had been for similar reasons to Gloucestershire. Like many of the Gloucestershire manufacturers, change had been resisted and delayed until it was too late and traditional markets were lost increasingly to Scottish tweeds and Yorkshire worsteds. In addition, the conservative attitude of the manufacturers to change meant that there had been little attempt to adapt existing products and patterns to new fashions. Once again, it seemed that the northern manufacturer went in search of new markets or strove to create them, whereas his western counterpart waited for the market to come to him.

For a time, Gloucestershire had continued to do rather better than Wiltshire, with important pockets of industry remaining around Stroud itself and along the lower Frome. However, time continued to take its toll and the industry that once formed the heartbeat of the Stroud valleys gradually became but a shadow of its former self. Fortunately for the local economy and employment situation, many redundant workers were subsequently redeployed in the successor industries. In 1913, Sir William Marling was to lament the decline of the industry that had made his family rich and powerful, but also to note that the period of decline had not been one of total despair:

"We who are still woollen manufacturers may regret that the number of woollen mills in the West of England has for years so diminished, and that consequently our trade does not possess the commanding position that it formerly occupied; but it is consolatory to feel that many other industries have grown
up, and that employment for the working classes is better served by the industrial eggs not being all in one basket!" (Marling, 1913: 332).

Today, cloth manufacture is limited solely to Cam Mills, recently modernised further and still producing cloth, and Lodgemore Mill, the latter now forming part of the American-owned Milliken Group. Part of the Stanley Mill site continues in use for the manufacture of felted industrial flooring although the main building remains largely unused. It is to be hoped that the future of these few remaining enterprises is secure, providing as they do, the last working link with the industry that shaped the lives of thousands and was largely responsible for the characteristic appearance of the region.
CHAPTER 10

MAJOR SUCCESSOR INDUSTRIES IN THE STROUD REGION

Contrary to what might be expected, the contraction of the cloth industry did not bring about wholesale decline in the local industrial base. In some instances, this very decline may have acted as a stimulus to other fledgling industries. The availability of redundant cloth mills was a crucial factor in the high level of adaptive reuse that took place in the wake of the cloth industry’s decline. As noted above, the cloth industry in the Stroud valleys declined gradually throughout a protracted period, with closures occurring in a piecemeal manner. As a result, even though such closures generally began earlier than in Yorkshire, Stroud businesses failed sporadically, with mills often becoming available for other uses in small numbers. There were clearly particularly depressed times when a number of mills stood idle, but frequently, a new occupier was eventually found. Such a pattern of on-going adaptive reuse has meant that a significant number of former cloth mills have survived in the region. Even where the main structures have gone, many mill sites remain in use for a variety of purposes.

As with many areas of such industrial activity, the new uses that redundant cloth mills were put to were many and varied. However, there were several important successor industries that helped to fill the void created by cloth-making’s gradual demise. Some examples of reuse remained linked with the cloth trade, one such example being dyeing and the manufacture of dyestuffs. As noted by Partridge (1975) a wide range of materials and techniques were involved in this specialist trade, one that had been developed to a high degree by a number of enterprises in the region.

- Dyeing and Dye Manufacture

The vast majority of redundant cloth mills in the region saw at least one phase of reuse (major ones have been examined earlier), often more. A number of these successor trades and industries remained linked directly with the woollen cloth trade and others not associated with cloth making developed out of the wealth of skills developed in allied fields. The former category included a number of former cloth mills that were turned over fully or partially to dyeing; these included Abbey, Arundells, Beards, Bowbridge, Bridgend, Dudbridge/Hawkers, Lightpill and Strange’s (Wotton) Mills. A few such as Hawkers formed important dyeing centres from the late 18th and throughout much of the 19th century, whereas others such as Beards Mill, remained under the control of one particular manufacturer, essentially only dyeing cloth for the particular company. A few, such as Bridgend Dyeworks near Stonehouse became specialised from an early date; in this case, Bridgend fulling mill had been supplanted by the dye works by 1775. Here, the highly skilled job of dyeing Stroud Scarlets was extensively carried out, much for the Clutterbucks of Stanley Mills (Tann, 1967: 148). Gardner &
Bishop later occupied the site, carrying on the same trade (Morris Dir. Glos. 1867: 175). Hawkers dyeworks at Dudbridge remained one of the largest and most important dyeworks in the region, occupying the site of several former cloth mills. At its peak, it was noted that 17 furnaces were in use around the clock, with up to 42 pieces of cloth being dyed in a single day. Many of the lesser cloth manufacturers relied heavily on the likes of Hawker for their dyeing, lacking the skills and/or facilities to dye their own products. As an alternative, there were a number of dyeworks that took in third party goods for dyeing even though they were partially or wholly owned by one of the larger cloth manufacturers. At Bowbridge Dyeworks, housed in a former cloth mill, such a system was operated, where the owners were Strachan & Co. of Lodgemore and Fromehall Mills (VCH. ii. 196). Presumably, their cloth took precedent over that of outsiders. At least one major dyer (Hawkers) not only carried out dyeing, they also acted as retailers of dyestuffs bought in from a variety of sources. For instance, the Hicks of Eastington, who carried out their own dyeing at Churchend Mill, obtained some of their dyestuffs from this source; on December 1814, Hawker invoiced the Hicks’ company for:

"400lbs of Cochineal at 40/- per pound...£800" (EM. Dec 1887).

This represented a substantial amount of money, however Cochineal was used to develop the colour of the famous "Stroud Scarlets". In some cases, allied to dyeing was the manufacture of dyestuffs, one of the other important sources of dyestuffs used in the area being logwood. Logwood was the hard, brownish-red wood of a Central American and West Indian tree and had been in use in Europe since the time of America’s discovery. Products derived from logwood formed an important source of dyestuffs for silk, and in this case, woollen cloth. The wood was often imported in the form of dense hard blocks and following chipping, the dyestuff was extracted by "lixiviating" the freshly cut wood with water. It was employed chiefly for the production of darker shades of wool and survived far longer than many other naturally-derived dyes. In its latter days, it was used in conjunction with chromium, tin and iron-based compounds, in order to produce a variety of different shades. Logwood dyes continued to be used locally throughout much of the 19th century, even when newly developed dyestuffs, such as aniline-based products, had become widely available. It was not until the close of the Edwardian period that these naturally-derived dyestuffs were finally fully displaced by synthetic derivatives.

Logwood was obtained in blocks or alternatively, was sometimes available in ready-chipped form. In 1814, the Hicks bought "6Hhds [hogsheads] of chipt logwood - 42:3:11 at 19/- per cwt...£40-14-1" (ibid) from the Bristol merchants Ames, Gadd & Wait. Locally-ground supplies were produced primarily between c1850-90, companies usually inhabiting former cloth mill sites. For instance, Alfred Haycraft was grinding logwood at Hazel Mill between c1850-70 and also from c1870 at Wades
Mill; he was again recorded as carrying on the trade at Hazel Mill in 1919 (Kellys. 1919: 1054). From the early 1860s-80s, John Thomas & Co. followed by Thomas Gold, were doing likewise at Rock Mill on the Painswick Stream, as were the Whites at Dyehouse Mill, Inchbrook (Tann, 1967: 102, 202, 212). Egypt Mill, upstream from the latter, also saw a period of logwood grinding carried on by at least two different companies in the 15 years or so from the mid 1870s (Mills & Riemer. 1989: 51).

Mattress Wool, Flock and Shoddy

This important group of materials originally had its roots in the utilisation of waste materials originating from the manufacture of woollen cloth although, in some cases it later came to depend largely on woollen waste and rags imported into the region from elsewhere in Britain and even abroad. Some resulting materials were not unlike freshly carded wool (VCH. ii. 197) and various types were produced over a period of nearly a century and a half, the distinction between them often being blurred. Thus, at different times manufacturers advertised their wares by a variety of names and for various purposes. In essence, shoddy was used to replace a percentage of fresh wool and used in the manufacture of lower grades of woollen cloth, whereas flock consisted of shredded wastes used primarily to stuff soft furnishings, mattresses, horse collars, etc: these originated as various shredded varieties or as the fine material shorn from woollen cloth at the shearing stage.

Shoddy was made by the boiling, drying and grinding up of soft woollen rags, the grinding machine or "devil" having first been put to use c1809 (Giles & Goodall, 1992: 116). It formed part of a succession of stages in the reclamation process. Rags were initially sorted and where possible, any cotton removed; this was followed by blending in warm oil and the grinding stage. In order to remove any cotton remaining, the shredded rags were then treated with an acid (wet carbonising using acid solution or dry carbonising using heated acid gas) - the wool content remained largely unaffected. The materials resulting from this process were reused in the low wool trade, being blended with fresh wool at the preparation stage. The vast majority of this was produced within a few areas of the Yorkshire woollen district although many mills came to house at least a few grinding machines (ibid). Tann notes that a number of Gloucestershire mills had installed flock engines as a sideline (Tann, 1970: 112). At the turn of the present century, the Stroud region was still producing "a small quantity annually for Yorkshire spinners and weavers" (VCH. ii. 197). Precisely how much was utilised locally is not clear however as the low woolen trade was carried on predominantly in the North, this may have formed the main market. In Yorkshire, post-1860s, the business had developed to the stage where specialist mills were established, dedicated solely to the production of shoddy and its brother, known as "Mungo"; this was made in a similar fashion but based on the use of hard rags. There is no evidence to suggest that this was ever produced in the Stroud region.
Working in flock and shoddy mills could be unpleasant. A contemporary account of life in a Dewsbury shoddy mill describes it thus:

"In tearing up the rags a great quantity of dust is produced so that persons standing three yards apart cannot clearly distinguish each other". (Addy, 1976: 106-107; quoting C R Wing. Evils of the Factory System, 1837: xxiii).

Even in the rural Toadsmoor Valley, there are apocryphal tales of the dust from Selwyns Mill obscuring visibility in the adjacent road!

Flock manufactured in the Stroud mills tended to be used locally for the manufacture of mattresses and other items requiring padding and several firms came to produce complete mattresses as opposed to merely their filling.

In terms of its overall importance to the British woollen industry, the impact of flock and shoddy production was not large however, by the late 1880s, Yorkshire could boast ~70 mills engaged in rag grinding, shoddy and mungo manufacture; by 1903, this had risen to 156 (Giles & Goodall, 1992: 4), many in localised areas specialising in this type of manufacture. As with some products of the Stroud valley mills, at times, the industry was reliant heavily on imported rags; Germany was the main supplier for parts of Yorkshire. The Stroud valleys utilised ~30 former woollen mills for this type of manufacture although not all at the same time. Thus, in both Yorkshire and the Stroud region, flock and shoddy remained important local industries, although the latter region could not be considered to be of national importance. In the region, the main areas where this type of manufacture came to be settled were predominantly in and around the Chalford/Toadsmoor/Nailsworth districts, where a succession of former woollen cloth mills were turned over to this use. Only in a single case does a mill appear to have been built specifically for flock and shoddy manufacture, Lewiston Mill on the Toadsmoor Brook, constructed by the Grist family in 1856.

The Grist family were the major manufacturers in the region for many years, successive family members (Elizabeth, William, Matthew, Richard, Charles, John, Lawrence, and Richard Lewis) running the business from the 1830s onwards, sometimes in partnerships with others relatives or individuals. Over the course of a century or so, the family operated from at least ten different mill sites, the majority of which were leased. Much of the output at least during the latter period, comprised mattress materials "of the more expensive kinds" (VCH. ii. 197). By 1867, the Grists were not only active in the Stroud valleys, they also had operations in Bristol and Huddersfield (Morris Dir. Glos. 1867: 119, 139).
The other major player was William Selwyn who operated primarily around the Toadsmoor area from the mid 1880s. Selwyn took over Toadsmoor Mills which had been producing flock, shoddy and mill-puff from the 1860s, having originally been operated by Charles Freeman and his partner Richard Davis. Selwyn’s business continued to form an important source of employment in the area, the company specialising in the production of a cheaper class of goods than those produced by the Grists. Substantial quantities of raw materials were imported for Selwyn’s mills from Holland, in the form of carpet rags (VCH. ii. 197).

The vast majority of the trade was carried on in the areas noted, however a few outlying mills operated for a time in the Painswick/Sheepscombe area, and a solitary mill along the Little Avon. A number of manufacturers were active for various periods however, most seem to have been fairly short-lived. Tabram was at Inchbrook Mill, then in partnership with the Grists for around a decade at Dyehouse Mill before appearing for a few years after 1889 at Rock Mill; following this period he disappears, as had Phelps, Roberts, Heath, Harrison, Teakle and Porter. The Grists carried on in business from Lewiston and latterly Merretts Mills up to the middle of the present century and Selwyns, to the late 1930s. Beyond this period, manufacture came to be primarily in the hands of the Stroud Flock Company who operated from Rooksmoor Mills up to 1963. The trade in the region is now extinct although it formed an important occupation for many years, helping to fill the void created by the contracting woollen cloth industry. It continued to employ many hands and made use of at ~30 former cloth mills at different times. This range of products appears to have been limited largely to these few areas of the former Gloucestershire woollen industry.

Although attempts were made to produce flock and shoddy by several firms in Wiltshire, they seem to have had little success. This is verified by Rogers’ extensive gazetteer of Wiltshire and Somerset mills (1976) which notes only a handful of mills that may have been involved in the flock trade, such as Cradle Bridge Mills and the Union St Factory in Trowbridge, both of which made "bedding" for a time. In addition, Freshford Mill may have been used for flock manufacture, having been sold to a flock maker in 1879 (TA.10 May 1879). Ponting notes that the Staverton Factory was another example and concludes that these materials were "never manufactured successfully in the West of England" (Ponting, 1971: 123) although the Stroud valleys were clearly the exception to this. In contrast, Mann suggests that flock manufacture in the West was a frequent successor industry that began in the 1830s and increased significantly post 1850 (Mann, 1987: 209) although it is apparent that such manufacture was limited largely to the Stroud region. Once again, Stroud was atypical in this respect to the remainder of the West of England textile region.

As a consequence of the importance of the trade to the local economy, a number of the engineering companies in the region devoted at least part of their output to the manufacture of flock making
machinery. For instance, Jehu Shipway & Sons of the Ebley Iron Works were noted for:

"...their improved flock making machines for which they gained a national reputation...have made a number of machines in this class for some of the largest flock mills in England and Ireland" (Industrial Gloucester, 1904: 14).

Similarly, Dudbridge Iron Works also manufactured flock machinery for a time (VCH. ii. 204). Doubtless, both formed further useful spinoffs to the local economy.
<table>
<thead>
<tr>
<th>Mill</th>
<th>Location</th>
<th>Date</th>
<th>Advertised Products*</th>
<th>Occupier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iles</td>
<td>Chalford</td>
<td>1879-1902</td>
<td>F, S</td>
<td>Ellis &amp; Evans, C Grist, W G Grist &amp; Sons</td>
</tr>
<tr>
<td>Bourne</td>
<td>Chalford</td>
<td>c1865-1900?</td>
<td>MW, MP, S</td>
<td>Grist, Sons &amp; Co, Richard Grist &amp; Co</td>
</tr>
<tr>
<td>Capels</td>
<td>Stroud</td>
<td>1856-c1880</td>
<td>MW, MP</td>
<td>Grist, Sons &amp; Co, Elizabeth Grist, Sons &amp; Co</td>
</tr>
<tr>
<td>Gussage</td>
<td>Toadsmoor</td>
<td>1879</td>
<td>MP</td>
<td>Richard Grist, Grist &amp; Co</td>
</tr>
<tr>
<td>Bourne</td>
<td>Toadsmoor</td>
<td>1872</td>
<td></td>
<td>Richard Grist</td>
</tr>
<tr>
<td>St Marys</td>
<td>Chalford</td>
<td>1867-1890s</td>
<td>F, S</td>
<td>W G Grist, Charles Grist</td>
</tr>
<tr>
<td>Dyehouse/Philpotts</td>
<td>Nailsworth</td>
<td>c1860-1870s?</td>
<td>MW, S, MP</td>
<td>G F Tabram, Grist &amp; Tabram</td>
</tr>
<tr>
<td>Merretts</td>
<td>Nailsworth</td>
<td>1863-post 1939</td>
<td>F, S, MP</td>
<td>Matthew Grist, Frank James, William Grist, Matthew Grist</td>
</tr>
<tr>
<td>Victoria</td>
<td>Rooksmoor</td>
<td>c1867</td>
<td>F, S, MP</td>
<td>John Grist &amp; Co</td>
</tr>
<tr>
<td>Nailsworth</td>
<td>Nailsworth</td>
<td>c1876-</td>
<td>F, S</td>
<td>George Heath, James Harris &amp; Co</td>
</tr>
<tr>
<td>Crystal Fountain</td>
<td>Inchbrook</td>
<td>c1933</td>
<td>F</td>
<td>Harry Grist</td>
</tr>
<tr>
<td>Ithells</td>
<td>Little Avon</td>
<td>pre 1867-1889</td>
<td>F</td>
<td>James Cox</td>
</tr>
<tr>
<td>Nind</td>
<td>Little Avon</td>
<td>post 1897-post 1939</td>
<td>F, S</td>
<td>William Selwyn</td>
</tr>
<tr>
<td>Wick</td>
<td>Doverton Brook</td>
<td>pre 1774-?</td>
<td>F</td>
<td>?</td>
</tr>
<tr>
<td>Holcombe/Spring</td>
<td>Nailsworth</td>
<td>1879-post 1939</td>
<td>F, S</td>
<td>Porter &amp; Co, Mallett, Porter &amp; Dowd, Purified Flock &amp; Bedding Company</td>
</tr>
<tr>
<td>Inchbrook</td>
<td>Nailsworth</td>
<td>c1867-post 1939</td>
<td>F, S, MP</td>
<td>G F Tabram, Harry Grist &amp; Co, Grist &amp; Tabram</td>
</tr>
<tr>
<td>Ashmeads</td>
<td>Chalford</td>
<td>1870</td>
<td>MW, S</td>
<td>Nathaniel Teakle &amp; Sons</td>
</tr>
<tr>
<td>Location</td>
<td>Description</td>
<td>Date</td>
<td>Product</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
<td>------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>Misenden</td>
<td>Misenden</td>
<td>1832-1850</td>
<td>F (+ corn)</td>
<td></td>
</tr>
<tr>
<td>Days</td>
<td>Nailsworth</td>
<td>1880s?</td>
<td>George Heath &amp; Co; James Harrison &amp; Co</td>
<td></td>
</tr>
<tr>
<td>Gig</td>
<td>Nailsworth</td>
<td>1850s</td>
<td>F, S</td>
<td>James Harris</td>
</tr>
<tr>
<td>Lower Horsley</td>
<td>Horsley</td>
<td>1879</td>
<td>F, S</td>
<td>John Roberts</td>
</tr>
<tr>
<td>Rock</td>
<td>Painswick</td>
<td>1889</td>
<td>F, S</td>
<td>Tabram &amp; Co</td>
</tr>
<tr>
<td>Paganhill</td>
<td>Paganhill</td>
<td>1840</td>
<td>F?</td>
<td>John Delafield Phelps</td>
</tr>
<tr>
<td>Churches</td>
<td>Woodchester</td>
<td>post 1900</td>
<td>MW</td>
<td></td>
</tr>
<tr>
<td>Griffins</td>
<td>Stroud</td>
<td>c1853</td>
<td>F, S</td>
<td>Elizabeth Grist &amp; Sons</td>
</tr>
<tr>
<td>Matthew Grist</td>
<td>Bennets Mill</td>
<td>c1830</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samuel Webb</td>
<td>Dutton House?</td>
<td>c1830</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheepcrome/Flock</td>
<td>Sheepcrome</td>
<td>pre 1743-?</td>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>

* S = shoddy, F = flock, MW = Mattress Wool, MP = Mill-puff

Amongst the successor industries that set up shop in the Stroud valleys, perhaps one of the most peculiar was the manufacture of walking sticks plus a range of other variants. From at least the 1840s, throughout the valleys, sticks were being produced predominantly in redundant cloth mills. The attractions were fairly obvious, namely available buildings in most cases, characterised by large open floor spaces. In addition, power source(s) were often still in place in the form of water and/or steam, usually sufficient to drive saw benches and turning machines, plus a pool of skilled labour was available in the district. Other factors that may have increased the attractiveness of the area included access to a region that was now well served with transport infrastructure in the form of roads, canals and railways, plus at least initially, an inexpensive supply of local beechwood.

Over the course of a century or so, at least 17 former cloth mill sites were either partially or wholly turned over to some aspect of stick manufacture. The industry thrived for much of the second half of the 19th and earlier part of the 20th centuries, however, the fashion for walking sticks waned and the market gradually decayed. The market for umbrella sticks and fittings may have suffered less during this period. Despite this, the stick manufacturing trade in the region was characterised by a handful of companies of great longevity, perhaps none more so than the manufacturing empire founded by the king of the stick makers, William Dangerfield. He can be credited with, if not introducing the trade to the area, developing it to the extent that at one time he was employing around a thousand hands. Even from an early date, his range of products was diverse although related, including bone umbrella handles, umbrella and parasol sticks, bone mounts, buttons and walking sticks. Dangerfield built up and expanded the business to the extent that by the 1860s, his manufactory was encompassing a clutch of adjacent former cloth mill sites. These included Bliss Mills, Woods/Randalls/Spring Mills, and Mugmoor/New Mills. Situated in the various existing buildings and additional structures erected was the equipment required for the various stages of stick manufacture, plus the assortment of mounts, etc. needed. In addition, for a time, Gussage Mill, nearby on the Toadsmoor Brook was operating as a turnery, presumably supplying components to the main Bliss Mills site.

When Dangerfield died in 1894, the business appears to have faced an uncertain future for a few years; however, in 1903 it was taken over by A C Harrison, himself a third generation stick maker. By now, the site had grown to some 6½ acres and following a serious fire, had been much rebuilt towards the end of Dangerfield’s life. The manufactory now consisted of a range of substantial production buildings, some in former mills and others in new buildings (erected after a major fire in 1888), large warehouses, a saw mill, carpenters shop, turning shops, and a fitting shop in which much of the specialised equipment needed was designed and built. Dangerfield himself was cited on a number of patents related to stick manufacture. Such was the scale of the operations at the Bliss Mills
site that the various buildings were linked by a tram system. Particularly when under Harrisons's
control, constant upgrading and improvement of machinery and facilities appears to have been carried
out; steam heating was used as was electric lighting, electricity being generated on site. The mills’
main power source consisted of a pair of 46 hp steam engines of Gloucester manufacture. The general
turning and manufacturing departments were housed in a room 110 x 80 ft, described as "one of the
finest workrooms in the country" (Industrial Gloucester, 1904: 40). The range of products being
manufactured by the early part of the present century consisted predominantly of varieties of walking
sticks and umbrella handles, produced in wood, celluloid or combinations of both. Walking sticks no
longer relied on local supplies of beechwood, now being manufactured from a range of woods that
included Congo, myrtle, furze, bamboo, cherry, hazel and orange. It was proclaimed that the site's
stock rooms held up to 14,000 samples of every conceivable design and that supplies were sent out
to branches in London, Manchester, Glasgow and Paris, ensuring that the company formed one of the
most important stick makers in the country (ibid). From 1912, the site, which had been acquired by
Sir Alfred Apperley, was occupied by Chalford Woodworkers who continued to produce a range of
sticks and tool handles up to c1930.

Although the new century was to see significant changes in the market for sticks, the picture was not
entirely gloomy. Many of the smaller makers had by now gone to the wall, however alongside
Harrisons, at least three other companies were destined to carry on manufacture for a considerable
time. These included the Hoopers of Griffin Mill, who operated up to the mid 1930s; H S Hack of
Bourne Mill, who made umbrella sticks up to c1967; and perhaps the most significant, the Chalford
Stick Company, set up in 1903 in the former St Marys cloth mill at Chalford, and the Walkers who
were at Dunkirk Mills up to 1937. The latter concern coexisted with the family's hosiery knitting
enterprise, also set up in Dunkirk Mills, stick making having taken over from the ailing umbrella and
walking stick manufacturing business of Drake & Co. Crucially, the Walkers were in a position to
pump capital into the venture with the result that the workforce was quadrupled and the scale of the
business expanded greatly. At Dunkirk, various rationalisation was carried out, resulting in seven
large rooms housing the various manufacturing departments. Like Harrisons, they came to produce
a wide assortment of sticks and were noted especially for their "better quality lines", some of which
were hand carved and/or featured gold and silver mounts. Imported woods were used extensively,
these including Congo wood, cherry wood from Austria, Ebony from Africa, furze and beech. A
significant trade was carried on not only within Britain, but also via exports overseas. The business
was finally closed down in 1937.
The Chalford Stick Company was the second major stick making venture set up early in the present century, formed with the intention of supplying a wide range of products in large volumes, much as the local competition was already doing. As with the Walkers’ enterprise at Dunkirk, the inside of St Marys Mill was significantly remodelled and state-of-the-art manufacturing equipment installed throughout. Under the new management of Messrs Dann, Isaac and Chelt, the manufactory was configured from the outset for rapid and efficient production, featuring a logical layout of the various departments; these included a turning shop, saw mill (steam-powered), bending and cane shop, plus varnishing and staining shops. Also, like the Walkers, a bewildering array of woods came to be used, these including beech, gorse, American birch and maple, scented cherry, Congo wood, orange, olive and myrtle. Much was apparently sourced directly from the various overseas and domestic growers. Alongside the wide range of walking, umbrella and parasol sticks, the company also produced specialities such as gold and silver mounts and celluloid and ivory handles. Much of the factory’s output went for export and sticks were held in London, Manchester and Glasgow, with overseas agencies in Paris and Berlin. Remarkably, the company carried on its operations at St Marys up to 1981, when it relocated to Churches Mill at Woodchester. In its latter guise, it continued to produce thousands of walking sticks for the National Health Service up to its eventual demise c1990 - the last survivor finally vanished.

In its day, the stick making trade in its various forms provided a significant amount of employment, especially during the period of the woollen trade’s continuing contraction and rationalisation. It was estimated that during the 1870s, up to 2000 hands were employed in the trade, around 1000 of these working for William Dangerfield. By the turn of the century, this had fallen although was still significant; in 1901, 442 men and 264 women were still making a living in the trade, split mainly between the former Dangerfield empire at Bliss Mills and the Hoopers at Griffins Mill (VCH. ii. 26).
Within a few years, a further 100 were taken on by the newly formed Chalford Stick Company and in 1912, H S Hack commenced operations at Bourne Mill, taking on others.

Table 28

**Stick Making-Related Enterprises in the Region**

<table>
<thead>
<tr>
<th>Site</th>
<th>Date</th>
<th>Occupier</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bliss Mills site</td>
<td>1840-c1930</td>
<td>1840 William Dangerfield</td>
<td>Bone umbrella handles, umbrella and parasol sticks, bone mounts, buttons, walking sticks</td>
</tr>
<tr>
<td>comprising: Woods/Randalls/Spring, Mugmoor/New and Bliss Mills</td>
<td></td>
<td>1903 A C Harrison &amp; Co</td>
<td>Umbrella and parasol sticks, bone mounts, buttons, walking sticks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1912 Chalford Woodworkers</td>
<td>Umbrella sticks and handles</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sticks and tool handles</td>
</tr>
<tr>
<td>Gussage</td>
<td></td>
<td>William Dangerfield</td>
<td>Wood turning</td>
</tr>
<tr>
<td>Griffins</td>
<td>1856-1935</td>
<td>Henry &amp; Richard Hooper</td>
<td>Walking and umbrella sticks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Charles Hooper</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Samuel Richard Hooper</td>
<td></td>
</tr>
<tr>
<td>Dunkirk (part)</td>
<td>1903-1937</td>
<td>Walkers Sticks</td>
<td>Walking sticks</td>
</tr>
<tr>
<td></td>
<td>c1900-1950s</td>
<td>Wright, Bindley &amp; Gell</td>
<td>Umbrella fittings</td>
</tr>
<tr>
<td>Southfields</td>
<td>1920s</td>
<td>Southfield Stick Mills Ltd</td>
<td>Walking sticks</td>
</tr>
<tr>
<td>Nodes</td>
<td>c1880-90s?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lightpill (part)</td>
<td></td>
<td>E Beard &amp; Co</td>
<td>Walking sticks</td>
</tr>
<tr>
<td>Horsley</td>
<td>c1885</td>
<td>Felix A Liddiat &amp; Co</td>
<td>Parasol, umbrella and walking sticks; also saw mill</td>
</tr>
<tr>
<td>Wimberley</td>
<td>c1879</td>
<td>James Harrison &amp; Co</td>
<td>Umbrella and parasol sticks</td>
</tr>
<tr>
<td>Illes</td>
<td>c1863-1865</td>
<td>Richard &amp; Joshua Jones</td>
<td>Walking sticks</td>
</tr>
<tr>
<td>Dark (part)</td>
<td>c1885-post 1919</td>
<td>James Harrison &amp; Co</td>
<td>Umbrella and parasol sticks</td>
</tr>
<tr>
<td>Workmans (part)</td>
<td>c1870-post 1919</td>
<td>Henry Workman</td>
<td>Saw mill and walking sticks</td>
</tr>
<tr>
<td>St Marys</td>
<td>1903-1981</td>
<td>Chalford Stick Co</td>
<td>Umbrella, sunshade and walking sticks</td>
</tr>
<tr>
<td>Bourne</td>
<td>1912-c1967</td>
<td>Henry S Hack</td>
<td>Umbrella sticks</td>
</tr>
<tr>
<td>Churches</td>
<td>1981-c1990</td>
<td>Chalford Stick Co</td>
<td>Walking sticks</td>
</tr>
<tr>
<td>Brookhouse</td>
<td>c1840</td>
<td>William Clark</td>
<td>Umbrella sticks</td>
</tr>
<tr>
<td>Smalls (Painswick)</td>
<td>c1853-1857</td>
<td>William Clark</td>
<td>Umbrella sticks</td>
</tr>
<tr>
<td></td>
<td>c1879</td>
<td>Thomas Hooper</td>
<td>Umbrella sticks and umbrella furniture</td>
</tr>
<tr>
<td>Pitchcombe</td>
<td>1842-c1846</td>
<td>Ebenezer Durdin</td>
<td>Umbrella sticks</td>
</tr>
<tr>
<td>Dudbridge (part)</td>
<td>c1899-post 1931</td>
<td>Stroud Metal Company</td>
<td>Umbrella furniture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stroud Metal &amp; Plating Company</td>
<td></td>
</tr>
<tr>
<td>Inchbrook</td>
<td>c1889-post 1919</td>
<td>Marmont &amp; Taylor</td>
<td>Umbrella furniture</td>
</tr>
<tr>
<td>Doreys</td>
<td>c1867</td>
<td>William Birt</td>
<td>Umbrella and parasol sticks</td>
</tr>
<tr>
<td>Upper Doreys</td>
<td>1863</td>
<td>King &amp; Co</td>
<td>Fancy umbrella and parasol sticks</td>
</tr>
</tbody>
</table>

The majority of silk processing carried on in the Stroud area was restricted to the stages leading up to that known as throwing. Although perhaps not as complex as the manufacture of woollen cloth, the processing of silk did entail a large number of separate stages. Locally, this normally took one of two routes, depending on the state of the raw material. This came either in its basic form of cocoons or as raw silk, several processing steps further on from the cocoon stage. If cocoons were being used, the initial stage was to heat them in boiling water in order to dissolve the gummy substance that held the filaments in place, followed by the twisting together of several threads. This was wound onto reels and was known as raw silk (Encarta 1994. B632).

Much of the silk thrown in the region was received in the form of raw silk, the main sources of supply being China, Persia, India and Italy (Fairbairn, 1865: 212). Irrespective of origin, a number of distinct stages were necessary in order to transform the raw silk into a more manageable form. The initial stage was known as winding, the hank of raw silk being extended on a "swift", giving it a hexagonal form. Subsequent steps cleaned the thread of extraneous matter, twisted it to increase its strength and elasticity, then 'doubled' it, the latter involving the twisting together of several threads.

Following doubling, the silk was thrown. Here, the throwing machine twisted the thread in a process that was similar to spinning; the thread was then wound onto reels of 43-44 inch circumference in order to produce hanks of thrown silk. This was now in a suitable form for dyeing, weaving, etc. (ibid). Depending on the end use, the silk thread carried different degrees of twist or numbers of individual filaments. For instance, organzine was a thread made by giving the raw silk a preliminary twist in one direction, followed by twisting two of these threads together in the opposite direction at the rate of around 10 turns per inch (Encarta 1993. B632). Organzine threads were generally used for the warp threads of materials. From here on, the thrown silk was passed onto other concerns for subsequent dyeing, weaving, etc.

In Gloucestershire, the silk trade was limited largely to the area centred on Blockley and Chipping Camden, much of which formed a detached part of Worcestershire, and a group of mills within a few miles of Stroud and Wotton. In terms of silk throwing, Blockley was the older of the two areas although the Stroud mills were later to eclipse those of Blockley as the industry faded in the latter. Although of local importance, the scale of activities centred around these two locations was but modest compared with the silk industry settled in the mills of East Cheshire. Here, from before the 1780s, seven large powered silk mills were in operation (Calladine & Fricker, 1993: 27) forming some of the earliest powered factories in Britain. All were water-powered and housed silk throwing machinery
During the 1820s, the silk trade had been characterised by severe depressions. Particularly during the period 1825-c1830, the Blockley mills were working at greatly reduced capacity however, the 1840s saw the return of better times. During this relatively brief period the British industry flourished, partially as a result of the political unrest and disturbances occurring in Europe, this helping to disrupt the important French silk trade. During this period, in 1844, the first of the Stroud mills to take up silk throwing came into operation. At Oakridge Lynch, the one mill specifically built as a silk mill was opened by John William Jones; the Jones family were to be very active in the silk trade over the next decade or so. The source of supply of raw silk is not known although the main points of origin at the time included China, Persia, Italy and India; Bengal was specifically mentioned (Fairbairn, 1865: 219). Oakridge Mill was built high up the valley side and only accessible via steep, narrow lanes. With no water power available in the location, it was built to use steam power from the outset, one of the few in the region to do so. A year or so later, Warehouse Mill at Brimscombe was set up by Samuel Hook, about who, little is known. At this time, silk was but a minor player alongside the production of woollen cloth in the region although it did come to form an important employer, at least in a few specific areas.

The period commencing c1850 was set to see a significant expansion in the Stroud silk trade and over the next decade, a number of ventures were set up in woollen cloth mills that were no longer in use. Thus, alongside Oakridge and Warehouse Mills, a further six mills came into the trade during this period. Of particular note was the appearance of William Dangerfield (in partnership with Sydney Foot) who was also busy building up what was to become his huge stick-making business. By 1856, the partnership was involved with ventures at both Gussage and Bourne Mills. In addition, by the same time, members of the silk-throwing Jones family were now also at Spring Mill in Chalford and by 1860, Randalls Mill and Masons Mill, the latter in Painswick. Others also entered the trade, although in some cases their stay was brief. Such was the case with Blower & Smart who, in 1856, started silk throwing at the former woollen Puck Mill. Their stay was soon over, being replaced by John William Jones.

The decade 1860-70 was to be characterised by differing fortunes for as a result of the removal of protective tariffs, the British silk trade entered a severe slump. The impact on the Blockley mills appears to have been significantly greater than in the Stroud region. This may have been at least partially attributable to the latter's later introduction to the trade. Although Blockley had been established somewhat earlier, as a result of the advances made in the technology during the first half of the 19th century, machinery installed in the Stroud mills was likely to have been of greater efficiency and reliability than that in use in Blockley. In Stroud, more redundant woollen mills
continued to be turned over to silk throwing, despite the general uncertainties associated with the trade. In 1863, three new ventures came into being in the shape of Charles Barton at Hope Mills, Richard Barton at Peghouse Mills (doubtless there was a family connection between the two), and W J Jeans at Avening Mill. Two years later, Sevilles Mill at Chalford was being used by Nathaniel Jones to throw silk and in 1867, Belvedere Mill nearby was being similarly used by Charles Hodgson. It appears that the Stroud trade continued to weather the storms in the industry at large and perhaps prospered at Blockley’s expense. The involvement in the trade of both Jeans and Hodgson seems to have been fairly brief and neither was recorded in any further ventures associated with silk throwing. Some rationalisation of the trade began to occur around this period and by c1865, Dangerfield & Foot ceased to use Gussage Mill for silk throwing and it seems that their business at Bourne Mill also came to an end. By 1868, N & J Jones had quit Masons Mill in Painswick.

The start of the 1870s saw a temporary upsurge in the trade which helped to sustain the ailing industry in Blockley, however, this reprieve was short lived and within a few years, a gradual, final decay had set in. By 1876, only three mills remained at work (Marshall, 1979: 13). The last silk mill in Chipping Camden closed in 1880 (Falconer, 1980: 102). Thereafter, the industry in this area faded out of existence, no longer able to compete. There are indications that the trade was perhaps also beginning to falter in the Stroud region although in 1879, John Knight took up the trade at Ashmeads Mill. There were changes afoot and there was a period where throwsters moved repeatedly to different sites and mills changed hands. During this period the long-established throwster Charles de Bary moved successively from Oakridge to Spring and finally to Ashmeads Mill. Similarly, the Jones family seemed to be everywhere although their brief reign had effectively petered out by the late 1860s. New names began to replace those long established in the business and individuals such as William Chapman supplanted the likes of Dangerfield & Foot and the Jones family. Chapman was at Warehouse Mill by c1870, Sevilles Mill by 1873 and finally at Oakridge, shortly before its final demise c1888.

By the 1890s, the trade had contracted to fewer sites. Oakridge Mill had closed and been demolished, the combination of its relative isolation coupled with the need to transport coal for its engine via pack horses and mules doubtless playing a part in its closure. In the same year, Warehouse Mill also closed its doors. It was during this period that the name of Tubbs & Lewis first appears, having briefly taken over Oakridge Mill c1887. Perhaps realising the drawbacks and limitations associated with the site, they continued to concentrate their efforts in three mills in the Kingswood/Wotton area. A large part of their business came to be associated with the manufacture of elasticated fabric at New Mills, their operation being one of the biggest of this type in the country (Industrial Gloucester, 1904: 22-23). New Mills had been used by the silk throwing concern of Philip le Gros (of Jersey) and his partner, Thomas, describing themselves as "crepe manufacturers". Another branch of the family were resident
in Frome where they also ran a crepe making mill. At New Mills, both hand and power loom weaving were used. When the mill was later sold to Samuel Long, the Le Gros company moved operations to Langford Mill nearby (Perry, 1986: 125, 128).

The second of the Tubbs and Lewis mills (Abbey Mills) was turned over to the production of "silk, cotton and flax fishing lines, elastic cords and braids of every description". The third mill which also came into their hands was Langford Mill, and here the company took over from Le Gros, concentrating on silk throwing, transforming "silk from the raw to the finished article" (ibid). Presumably, the company was using imported raw silk as opposed to cocoons; the former had remained the starting point for most of the silk thrown in the region.

It seems that the scale of operation of the 'typical' Gloucestershire silk throwster was relatively modest compared with, for instance, silk throwing being carried on in the mills of East Cheshire; Slates Dane Mill in Congleton was noted as having 2500 swifts and 255 dozen spinning spindles (Calladine & Fricker, 1993: 30). Similarly, when space in a newly-erected silk mill near Congleton was advertised in 1825, it noted that each individual room contained 300 dozen spinning spindles (ibid. 43). Comparison with the capacity of Sevilles Mill at Chalford in 1873, perhaps one of the larger ventures around Stroud, noted that the mill housed 497 assorted swifts and 52 dozen spinning spindles (Tann, 1967: 197). Power was supplied through a combination of a 13 ft diameter water wheel in combination with a steam engine (GRO. D1241). Even the long-established Blockley mills appear to have been of similar capacity. Although little evidence concerning the latter has survived, it is known that when Snugborough Mill was sold in 1879, the inventory included some 344 swifts (Marshall, 1979: 8). This seems to imply a similar size to those businesses around Stroud. Some firms were known to be small operations, such as that housed in the Days Mill site which was apparently restricted to the small former single-storey loom shed. In other words, the Congleton mill had some five times the capacity of the Gloucestershire mills and although it is dangerous to assume that this was always the case, it seems clear that in general, the industry being carried on further north was, like woollen cloth, on a much greater scale than in the West. However, at least one Gloucestershire silk mill employed workers on a scale that was at least approaching some of the Cheshire mills. Le Gros & Thompson operated New Mills with a staff of 51. At its peak, the Washford silk mills at Buglawton in Cheshire, had some 60 workers (Bonson, 1996: 8-18), not a great deal of difference. However, it seems likely with few exceptions, the silk mills operating in the Stroud/Wotton regions were generally rather smaller than their more northern counterparts.

In Gloucestershire, apart from Tubbs & Lewis, few of the silk throwing concerns survived into the 20th century. During the first part of the present century, operations ended at Sevilles and Hope Mills and an unnamed mill near Slad, which tradition suggests was a silk mill, apparently closed c1914.
Survivors included the modest concern that had taken over part of the Days Mill site in Nailsworth and which operated solely with a single water wheel for power up to the time of the Second World War (Mills & Riemer, 1989: 49) and Tubbs & Lewis, who carried on at Langford Mill. In the latter, the situation was somewhat different as silk weaving was also carried on alongside throwing (Perry, 1986: 128). Tubbs and Lewis and Le Gros Thompson appear to have been the only two companies in the region to diversify from merely throwing, to weaving as well.

Although the silk trade in the Stroud and southern Gloucestershire region never existed on a scale approaching that of woollen cloth production, along with the other successor industries, it did provide significant employment in localised areas, with over twenty mills being active in the trade at various times. How did this compare with silk throwing in the rest of the former West of England woollen districts? Mann suggests that in the wake of the woollen industry’s contraction, "silk was everywhere" (Mann, 1987: 209) although this statement does not seem to be confirmed by data generated by Rogers (Rogers, 1976 and 1986) plus examination of individual mill histories, which suggests that far from being everywhere, considering the large geographical area involved, silk throwing was a relatively isolated occurrence.

Silk throwing in the Wiltshire and Somerset regions started somewhat earlier than in Gloucester, most ventures commencing in the period c1815-1830; initial activity in the Stroud region started in the mid 1840s with the majority occurring from c1855 onwards. Like Stroud, most silk throwing came in the wake of the contraction of the woollen cloth market with redundant cloth mills being turned over to silk from as early as the 1820s. Silk’s importance varied from place to place, with only a few centres where production was concentrated. For instance, in Shepton Mallet, silk was an important successor industry for a while, with four former cloth mills being used. In 1833, the Factory Commissioners noted that the only textile-related businesses were now centred on silk throwing, with only Nalder & Hardisty accounting for the bulk of this (Rogers, 1986: 99). The only other important centre for silk appears to have been Devizes where four former woollen mills were in use for throwing by the early 1820s (Mann, 1987: 160). Such concentrations of silk mills were exceptions and by the 1820s, apart from the preceding two centres, only isolated mills were dotted throughout the region. These were at Batheaston, Chippenham, Crockerton, Bradford St. Martin near Salisbury, and Horningsham. Most were in use by the early 1820s, several decades prior to the industry’s takeoff in the Stroud region. Like Stroud, few mills were set up specifically for silk with the exception of odd examples such as the factory at Merchants Barton in Frome; this was in operation as a silk and crepe factory on a comparatively significant scale from c1823 (Rogers, 1986: 99). An earlier attempt to set up a silk mill at Bruton had failed c1812 (ibid. 100).

Overall, considering the number of mills and the large geographical area involved, relatively little
takeup of silk throwing as a replacement for woollen cloth manufacture occurred. There were only a few centres of importance however, like Stroud, these formed important employers for a time. Few seem to have survived into the later part of the 19th century, one of the few exceptions being Cannops Mill at Malmesbury, which worked up to c1939, a date that coincides with the closure of the last silk mill in the Stroud region.

Thus, in neither the Stroud area or the West of England at large, compared with woollen cloth, could silk be viewed as a major industry. However, there was an area of relatively intense activity around the former that effectively reached a peak several decades after that of Wiltshire/Somerset. It may be that this relatively late entry into the trade gave Stroud the advantage of machinery that had been the recipient of 20-30 years further development; this may account partially for the later survival of silk throwing in the Stroud region, although it seems likely that Stroud possessed a further advantage in that the highly industrialised valleys were, by now, well served by a combination of good roads, canals and railways. These ensured the rapid movement of raw materials and finished products between ports and major markets. Many of the former mill sites in Wiltshire and Somerset were considerably farther away from important markets in London, the Midlands, etc.

Silk, in the face of increasing competition from overseas and the appearance of man-made fibres, gravitated predominantly to only a few locations including parts of Yorkshire and Cheshire such as Macclesfield; the latter came to dominate the silk-throwing and hand weaving markets, whereas Congleton became the major centre for silk spinning. Those companies that survived the longest were the ones that had, by the mid 19th century, encompassed both throwing and weaving (Calladine & Fricker, 1993: 14); such was the case in Gloucestershire, where Tubbs & Lewis had done likewise. But even here, it was only a case of time before most businesses succumbed to the inevitable.
<table>
<thead>
<tr>
<th>Site</th>
<th>Date</th>
<th>Occupier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Langford</td>
<td>pre 1872-post 1939</td>
<td>P le Gros Tubbs &amp; Lewis</td>
</tr>
<tr>
<td>New, Kingswood</td>
<td>c1840-post 1872</td>
<td>Le Gros &amp; Thompson Tubbs &amp; Lewis</td>
</tr>
<tr>
<td>Brookhouse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oakridge Lynch</td>
<td>1844-c1890</td>
<td>1856 John William Jones 1863 Charles de Bary c1887 Tubbs &amp; Lewis c1888 ? Chapman</td>
</tr>
<tr>
<td>Hope</td>
<td>1863-post 1919</td>
<td>Charles Barton Charles Barton &amp; Son</td>
</tr>
<tr>
<td>Belvedere</td>
<td>c1867</td>
<td>Charles Hodgson</td>
</tr>
<tr>
<td>Spring, Chalford</td>
<td>1856</td>
<td>1856 Joseph Jones 1860 Francis Jones 1865 Charles de Barry &amp; William Rudulph</td>
</tr>
<tr>
<td>Victoria Silk Mills, Chalford</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woods/Randalls</td>
<td>1860</td>
<td>Nathaniel Jones</td>
</tr>
<tr>
<td>Sevilles</td>
<td>c1865-post 1919</td>
<td>John Sparling 1873 William Chapman</td>
</tr>
<tr>
<td>Ashmeads</td>
<td>1879</td>
<td>John Knight 1896 Charles de Bary</td>
</tr>
<tr>
<td>Puckshole</td>
<td>late C19</td>
<td></td>
</tr>
<tr>
<td>Masons</td>
<td>1860-c1868</td>
<td>N &amp; J Jones</td>
</tr>
<tr>
<td>Peghouse/Woodlands</td>
<td>1863</td>
<td>Richard Barton</td>
</tr>
<tr>
<td>Gussage</td>
<td>1856-post 1867</td>
<td>William Dangerfield &amp; Sidney Foot</td>
</tr>
<tr>
<td>Days</td>
<td>1890s? - c1939</td>
<td></td>
</tr>
<tr>
<td>Warehouse</td>
<td>1845-1890</td>
<td>Samuel Hook 1863 Dangerfield &amp; Foot 1870 William Chapman</td>
</tr>
<tr>
<td>Hallidays/Stoneford</td>
<td>post 1860-post 1882</td>
<td>Cox &amp; Chapman</td>
</tr>
<tr>
<td>Bourne</td>
<td>1856-post 1867</td>
<td>Dangerfield &amp; Foot</td>
</tr>
<tr>
<td>Puck</td>
<td>1856</td>
<td>Blower &amp; Smart 1860 John William Jones</td>
</tr>
<tr>
<td>Avening</td>
<td>1863</td>
<td>W J Jeans</td>
</tr>
<tr>
<td>Park (Inchbrook)</td>
<td>post 1832-c1890s</td>
<td></td>
</tr>
<tr>
<td>Unnamed - below Slad</td>
<td>? - c1914</td>
<td></td>
</tr>
</tbody>
</table>

**Pin Manufacture**

In the realm of successor industries, the appearance of some is easier to explain than others. The introduction of silk throwing into a region so long steeped in textile manufacture is understandable. Likewise, the local availability of cheap beechwood played an important role during the early days of walking stick manufacture. However, in the case of pin manufacture, there is little to explain why the industry came to thrive in several locations in the region, notably Painswick. Admittedly, pin making had been established in the City of Gloucester by the 17th century where it continued to form an important industry, initially predominantly under the control of John Tilsby. At the time, pins were being made from drawn brass and iron wire; Tilsby specialised in the former which were considered to be of better quality. From this time, pin making continued to form an important trade in the City, but suffered a serious blow in c1808, with the bankruptcy of an important maker, Thomas Hayes. Pin making never recovered to its former level however, considerable practical experience had been accumulated in the manufacture of solid-headed pins although this manufacture had remained based largely on hand processes. It was acknowledged that the manufacturing of pins using the techniques then employed resulted in "each pin passing through 25 pairs of hands" (VCH. ii. 207). Essentially, the wire was drawn and pointed in the manufactory, with the heading being carried out in outside workshops or the homes of outworkers.

Pin making in the region later emerged in Stroud. In 1824, Lemuel Wright patented a machine for making solid-headed pins; this was subsequently taken up by Daniel Foot Taylor and installed in Lightpill Mill (part of the mill was used. GJ. 15 Feb 1834) where he attempted to produce pins on a commercial basis. Taylor was later declared bankrupt, his machines being taken over by a Birmingham manufacturer who finally managed to achieve the elusive goal of fully automated production. On subsequently deciding to remove his business back to Birmingham, three of the manufacturer’s apprentices decided to set up their own business and the noted local pin-making firm comprising Albert Perkins, Henry Critchley and Joseph Marmont came into being (SN&J. Critchley Brothers Ltd. Centenary Supplement. 19 May 1983), their initial base of operations being Frogmarsh Mill.

Processes used to manufacture conventional pins and hair pins (the latter, a speciality of the area) clearly differed in detail although in both cases, various mechanical arrangements were developed to carry out the successive stages of production; many of these machines were designed and/or built at the particular mill, taking on special features often designed by the owner himself. In both cases, initially wire of the appropriate gauge was bought in from outside sources; Savorys were the one exception to this, buying in "rough wire" and drawing it down themselves. In general, pin-making machines drew stiff wire from a hank or cylinder and wound it onto a drum. From here it was pulled...
off by a set of powered rollers, being straightened in the process. A pin length of wire was then extended by a set of jaws and the one end struck several times by a header-die, thus forming the head of the pin. This was then cut off and carried along, passing over a set of files or cutters designed to produce the point. Following this, the pins were usually tumbled in sawdust or similar in order to clean them prior to electroplating to give a surface layer of tin (Mills & Riemer, 1989: 18-19).

Production of hair pins (and hooks and eyes) shared a number of similarities in their manufacture in that a length of wire was drawn from the drum and fed into the appropriate machine; this duly cut off the required length of wire which was then bent to shape around mandrels and guides of the appropriate form. The final stage of manufacture usually encompassed some form of japanning or the application of a lacquered finish prior to packing, etc. As noted already, virtually all such machines were custom-made to the specification of the owner, often in the mill's own workshops.

A major competitor to the British pin industry had long been France, however, this was effectively removed during the Franco-Prussian war. In 1870, the Germans destroyed six major French pin factories, allowing the British pin makers to capitalise on this unexpected windfall. The bulk of European pin manufacturing now resided in Britain and Henry Critchley was despatched overseas in order to promote widely the company's products. Exports increased, with a variety of pin variants being sent to European markets and beyond; one early specialist product comprised large blanket pins, destined for Africa.

Pin making came to occupy several locations within the region with Perkins, Critchley & Marmont dominating production nearer to Stroud. In 1883, following the breakup of the partnership two years earlier, the Critchley component of the company set up what was to become a very successful venture trading as Critchley Brothers, at Wimberley Mills. Henry's sons, Uriah and Francis Edward continued to manufacture pins, the mill being equipped with newly developed automatic pin making machines, powered by a 50hp water wheel (ibid). The product range was wide, ranging from large "Kaffir pins" of 4½ inches in length destined for African markets, to "minikin pins" of ~ ¼ inch length (VCH. ii. 207). Over the following decade or so, the mill continued to be modernised and further refinements were carried out to the manufacturing processes. Water power alone was no longer sufficient and a Gloucester-built steam engine was added to supplement the water wheel. Electric light, steam heating,
lifts and "speaking tubes" were installed throughout the mill and the brothers continued to develop the manufactory to the point where it was almost entirely self-sufficient. Departments were created to print the necessary pin sheets, packets and labels, and packaging boxes and crates made on site. The raw material for the pins themselves was bought in in the form of rough wire, however every subsequent stage of manufacture was carried on within the manufactory.

Virtually all of the successful pin makes in the region depended heavily on machinery invented and/or developed by themselves; this was also the case here, as Francis Critchley was noted as having "designed and built most of the machines and appliances" needed (Industrial Gloucester, 1904: 20). Such was the extent of the company's success that c1900, the mill's manufacturing capacity was doubled and large stocks of products held at centres in London, Manchester, Glasgow, Belfast, Dublin, Amsterdam, Copenhagen and Melbourne. Each week, the company produced around 15 tons of pins and hair pins, the latter having been added to the range in 1900 (SN&J. Centenary supplement).

Wimberley Mill continued to expand and by the 1930s, water power had finally been ousted by steam. On the mill's ground floor, 30 hair pin machines were in operation driven by overhead line shafting; the first floor had over 60 pin machines, plus 10 hair grip machines, and the upper floor contained the work's printing department, the company still continuing to produce all of its own packaging material.

The other major centre for pin manufacture was Painswick, pin making having been introduced into the parish in 1796 as a means of providing employment to the poor in the workhouse (Vestry Min. Bk. 1784-1800. 79). At this time, this would have been reliant on hand processes, such as those used in Gloucester. Remarkably, around the same period that Perkins, Critchley & Marmont were starting out, no less than three separate pin manufactories were also being set up in and around Painswick, each settled in a former woollen cloth mill. Industrial Gloucester noted that:

"It may not be generally known, and it would scarcely be suspected, that in the village of Painswick...are manufactured more hair pins than in any other one place in the world. Three large factories employing almost as many hundred hands and equipped with hundreds of automatic machines turning out the product with marvellous rapidity are in constant operation, daily transforming miles of wire into tons of finely finished pins" (Industrial Gloucester, 1904: 19).

At Cap Mill, Peter Watkins began producing hair pins and Trotman Brothers did similarly at Masons Mill. Downstream, Buck & Holman also began making pins at Rock Mill. Although pin making had earlier been carried out in the Parish Workhouse, precisely why no less than four separate concerns should be established within a 1-2 year period remains a mystery, although in the case of Peter Watkins, there is tentative evidence to link him with the earlier pin making concern at Lightpil Mill.
during the first half of the 1840s, an enterprise that also spawned Perkins, Critchley & Marmont. Watkins is known to have worked in the trade in Birmingham and Stroud, the Lightpill venture being the only known one in the area at this date. In 1853, Watkins formed a partnership with Mr Okey, their business occupying Cap Mill. Watkins & Okey were later credited with being "one of the oldest hair pin manufacturers in England" and that:

"...the rapid and economical manufacture of hair pins by machinery was probably due as more to Mr Peter Watkins as to any one man in England" (ibid. 18).

Like the other local pin makers, Watkins designed and built much of the specialised machinery needed. The theme of inventiveness and self-sufficiency was a continuing one throughout the period of pin manufacture in the region. The success of the company through his efforts cannot be doubted and in 1860, expansion meant that Kings Mill nearby was taken over. The partnership was subsequently dissolved and Watkins carried on alone until his death in 1901, being succeeded in the business by his sons George Price Watkins and C J Watkins. At this time, the works still relied on water power, George continuing to design and refine the manufacturing machinery required for the production of a range of hairpins, some of "exclusive design". At Rock Mill, the pin-making venture appears to have been comparatively short-lived. Initially set up by Buck & Holmes, in 1856, the Stroudwater Pin Co. was recorded as being in residence. Production ceased in 1859 although a company of the same name later took over Howards Upper Mill in Dursley.

Meanwhile, the enterprise of the Trotman Brothers at Masons Mill was being taken over by W H Cole & Co. although interestingly, for a brief period it apparently became Trotman & Cole, before reputedly being taken over by E & E W Reed. Like the other pin makers in the vicinity, W H Cole & Co. was characterised by production processes that were constantly being improved and updated, machinery being both designed and built on site; doubtless competition ensured that this continued to be on-going situation. In this case, power came from a water wheel, supplemented by a steam engine. At the company's peak, around 100 automatic pin making machines were in constant use, each producing over 70 hair pins each minute. Similarly, hooks and eyed were also being made at the rate of 120 minute. Alongside these two lines, safety pins were also in production, Cole's being the only factory in the district to do so (ibid. 1904. 18). Finished goods were either electroplated or enamelled. Like several other manufacturers, Cole's were proud of their exclusive patented designs. The company eventually moved to the Zona Works in Cheltenham where they continued to manufacture hooks and eyes for a time (Kellys Dir. Glos. 1939: 515).

The mid 1870s saw the start of an association between the pin-making Savory family and Painswick that was last for almost exactly a century. Around 1876, Harry and William Savory set up their pin
making enterprise in the former woollen Brookhouse Mill. Under the control of various family members and their senior employees, the company continued to produce hair pins up to 1982. The company apparently chose its employees carefully and in 1904 it was noted that the Managing Director was Mr M O Phipps, a man who had been involved in the trade for the past 24 years. Like their immediate competitors, Savory's manufactory and machines were constantly improved and upgraded. The mill was heated with steam, lit with gas lighting and had been equipped with lifts. The machinery therein was considered to be fully automatic and to require little attention when in operation. The workforce was carefully segregated, with women used exclusively for sorting, counting, weighing, wrapping and labelling, all considered to be "clean" duties. The works was almost fully self-sufficient, even to the extent of drawing their own wire, one of the few in England to do so. Like some of the competition, Savory's printed all of their own packaging and made their japan and cardboard boxes and crates on site. The range of hair pins produced in the idyllically situated factory was wide, with stocks being held in London depots and other agencies throughout the country; from these, much went to export. In 1910, the company took over the pin-making concern of G P & C J Watkins at Kings Mill. Kings Mill was still reliant on an overshot water wheel for its power. Remarkably, up to 1962, the main manufacturing site of Brookhouse Mill relied on the combination of an ancient gas engine and a single water wheel for its power. As a result of the gradual silting up of the mill pond, the wheel had been used on a half time basis with the engine. Ironically, it was the eventual demise of the latter that was to see the introduction of electrical power. The company eventually succumbed in 1982; it had been the last and longest-lived of the Painswick pin makers. In 1928, Hyett noted that Brookhouse Mill was "...the only pin-mill left in Painswick" (Hyett, 1928: 108), their competition having closed down some years earlier.

Elsewhere within the region, pin making had been carried on with varying degrees of success. There is anecdotal evidence to suggest that both Pitts and Freames Mills at Inchbrook may have been associated with the trade and Howards Upper Mill at Dursley certainly saw nearly two decades of this type of manufacture. In addition, Tubbs & Lewis's New Mills at Kingswood was being similarly used, manufacture carrying on in the basement section of the mill, elastic fabric being manufactured in the upper storeys. Tubbs & Lewis gathered together a variety of trades, buying up the old established pin-making firm of Perkins & Marmont of Frogmarsh Mill and establishing it in one of the existing buildings forming the Charfield Mill site, a few miles from New Mills (Perry, 1986: 128).
Table 30

**Pin Manufacture**

<table>
<thead>
<tr>
<th>Site</th>
<th>Dates</th>
<th>Occupier</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brookhouse</td>
<td>■ c1876 ■ 1879 ■ 1889 ■ ?-1982</td>
<td>■ Harry &amp; William Savory ■ H B Savory ■ Frank Savory ■ Savory &amp; Sons</td>
<td>Hair pins</td>
</tr>
<tr>
<td>Cap</td>
<td>■ c1851 ■ 1853-c1867</td>
<td>■ Peter Watkins ■ Watkins &amp; Okey</td>
<td>Hair pins</td>
</tr>
<tr>
<td>Masons</td>
<td>■ c1850 ■ ?-c1869 ■ 1870-post 1904 ■ ?-1920</td>
<td>■ Trotman Bros ■ W H Cole &amp; Co ■ Trotman &amp; Cole ■ E &amp; EW Reed</td>
<td>Hair pins ■ Safety pins</td>
</tr>
<tr>
<td>Pitchcombe Upper</td>
<td>■ c1851-2</td>
<td>Thomas Trotman</td>
<td>Hooks &amp; eyes</td>
</tr>
<tr>
<td>Rock</td>
<td>■ c1850 ■ 1856-1859</td>
<td>■ Buck &amp; Holmes/Peter Watkins ■ Stroudwater Pin Co.</td>
<td>Pins</td>
</tr>
<tr>
<td>Wimberley</td>
<td>1883-post 1935</td>
<td>Critchley Brothers</td>
<td>Pins ■ Hair pins</td>
</tr>
<tr>
<td>Frogmarsh</td>
<td>■ c1851 ■ c1881-1934</td>
<td>■ Perkins, Critchley &amp; Marmont ■ Perkins &amp; Marmont</td>
<td>Pins</td>
</tr>
<tr>
<td>Lightpill</td>
<td>■ 1834-? ■ c1842-1843 ■ 1843-1846</td>
<td>■ Daniel Foot Taylor ■ ? ■ ?</td>
<td>Pins</td>
</tr>
<tr>
<td>New, Kingswood</td>
<td></td>
<td>Tubbs &amp; Lewis</td>
<td>Pins</td>
</tr>
<tr>
<td>Howards Upper (Dursley)</td>
<td>1870-c1898</td>
<td>Stroudwater Pin Company</td>
<td>Pins</td>
</tr>
<tr>
<td>Charfield</td>
<td></td>
<td>Tubbs &amp; Lewis</td>
<td>Pins</td>
</tr>
</tbody>
</table>


Pins were also manufactured by several other manufacturers not necessarily located in former cloth mills. These included Charles Lambert & Sons of Kingswood (pre 1889-post 1935) and H R Heaven of Brimscombe (?-post 1935).
Fibre board, Millboard and Leatherboard

Although production was centred at only a handful of sites, this family of materials was manufactured for extended periods and on a large scale at both Meadow Mill in Eastington and Nailsworth Mill, both redundant cloth mills. There were a number of variants produced, most produced using waste materials, different manufacturers frequently calling what was virtually the same material by alternative names.

Generally speaking, "Millboard" was a type of stout board, made from a pulp of old rope, sacking, and other coarse material, that had been mixed, mashed and rolled out into sheets under high pressure. "Pasteboard" was made by laminating thin sheets of millboard together, the finished article being particularly favoured by bookbinders and as artist's backing material. "Leatherboard" was yet another variant, produced in a similar fashion, using a pulp of paper, rags, string, old newsprint, and in this case, scraps of leather. Leatherboard was used widely by the shoe trade, being pressed into service for internal shoe parts such as stiffeners. For a time, there were a whole host of variants on the theme: engine boards, suitcase boards, embossed boards, portmanteau boards, etc. each reflecting a specific use for this versatile range of materials.

In the case of Meadow Mill, power was (partially) supplied by a pair of water turbines, these providing enough power to drive the three or four pulp beaters installed in a brick-built building at the front of the main mill referred to as the "Pot House". In here, the pulpers mixed up the constituents for the various boards produced. In later years, power was supplemented by a Robey steam engine that could be coupled up to the turbine drive when necessary. A pulper supplied by Emell Hassberg of Berlin, was also installed for newspaper pulping; this used a worm drive and operated almost soundlessly (Pers. Comm. Mr F J Ireland).

The boards produced were pressed to the required thickness courtesy of an hydraulic press, following which they were passed through rollers which created the required surface effect. Where appropriate, a painted finish was applied using rubber rollers. Finally, the painted boards were dried in a long tunnel oven or a large rotary drier, this replacing the traditional and time-consuming method of hanging up the sheets in a steam-heated room and allowing them to dry naturally. The top floor of one block formerly housing hand looms was used for board "seasoning". Finished sheets were cut to size using a powerful guillotine.

Meadow Mill's fibreboard was used heavily by the boot and shoe trade, in the form of insoles and heel stiffeners, although a further speciality also developed as the mill became a major supplier of large sheets of fibreboard destined for suitcase manufacture. Suitcase manufacturers became a major
customer, taking a variety of types of board with either textured, embossed surfaces, or with painted finishes. These were usually red, black or brown (self-coloured) although the firm also prepared some of their own surface coatings using pure Shellac in order to give a high gloss finish. A range of products evolved, including a pig-skin embossed finish plus a variety of painted finishes including "London Tan", the latter chiefly supplied to Cohen & Co. In addition, sheets were supplied to the car trade, for use as internal panels by companies including the Standard Car Company and Vauxhall.

A further outlet for the mill’s fibreboard developed with the increasing popularity of the radio, as a specialist niche was found in supplying radio backs to most of the major manufacturers including Pye, Murphy, Halcyon, Graves, Vulcan, Cassor and Echo. The backs were stamped using a variety of specialised presses supplied by Taylor & Challenor and H O Strong of Bristol. These punched out the required shape and number and pattern of ventilation holes.

For many years, leatherboard production formed the major output of the mill; throughout the 1920s and 30s, trade directories refer specifically to the manufacture of this. However, by 1939, the Ruberoid Company were in residence, emphasis now shifting to fibreboard. Ruberoid’s occupation of Meadow Mill was a wartime evacuation, ensuring that all of their production was no longer centred on Enfield, an area at greater risk from bombing. The company carried on making fibreboard for a time and also manufactured roofing felt, damp proof courses and electrical insulation, most aimed at the construction industry.

The other local manufacturer consisted of the company set up in Nailsworth in 1879 by Mr E A Chamberlain, output concentrating initially on the production of leatherboard (Kellys Dir. Glos. 1885: 531). Chamberlain as "sole representative of the British Board Mills" acquired the site from the defunct cloth manufacturing concern of Flint & Sons (SdJ. 12 January 1878), once an important local employer. The company prospered and expanded but suffered a serious setback when the old mill was destroyed by fire in 1901. However, production was resumed in replacement buildings although some sections of the original mill that escaped the fire were incorporated into the new works; these also survived later alterations to the site. The Chamberlain family continued to control the business, production gradually diversifying to include the manufacture of interior shoe parts (such as insole reinforceers made of leatherboard), plus the production of cardboard and latterly, fibreboard. By the close of the 1930s, alongside the manufacture fibreboard and fibreboard components, leathercloth was also being made (Kellys. Dir. Glos. 1939: 522). Fibreboard output came to dominate the company’s output in the latter part of its life, with sheet materials being supplied to a range of industries including the electrical, trade goods and footwear industries. In addition, a range of moulded panels was produced for suitcase manufacture and as interior panelling for the motor trade; markets for both were international (Hadfield, 1973: 134). These remained major products up to the company’s demise in
the 1970s. By this time, the mill was rated as the second largest in Europe turning out such products.

In the case of Meadow Mill, the gradual decay and erosion of its traditional markets was as a direct result of competition from newer materials characterised by improved properties and/or manufacturing processes. Stamped shoe parts gave way to injection moulded artifacts made of thermoplastics. Likewise, the market for radio backs diminished as radios themselves changed in design. Chamberlains survived longer, presumably by adapting more quickly to changing market requirements, however, even they eventually succumbed in the face of increased in-house manufacturing by the motor industry. The only other mill site to have been involved in this type of manufacture was Millbottom Mill near Nailsworth. Here, stamping of fibreboard components was carried out for a time, possibly associated with Chamberlains’ operations nearby.
Miscellaneous Reuse

Corn Milling

Another function that was always, in a variety of ways, carried on alongside cloth manufacture, was that of corn milling. For obvious reasons, this was to be found along all of the major streams of the region and throughout all periods. During the early period of development of the cloth industry in the Stroud region, it was not uncommon for both milling and fulling to be housed under one roof and examples of this arrangement once abounded. For example, by the 1440s, Churchend Mill in Eastington consisted of both corn and fulling mills and remained as such up to the close of the 18th century. Such dual function was found on all the major water courses and survived throughout the centuries; mills included Halmore (by the 1560s), Kings (c1580s), Stratford (by 1607), Ithells (by 1616), Churches (by 1637), Painswick (by 1738), Sury (by 1741), and Cam. In the 1770s, the latter was described as:

"...two water grist mills together with one fulling or stock under one roof" (Tann, 1967: 119).

Various combinations of corn and fulling mills were to be found. During the 17th century, Woodchester Mill consisted of:

"...two fulling mills and a grain mill under one roof“ (Inq.p.m.Glos. 1625-42. ii. 126-7).

Around the same period, Mundays Mills consisted of:

"...an ancient messuage with divers lands and a fulling mill and grist mill under one roof“ (Berkeley MSS. III. 267; Cited by Tann, 1967: 110).

These examples were just a handful of those mills in which both corn and fulling functions coexisted at different times. However, as woollen cloth came to predominate the working lives of the local populous, it became increasingly common for attention to become more focused on fulling cloth and for corn milling activities to be dropped. However, it clearly remained appropriate for at least some mills to be retained in the latter form although closer examination of individual mill histories often reveals few corn mills that have not, at some point, been associated in some way with cloth manufacture. For instance, of the numerous Uley mills, only one (Owlpen Mill) was never linked to the cloth trade. Similarly, along the entire length of the Painswick Stream, possibly only Suttons and Skinners Mills were worked solely as corn mills, virtually all of their peers being associated with a period of cloth manufacture.
Ironically, as the cloth trade began to diminish, throughout the 19th century it became increasingly common for mills that had been converted from corn milling to fulling, to be reconverted to the former. Instances of this occur throughout the region, in fact, some mills being re-equipped as corn mills as early as the latter part of the 18th century; Friggs Mill near Lightpill, formerly in use as a fulling mill, once again became a corn mill c1790, spending the remainder of its working life in this trade.

It was not uncommon for some of the more remote village-based corn mills to be associated with baking, the baker milling only sufficient corn to meet his own needs, whilst operating as perhaps the sole village bakery. Many were small concerns only intended to meet purely local needs. Such as the case with Pitchcombe Upper Mill which was described as a "...former clothing mill now used for years as a water power corn mill and bakery" (GJ. 15 January 1853).

This mill was but one of many along the Painswick Stream to be turned over to corn milling in the wake of woollen cloth’s demise. It is difficult to ascertain how successful individual ventures were especially as from the first quarter of the 19th century, the country miller was finding it increasingly difficult to compete with his urban-based peers; the period of operation of corn mills along the Painswick Stream covers much of the century. Closure dates are often impossible to define with any degree of accuracy as many of the smaller mills tended to wane gradually, ending their working days being operated on a part-time basis or perhaps in association with a farm, sometimes producing flour solely for the farmer and/or grinding animal feed. In chronological order, former cloth mills turned over to corn milling included the following:

**Table 31 - Corn Mills along the Painswick Stream**

<table>
<thead>
<tr>
<th>Mill</th>
<th>Date of Commencement of Corn Milling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tocknells</td>
<td>by 1786</td>
</tr>
<tr>
<td>Stratford</td>
<td>c1800</td>
</tr>
<tr>
<td>Salmons</td>
<td>1820</td>
</tr>
<tr>
<td>Grove</td>
<td>post 1826</td>
</tr>
<tr>
<td>Pitchcombe Upper</td>
<td>1838</td>
</tr>
<tr>
<td>Lovedays</td>
<td>post 1840</td>
</tr>
<tr>
<td>Brookhouse</td>
<td>1853</td>
</tr>
<tr>
<td>Damsells</td>
<td>c1854</td>
</tr>
<tr>
<td>Olivers</td>
<td>post 1880</td>
</tr>
<tr>
<td>Rock</td>
<td>c1900</td>
</tr>
</tbody>
</table>
Geographically, corn milling was to be found throughout the length of the Painswick Stream, from Tocknells near its source, to Stratford Mills close to its confluence with the Frome. Some such as Pitchcombe Upper Mill, were apparently short-lived whereas others such as Lovedays Mill, survived for much longer (up to c.1914). Most corn mills in the area eventually succumbed to competition from the large steam-powered mills set up in and around Gloucester Docks and from several corn milling companies near to Stroud itself. Of these, John Biddle’s company was probably the largest, at times operating from Oil, Cuttles and Stratford Mills, the latter on the lower stretch of the Painswick Stream. Such was Biddle’s capacity that he maintained his own warehouse in Gloucester Docks.

It was not only the Painswick Stream that came to power redundant cloth mills turned over to corn milling, not surprisingly, throughout the region the situation was repeated many times. Along the River Cam, particularly in the Dursley/Cam area, a number of substantial corn mills were set up notably Townsends, Upper and Middle Cam, and Draycott Mills. Similarly, corn mills were in operation at different points in the post-woollen phase along all of the major water courses including the Avening and Nailsworth Streams, and the Horsley and Slad Brooks. In the Wotton/Kingswood area, several former cloth mills joined the ranks, including mills in Alderley and Kingswood itself. Along the entire length of the Frome, redundant mills converted or reconverted to corn mills were to be found. For example, high up the Frome was Twissells Mills whilst along the lower reaches approaching the Vale, were Millend and Fromebridge Mills. Millend Mill in particular, was of relatively large capacity for a "country" mill. Initially converted c.1876, the sales particulars of 1887 noted:

"...two powerful wheels each driving four pairs of mill stones in metal with bevel gears, elevators, & c...the stone floor fitted with seven pairs of first class French mill stones". (GRO. D1388 Sl/25. 1869 and D2500. Sales particulars. 1887).

Following this period of corn milling, c.1895 Millend was converted to a maltings however c.1927, it was once again converted to milling, this time being equipped with more modern roller mills. However, like all of its peers, it ultimately closed, unable to compete with the steam-powered Gloucester Docks mills. Here, grain was barged in from Avonmouth in huge quantities and unloaded directly into the mills, thus transport and handling costs were greatly minimised. By 1939, throughout the entire Stroud region, only eleven corn mills were still in operation (Kellys Dir. Glos. 1939: 530) although with the advent of World War II, a few that would have otherwise closed, received an artificially extended life. By the 1950s, most had gone with a few such as Fromebridge and Oil Mills being turned over to animal feed production. This sustained their working lives up to c.1990 and 1993 respectively, the former still relying on a single water turbine for its power.
As with woollen cloth production, corn milling activities in the region gradually contracted to a handful of centralised highly mechanised sites, as outlying mills succumbed one by one. In many of the region’s mills this was yet another step in the chain as a further use replaced an earlier one. However, this was not always the case and some mills such as Damsells and Lovedays failed to find another commercial use and were converted to by now, highly desirable dwellings.

Clearly, in some areas, corn milling had a long-running career. For instance, many of the mills along the Painswick Stream saw periods of use for corn milling and there were an important clutch of corn mills in the Cam area. There is little evidence to suggest that such intensity was linked with population growth in these areas and it might be expected that the majority of corn milling activities would be in and around the town of Stroud itself. However, only a relatively small number of these mills were turned over to milling. As the hub of local industries, redundant mills close to Stroud itself doubtless attracted a high degree of reuse for other industrial and commercial uses, thus were rarely available for conversion to corn mills. In contrast, the high incidence of such conversions with mills along the Painswick Stream was due largely to their early exit from the woollen trade. As most were small and relatively remote from the bustling commercial life closer to Stroud, they may not have been so attractive for industrial reuse. There was no canal or rail link close at hand to ease transport problems.

The Cam mills were closer to centres of population although their rise in importance was not linked to increasing population in the area. Indeed, as the woollen trade declined, although Cam and its near neighbour Dursley, saw a number of successor industries move in, there was no dramatic increase in population, more likely the reverse was true. What the Cam mills had that the Painswick mills lacked was a railway, linking them directly to the main Bristol-Gloucester line a few miles away. Thus, these particular mills were able to adopt steam power and develop considerably in size, no longer being reliant solely on local markets. Hence, the situation between the two areas was entirely different, several of the Cam mills prospering until recent years.

Like the Painswick mills, corn milling conversions in other parts of the region were often small-scale and catered specifically for localised markets. However, as competition from urban steam powered mills ate away at their markets, most simply faded away, a symptom of the changing face of the industry. Overall, many of the conversions carried out during the 19th century were either small-scale or short-lived and merely reflected a time when it was possible for a small mill to survive supplying the population in the vicinity. Thus, for a time, small-scale corn milling represented an acceptable fallback position should a cloth mill close. Running costs could be moderate and the mill could be operated by only a few men. As the impact of urban millers increased, this situation became untenable, the result being the gradual, and often final, closure of the mill.
Table 32
Cloth Mills Turned Over to Corn Milling

<table>
<thead>
<tr>
<th>Mill</th>
<th>Stream</th>
<th>Dates</th>
<th>Mill</th>
<th>Stream</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cuttles</td>
<td>Frome</td>
<td>c1850 - c1870</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Twissells</td>
<td>Frome</td>
<td>1856-post 1882</td>
<td>Tocknells</td>
<td>Painswick Stream</td>
<td>by 1786-post 1853</td>
</tr>
<tr>
<td>Belvedere</td>
<td>Frome</td>
<td>c1850-c1914</td>
<td>Olivers</td>
<td>Painswick Stream</td>
<td>by 1880s</td>
</tr>
<tr>
<td>Dark</td>
<td>Frome</td>
<td>1784-</td>
<td>Damsells</td>
<td>Painswick Stream</td>
<td>c1854-</td>
</tr>
<tr>
<td>Oil</td>
<td>Frome</td>
<td>1840-</td>
<td>Painswick</td>
<td>Painswick Stream</td>
<td>by 1867-</td>
</tr>
<tr>
<td>Ryeford</td>
<td>Frome</td>
<td>c1853-</td>
<td>Lovedays</td>
<td>Painswick Stream</td>
<td>post 1840-c1914</td>
</tr>
<tr>
<td>Millend</td>
<td>Frome</td>
<td>c1876-c1950</td>
<td>Brookhouse</td>
<td>Painswick Stream</td>
<td>1853-post 1867</td>
</tr>
<tr>
<td>Fromebridge</td>
<td>Frome</td>
<td>1850s-1950s</td>
<td>Pitchcombe Upper</td>
<td>Painswick Stream</td>
<td>1838-1846</td>
</tr>
<tr>
<td>Cricketty</td>
<td>Toadsmoor trib.</td>
<td>? - c1826</td>
<td>Rock</td>
<td>Painswick Stream</td>
<td>c1900-</td>
</tr>
<tr>
<td>Dursley</td>
<td>Ewelme/Cam</td>
<td>c1809-</td>
<td>Grove</td>
<td>Painswick Stream</td>
<td>post 1826-post 1918</td>
</tr>
<tr>
<td>Townsend</td>
<td>Cam</td>
<td></td>
<td>Salmons</td>
<td>Painswick Stream</td>
<td>1820-</td>
</tr>
<tr>
<td>Upper Cam</td>
<td>Cam</td>
<td>c1840-post 1867</td>
<td>Stratford</td>
<td>Painswick Stream</td>
<td>c1800-post 1867</td>
</tr>
<tr>
<td>Draycott</td>
<td>Cam</td>
<td>c1801-post 1867</td>
<td>Little</td>
<td>Washbrook</td>
<td>c1880-1890s?</td>
</tr>
<tr>
<td>Halmore</td>
<td>Cam</td>
<td>?- post 1867</td>
<td>Washbrook</td>
<td>Washbrook</td>
<td>pre 1867-c1900</td>
</tr>
<tr>
<td>Avening</td>
<td>Avening Stream</td>
<td>post 1840-</td>
<td>Badbrook</td>
<td>Slad Brook</td>
<td>1856-</td>
</tr>
<tr>
<td>Egypt</td>
<td>Nailsworth Stream</td>
<td>1890s-</td>
<td>Wades</td>
<td>Slad Brook</td>
<td>1820-c1900</td>
</tr>
<tr>
<td>Friggs</td>
<td>Nailsworth Stream</td>
<td>c1790-</td>
<td>Little</td>
<td>Slad Brook</td>
<td>pre 1867-</td>
</tr>
<tr>
<td>Millbottom</td>
<td>Horsley Brook</td>
<td>1880s</td>
<td>Alderley New</td>
<td></td>
<td>pre 1867-</td>
</tr>
<tr>
<td>Locks</td>
<td>Horsley Brook</td>
<td>? - post 1882</td>
<td>Walk</td>
<td></td>
<td>pre 1889-</td>
</tr>
<tr>
<td>Days</td>
<td>Horsley Brook</td>
<td>1890s</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 33
Assorted Miscellaneous Reuse
(excludes corn milling, pin manufacture, stick making and silk throwing)

<table>
<thead>
<tr>
<th>Site</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbey</td>
<td>Dye works</td>
</tr>
<tr>
<td>Arundells</td>
<td>Dye works. Artificial manure</td>
</tr>
<tr>
<td>Badbrook</td>
<td>Saw mill</td>
</tr>
<tr>
<td>Beards</td>
<td>Dye works</td>
</tr>
<tr>
<td>Belvedere</td>
<td>Hampton car bodies</td>
</tr>
<tr>
<td>Bowbridge</td>
<td>Dye works</td>
</tr>
<tr>
<td>Bonds</td>
<td>Engineering. Electronics manufacture</td>
</tr>
<tr>
<td>Boulton, Dursley</td>
<td>Carpets</td>
</tr>
<tr>
<td>Bourne</td>
<td>Cabinet works</td>
</tr>
<tr>
<td>Bridgend</td>
<td>Dye works</td>
</tr>
<tr>
<td>Britannia</td>
<td>Postcard printing</td>
</tr>
<tr>
<td>Brimscombe Upper/Lower</td>
<td>Worsted spinning. Electroplating. Foundry. Knitting needles</td>
</tr>
<tr>
<td>Cam Middle</td>
<td>Manure works</td>
</tr>
<tr>
<td>Cambridge</td>
<td>Wire works. Saw mill</td>
</tr>
<tr>
<td>Cap</td>
<td>Hook &amp; eye manufacture. Saw mill. Wood turning</td>
</tr>
<tr>
<td>Clayfields</td>
<td>Saw mill</td>
</tr>
<tr>
<td>Churches</td>
<td>Brush manufacture. Wood turning</td>
</tr>
<tr>
<td>Cricketty</td>
<td>Brewing/malting</td>
</tr>
<tr>
<td>Coaley</td>
<td>Iron works. Edge tools</td>
</tr>
<tr>
<td>Dark</td>
<td>Gun felt. Shear grinding. Knitting needles. Bone turning</td>
</tr>
<tr>
<td>Daunceys</td>
<td>Saw mill</td>
</tr>
<tr>
<td>Doreys</td>
<td>Wood turning</td>
</tr>
<tr>
<td>Dudbridge</td>
<td>Dye works. Engineering.</td>
</tr>
<tr>
<td>Dunkirk</td>
<td>Hosiery knitting. Engineering.</td>
</tr>
<tr>
<td>Egypt</td>
<td>Dye manufacture</td>
</tr>
<tr>
<td>Freames</td>
<td>Chemicals</td>
</tr>
<tr>
<td>Frogmarsh</td>
<td>Tanning. Soft drink manufacture</td>
</tr>
<tr>
<td>Fromebridge</td>
<td>Brass and iron works. Wire works</td>
</tr>
<tr>
<td>Gig</td>
<td>Engineering</td>
</tr>
<tr>
<td>Griffins</td>
<td>Saw mill</td>
</tr>
<tr>
<td>Grove</td>
<td>Maltings</td>
</tr>
<tr>
<td>Gussage</td>
<td>Wood turning</td>
</tr>
<tr>
<td>Location</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hack, Wotton</td>
<td>Paper mill. Corn and oil cake</td>
</tr>
<tr>
<td>Hallidays</td>
<td>Cabinet works</td>
</tr>
<tr>
<td>Ham</td>
<td>Carpet manufacture. Spinning</td>
</tr>
<tr>
<td>Hawkers</td>
<td>Dye works</td>
</tr>
<tr>
<td>Hazel</td>
<td>Dye manufacture</td>
</tr>
<tr>
<td>Howards</td>
<td>Saw mill. Engineering</td>
</tr>
<tr>
<td>Huntingford</td>
<td>Water pumping. Electricity generation</td>
</tr>
<tr>
<td>Iles</td>
<td>Bone turning</td>
</tr>
<tr>
<td>Iron</td>
<td>Saw mill</td>
</tr>
<tr>
<td>Lightpill</td>
<td>Dye works. Printing. Casein and plastics manufacture</td>
</tr>
<tr>
<td>Little (Stroud)</td>
<td>Saw mill</td>
</tr>
<tr>
<td>Lot</td>
<td>Engineering</td>
</tr>
<tr>
<td>Marsh</td>
<td>Saw mill</td>
</tr>
<tr>
<td>Meadow</td>
<td>Leatherboard and fibreboard</td>
</tr>
<tr>
<td>Middle (Cam)</td>
<td>Iron founding. Manure works. Fibreboard</td>
</tr>
<tr>
<td>Millbottom</td>
<td>Leather stiffening. Brass working. Ink and dye manufacture</td>
</tr>
<tr>
<td>Nailsworth</td>
<td>Leatherboard. Fibreboard</td>
</tr>
<tr>
<td>New (Kingswood)</td>
<td>Elasticated fabric. Electronics manufacture</td>
</tr>
<tr>
<td>New (Stroud)</td>
<td>Laundry</td>
</tr>
<tr>
<td>Olivers</td>
<td>Farm</td>
</tr>
<tr>
<td>Painswick</td>
<td>Hook &amp; eye manufacture</td>
</tr>
<tr>
<td>Pitchcombe</td>
<td>Naphtha and vitriol manufacture. Artificial manure. Saw mill</td>
</tr>
<tr>
<td>Pitchcombe Upper</td>
<td>Malting. Hook &amp; eye manufacture. Saw mill</td>
</tr>
<tr>
<td>Port</td>
<td>Engineering</td>
</tr>
<tr>
<td>Pitts</td>
<td>Chemical manufacture</td>
</tr>
<tr>
<td>Rivers</td>
<td>Wire and wire cards. Engineering. Electrical components</td>
</tr>
<tr>
<td>Rock</td>
<td>Dye manufacture</td>
</tr>
<tr>
<td>Rockstowes</td>
<td>Dairy equipment manufacture. Felted materials</td>
</tr>
<tr>
<td>Ryeford</td>
<td>Saw mill</td>
</tr>
<tr>
<td>Salmons</td>
<td>Maltings</td>
</tr>
<tr>
<td>Sevilles</td>
<td>Wood and bone turning</td>
</tr>
<tr>
<td>Sheppards</td>
<td>Iron works. Saw mill</td>
</tr>
<tr>
<td>Smalls, Painswick</td>
<td>Saw mill. Wood turning</td>
</tr>
<tr>
<td>Staffords</td>
<td>Paints and chemical manufacture</td>
</tr>
<tr>
<td>Steanbridge</td>
<td>Saw mill</td>
</tr>
<tr>
<td>Location</td>
<td>Industry</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Stonehouse Lower</td>
<td>Paper bag manufacture</td>
</tr>
<tr>
<td>Stonehouse Upper</td>
<td>Brush manufacture</td>
</tr>
<tr>
<td>Stoneford</td>
<td>Cabinet works</td>
</tr>
<tr>
<td>Stranges, Wotton</td>
<td>Dye works</td>
</tr>
<tr>
<td>Stratford</td>
<td>Manure works</td>
</tr>
<tr>
<td>Tayloes</td>
<td>Upholstery works. Electronics manufacture</td>
</tr>
<tr>
<td>Thrupp</td>
<td>Iron works. Engineering</td>
</tr>
<tr>
<td>Upper (Dursley)</td>
<td>Bicycle manufacture</td>
</tr>
<tr>
<td>Upper Doreys</td>
<td>Cabinet works</td>
</tr>
<tr>
<td>Valley</td>
<td>Saw mill</td>
</tr>
<tr>
<td>Vatch</td>
<td>Paper</td>
</tr>
<tr>
<td>Woodchester</td>
<td>Piano manufacture</td>
</tr>
<tr>
<td>Woodland</td>
<td>Rope and twine manufacture</td>
</tr>
<tr>
<td>Wymberley</td>
<td>Dye works</td>
</tr>
</tbody>
</table>

As will be clear from the above Tables, alongside the incidences of "speciality" reuse such as walking stick and pin manufacture, a wide variety of other trades and industries came to inhabit the region's redundant cloth mills. No longer was the area reliant solely on a single trade, its industrial base now encompassing many commercial activities, some of which had their origins in the cloth trade and others that did not. The local economy was now reliant on a multitude of manufactures and a slump in one did not now necessarily spell disaster for the region as a whole.

**Multiple Occupancy**

Increasingly, redundant mills became characterised by multiple occupancy, effectively vertical precursors of the trading and industrial estates that were to become a common feature later in the 20th century. Some mills such as Dark, Bowbridge and Millbottom Mills were housing multiple tenancies at various points in the 19th century and many others came to do likewise as the 20th century progressed. Often, mills were located in what were by now, prime industrial locations, and many came to form the nucleus of trading and manufacturing communities. Examples in the region are numerous and include Meadow, Bonds, Upper and Lower Stonehouse, Fromehall, Staffords, Griffins, Lightpill, Hope, Bliss, Holcombe, Frogmarsh and Merretts Mills.

There was a great attraction for redundant mills to be sub-divided into a number of smaller commercial enterprises, the buildings' non-specific nature coupled with large open floor areas, generally allowing easy adaption. It was sometimes easier to sub-let in this manner than to find a single new occupier.
Small companies could rent perhaps a single floor in what was usually a solid, secure building. In fact, the advantages of mills turned over to multiple occupancy were exactly the same as those that attracted many of the area’s major successor industries (see earlier) with the added bonus of shared maintenance etc. of the buildings themselves. On occasion, symbiotic relationships developed between different companies sharing the same site. For instance, makers of umbrella fittings shared buildings with umbrella manufacturers although they were separate concerns. Likewise, many engineering-based enterprises manufactured parts or sub-contracted to each other.

Where premises and the power source were shared, carefully stipulated arrangements were sometimes entered into. When Bowbridge Mill was being used by two concerns, it was agreed that when water was in short supply, both parties would stop work until sufficient head had been built up to allow both to resume work (GCL. Box 69). Clearly, where the mill’s main power source was not in use or being used by a single partner, arrangements were simpler.

In some instances, reuse has centred around conversion to dwellings as opposed to industrial purposes. Of these, the most recent has been the conversion of the huge Dunkirk Mills complex to dwellings, a project only part-completed and still dogged with financial difficulties. Earlier in the century, some smaller mills were more successfully adapted to dwellings. Examples include Damsells, Clayfield, Iles and Warehouse Mills. In areas more remote from Stroud itself, smaller mills or at least surviving parts of them have been similarly converted. In the Uley Valley, these have included Owlpenn, Sheppards, Daunceys, Rockstowes, Marsh and Eyles Mills where all have been turned over at least partially to domestic use. In some instances such as Daunceys Mill, the mill itself has been suitably converted whereas at others, surviving ancillary structures have been used; for instance, at Rockstowes, the wool warehouse now forms two dwellings.

Thus, in a remarkable number of cases, redundant cloth mills were given a second or even third or fourth lease of life, extending their working lives way beyond those of cloth mills in many other former cloth producing regions.
Figure 85. Ebley Mill, Stroud, undergoing conversion to Council offices
Reasons for Adaptive Reuse of Redundant Gloucestershire Mills

What were the attractions of reusing redundant textile mills as opposed to building anew? Some are obvious although others were specific to a particular mill or location. However, mills tended to be well-built durable structures. Their walls or frameworks were built to withstand substantial stresses and strains and were capable of carrying massive floor loadings (Binney, 1990: 13). An additional factor in their favour was that they were usually of open-plan design; once textile processing machinery had been removed, the new occupier had a clean slate with which to proceed. The non-specific nature of mills allowed for the easy installation of new processes, unencumbered by what had gone before. In many cases, redundant mills offered large floor space at relatively low rents, clearly encouraging fledgling trades and industries to move in; Binney notes a number of examples of this in Yorkshire, and clearly, numerous examples also existed around Stroud.

What were the reasons behind such a high incidence of successful adaptive reuse in Gloucestershire? In the following section, these are explored.

- **Availability and Access to Factory Floor Space**

Even the smallest of the 19th century mills in the Stroud region was characterised by comparatively large floor spaces, usually unobstructed by dividing walls, etc. Mechanised cloth making processes required a considerable amount of floor space however, when no longer in use, machinery could be removed leaving large uncluttered work spaces, whether in single or multi-storey blocks. Often, the only hindrance was the presence of supporting columns of wood or iron, and in some cases, the removal of heavy machinery from upper floors enabled at least some to be removed, thus freeing up additional floor space for alternative uses. Cloth making machinery usually consisted of discrete individual units that once removed, left little behind to hinder reuse. Once the cloth manufacturer had left, there was little to betray his earlier presence. Some successor uses, such as malting, required considerable floor space allied with relatively meagre power requirements, hence the large vacant spaces in Millend Mill, plus a number of others, provided the appropriate environment for this particular mode of reuse.

Once the fledgling Chalford Stick Company had established itself in the empty St Marys Mill at Chalford, it was noted that as a direct result of the internal layout of the mill it now had:

"the largest floor space of any similar works in Great Britain" (Industrial Gloucester, 1904: 39).
This had allowed for the logical layout of the various departments, permitting the easy and efficient passage of sticks from one stage of manufacture to the next. It was also noted that the large, lofty, well ventilated rooms greatly enhanced working conditions.

An added bonus for many new occupiers was that such floor spaces were generally well lit by natural daylight. Even where artificial light predominated, there is every reason to suppose that this system would have been retained in any post-woollen occupation, an added attraction for any new potential occupier.

By their very nature, cloth mills required good access to all floors for both workers and raw materials, hence the presence of taking-in doors at all levels, a crane or similar lifting device permitting easy ingress and egress of materials. Even such bulky, heavy items as completed pianos were moved by this means from the upper floors of Woodchester Mills during the earlier part of this century. Thus, the availability of easily accessible floor space found favour with new occupiers, frequently allowing replacement machinery or processes to be installed with the minimum of fuss.

### The Opportunity for Expansion

Even though considerable areas of production space could be available, there were occasions where the new occupier was looking ahead to possible further expansion. Where vacant mill sites had additional land available for expansion, this sometimes formed an important attraction over competing sites. When Tubbs & Lewis moved to the empty New Mills at Kingswood in the 1870s, they cited their reasons as including the fact that several abandoned cloth mills were available that could be adapted to new requirements, but that in addition, there was the possibility of acquiring further building land should the need arise. Of the mills in the Stroud region, those along the Lower Frome were at something of an advantage in this respect; as the land became flatter towards the Vale, mill sites became less restricted and free of the physical constraints often suffered by mills further up the valleys. As a result, mills such as Stonehouse Lower and Upper, Bonds and Meadow Mills had been able to spread outwards with relative ease. Easily available land had allowed the construction of substantial weaving sheds and sundry other buildings with the potential for further site expansion if required. No doubt this encouraged at least some of the new industrial users of the sites. However, the requirement for further site expansion was not always of prime importance; many former cloth mills came to house various small concerns that were easily accommodated within existing structures. With increasing frequency, mills were sub-let and divided in order to house...
various combinations of commercial activity.

**Reuse of Existing Power Sources and Transmission Systems**

The majority of successor industries that took over redundant cloth mills in the region still required some form of mechanical power supply. It was not uncommon for existing water and to a lesser extent, steam power systems to be left in situ when the mill was vacated. Clearly, water wheels and their associated works were left intact, usually forming an integral part of the mill itself although depending on the particular circumstances, the existing steam engine could be sold off at the time of the closure. By the later part of the 19th century, steam engines in the region's mills were often of the free-standing variety and unlike earlier beam engines that were essentially built into a dedicated engine house, were easier to move to new locations. By way of example, when the engine was removed from the steam-powered saw mill at Daneway, it was transported (by nine horses and in two loads) to the corn mill at Shipton Moyne. It later found a third lease of life and was again transferred to a mill in the Chippenham area of Wiltshire (Gardiner & Padin, 1989: 114). Similarly, when Ithells Mill on the Little Avon closed, the engine was moved to Charfield Mills (Tann, 1967: 88). Likewise, in 1908, the engineering company of H J H King were commissioned to remove and reinstall an 8 x 14 inch tandem steam engine from New Mills to a mill at Charfield; the total cost was £29. (GRO. H J H King order books. 1908. Entry 3580). These were but three examples of what must have been many.

However, engines were not always moved and the new occupier sometimes inherited a water-based power source and in some cases, also a steam engine. The extent of the power available through existing sources varied from site to site although in many instances, the successor industry required less power than had been required for cloth manufacture at the site. This may have been considerable, power being required to operate carding and spinning machines, power looms, fulling stocks, cloth washers, shearing machines, etc. Consequently, it was sometimes possible to meet the new requirements through the use of the existing water power capacity alone. For instance, like many mills in the area, part of Days Mill in Nailsworth was turned over to silk throwing. Here, the single surviving water wheel provided sufficient power for the processing machinery, up to the time of the Second World War. The steam engine had been sold off c1900 for the sum of £45-7s (Mills & Riemer, 1989: 49).

In 1894, the famous picture postcard producing company of F Frith & Co. took over the former Charfield woollen cloth mill. At the time, the company acquired the freehold of the site which amounted to some 2½ acres. The interior of the stone-built building was "entirely
remodelled" however the existing water power system was retained, providing the sole power source for all of the presses and other machinery (Industrial Gloucester, 1904: 61). This water power was more than adequate to contribute to the company producing up to 1½ million postcards per month. Here again were the circumstances that through the combination of well lit floor space coupled with an ample existing source of water power, had been enough to attract the company to this rural location.

**Working Conditions**

Some of the more paternalistic employers moving into redundant cloth mills in the region appear to have given at least some consideration to the working conditions of their employees, and in some cases this seems to have ranked highly alongside the more practical requirements of their business. Thus, when Tubbs & Lewis moved into several mills in the Wotton-under-Edge area, they noted that:

"...the cleanly and wholesome conditions under which the operatives live and labour...thereby increasing their efficiency" (Industrial Gloucester, 1904: 22).

This was clearly a determining factor in the mills' new roles. No doubt manufacturers moving their businesses and workforce from perhaps polluted urban-based situations discovered, as in this case, that a healthy contented workforce provided a distinct advantage. Certainly, this appears to have been the situation at Cole’s pin manufactory in Painswick where the working surroundings contrasted sharply with those generally to be found in city-based workshops. Evidently, the factory was very clean, both inside and out. An observer noted that:

"...this phase of the industry has frequently been commented on by London and other buyers…and who had expected, apparently, to find conditions such as prevail among the factory toilers in large cities…greater contrast could scarcely be imagined…the appearance and deportment of the average operative in the Painswick factory is a strong argument in favour of the establishment of industries in the less crowded districts". (ibid. 19).

Similarly, Savery’s pin works nearby were described as being in:

"exceedingly picturesque surroundings. Indeed, the entire environment which would be a surprise to those accustomed to the smoke and grime usually inseparable from the metal working industries, could scarcely be improved if they were designed by Ruskin". (ibid).
Skilled Available Workforce

The workers of the Stroud valleys were generally adaptable and skilful and, unlike a working population that had been steeped in agriculture and whose routines had been governed by the rhythms of the seasons, most of the region's population were long used to the rigours and disciplines of commerce and industry, where their work patterns were dictated by the clock and the factory bell.

The long heritage of woollen cloth manufacture in the region ensured that a highly skilled pool of labour was available, a clear advantage where a manufacturer was seeking workers for alternative textile-related purposes. Such skills were taken up predominantly in one of two ways, namely in silk throwing and variants of woollen cloth manufacture. The latter were limited to relatively few applications however some wool-based textile manufacture did come into the area. At the Woodlands (Peghouse) Mill site, a succession of woollen cloth manufacturers came to an end when Northcott Cartwright & Co, who had worked the mill since the 1880s, closed down. They were subsequently replaced c1902 by a newcomer to the area in the shape of Humphreys & Co, long-time makers of flannels and tweeds in Narbeth, South Wales. One of the reasons given for extending their business into the Stroud valleys was:

"...the advantage of commodious existing premises and supply of labour skilled in the manufacture of textile fabrics" (Industrial Gloucester, 1904: 28).

As a result of the pool of skilled labour available, Humphreys was only required to bring in a few workers from his flannel factory in Wales in order to instruct the Stroud natives (VCH. ii. 196). "Jubilant Welsh Flannels" continued to form part of the company's output up to its eventual demise in 1924 (Tann, 1967: 212).

Supplies of Local Raw Materials

In some situations, locally available supplies of raw materials had some degree of influence on the development of successor industries, although this was not always the case. When the stick making industry was being developed in the area there is little doubt that a local supply of inexpensive beechwood was a significant factor in the equation; in later years, by the time the industry was at its peak, the range of woods used had become diverse, with varieties being sourced from growers throughout Britain as well as from overseas suppliers in Europe and Asia. What started as purely a local concern based on local materials had now taken on an international dimension. Hence, although in its infancy, a source of local raw material had
played an important role in helping to establish the industry, this importance gradually receded.

In a similar vein, flock and shoddy manufacture developed initially in response to the local availability of waste materials generated within the local woollen industry. At its most productive period, substantial quantities of raw materials were available to support the trade, however, as the industry contracted and the flock and shoddy trades developed in both their technology and marketing arrangements, local supplies became inadequate. For instance, Selwyn's (flock and shoddy) Toadsmoor Mill came to rely heavily on carpet rags imported from Holland (VCH. ii. 197). Thus, in both the case of stick making and flock and shoddy manufacture, local supplies had been of importance in the industries' formative periods, but through changing circumstances, lessened in importance in later years.

The availability of local materials played little or no role in the development of several other successor industries in the region. Silk throwing was clearly wholly dependent on imported raw silk and pin manufacture relied heavily on wire produced in the metal working districts of the Midlands and elsewhere. Tradition suggests that paper-making concerns were set up in the region in order to capitalise on the easy availability of waste woollen-based materials as a source of raw materials, however, as already noted, supplies of these became insufficient to meet other needs. In addition, it seems that the major paper makers in the county, such as Evans, Adlards & Co. of Postlip Mills at Winchcombe, based the majority of their manufacture on cotton wastes and rags brought in from elsewhere (Industrial Gloucester, 1904: 60). Similarly, producers of leatherboard and fibreboard established considerable manufactories at several sites, but here, supplies of raw materials were certainly not limited to local sources.

Overall, in several cases, locally available raw materials were initially of importance, however as the particular industries developed further, their initial importance waned and materials brought into the area from elsewhere assumed a much greater importance.

- Transport & Communication Infrastructure

As explored elsewhere in the present thesis, transport and communication systems were of considerable importance to the successful development of industry within the region. Much of this infrastructure had been poor throughout the period leading up to the beginning of the 19th century and it was not until this time that major improvements were made to local roads. During this period, a network of greatly improved roads were built, centred on Stroud, plus
a series of new roads built along the valley bottoms, linking mill sites directly for the first time. By now, movement of goods into and out of the area had already been aided by the opening of the Stroudwater Canal in 1779. In 1789, the Thames & Severn Canal, joining end-on with the Stroudwater, was opened throughout, forming a direct water-borne link to the capital. Half a century later the first rail link reached Stroud and several important branch lines were subsequently added. Many short links were constructed to serve individual mill sites. Thus, by the time that the local woollen industry was in a state of steady decline and successor industries were moving into the redundant cloth mills, much of the region was well served by a combination of road, canal and railway although by now, the Thames & Severn was losing much of its effectiveness through a combination of water shortages and competition with the railways; the Stroudwater Canal continued to form an important route primarily for the import of coal into the region. Overall, much of the region was now easily accessible and raw materials could be moved with relative ease.

There can be little doubt that this ease of transport helped encourage at least some successor enterprises into the area, allowing goods to be carried speedily to various destinations. For instance, all of the major walking stick manufacturers in the region relied heavily on the railways to transport their products to major cities throughout England and Scotland, as well as linking them directly to ports, allowing easy overseas exports.

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Aside from physical features, the local overall industrial climate also played a significant part in the extent of reuse. Throughout much of the 19th century, the valleys around Stroud were packed with a bewildering variety of industrial and commercial enterprises of all shapes and sizes. Often, the success of one form of enterprise encouraged others and the area was marked by an entrepreneurial spirit that may not necessarily have been found elsewhere. In such a climate, the availability of industrial space was of tremendous importance to the area's local businesses, many of which branched in new directions in the wake of wool's decline.

From the earlier data, there can be little doubt that a high degree of adaptive reuse of redundant cloth mills characterised the gradual decline of the woollen trade in the Stroud valleys. The gradual rundown and rationalisation, in terms of the number of mills, was actually under way by the early part of the 19th century and even at this relatively early period, many redundant mills were finding a second lease of life. For several decades following this period, reuse continued as new commercial and industrial activities replaced various cloth making enterprises. During the 1830s and 40s, for a variety of reasons, a number of cloth manufacturers left the trade, their redundant mills sometimes
finding a new owner to carry on cloth manufacture, but often, turning it over to some new purpose. The rate of closure and reuse remained fairly steady until the period between c1850-70, where it accelerated significantly. During this period, numerous cloth mills ceased operations and although a few failed to find a new industrial use, a surprising number carried on with some form of manufacturing activity. Although the rate of cloth mill closures slowed post-1870, in most cases, the high rate of reuse continued, a trend that carried on well into the 20th century. Even during the 1960s and 70s, as the handful of cloth mills still in operation declined further, redundant mills were still an attractive proposition for commercial purposes. In later years, the trend had been increasingly away from a single replacement activity, to multiple occupancy, former mills housing a variety of small-medium sized concerns. In a number of cases, such mills have formed the nucleus of small trading estates, housing an assortment of firms in a combination of old and new buildings. Even where the mill itself has not found reuse, the sites have frequently been put to new commercial purposes. Thus, uninterrupted commercial activities have continued to take place on the same sites for at least several centuries. As one use faded, it was frequently replaced by another and this in turn, by perhaps three of four more. Many mill sites have hosted a succession of new industries and despite the inevitable changes of use and ownership, have remained in more or less constant use. For example, by the 1870s, Dark Mill no longer remained solely a fulling mill, now also housing a shear grinders shop and a dye works. By 1870, this combination had been replaced by a gun-felt manufactory, by 1876 it was a dye works, by 1881 a saw mill, and by 1885 had been turned over to the manufacture of umbrella sticks. By 1903, wooden knitting needles and crochet hooks were being produced, still essentially within the existing building (Gloucester trade directories - various; VCH. xi. 125).

Such successive reuse of larger mills such as Dark Mills, occurred frequently. Thus, Dunkirk Mills was successively turned over to the manufacture of walking sticks and hosiery, the manufacture of umbrella fittings, then occupied by a variety of manufacturing and commercial concerns, eventually being converted (partially) to dwellings. In a similar way, Millbottom Mill was transformed from a fulling mill to a corn mill and dye works, timber mill, corn mill, leather stiffener works, brass finishing shop, leatherboard stamping works, and ink and dye manufactory, before being converted to dwellings and eventually, a craft centre. Such repeated reuse of mills that had left the cloth trade was to remain a major characteristic of the overall industrial development of the region over several centuries. Frequently, several successor industries existed side by side in the larger mills; clearly, smaller mills put to new uses may have only been capable of housing a single occupier at a particular time.

The trend of successive reuse was summarised succinctly in *Industrial Gloucester* (1904) which noted, when describing the pin making concern of W H Cole & Co. of Painswick:
"As is the case with many of the industries in and about the Stroud valley, Messrs Cole & Company's premises were formerly used for other purposes, at one time having been a well known silk mills. This adapting of the old silk mill to another and comparatively modern industry is a gratifying proof, of which Gloucestershire furnishes so many, that the resourcefulness of British manufacturers is still able to meet the changing conditions".

What it failed to note was that prior to its use as a silk mill, it had originally been built and used as a woollen cloth mill.

The publication went on to note that in a similar fashion, Savory & Sons pin works housed nearby in Brookhouse Mills:

"...like the other Painswick factories...in an old cloth mill, adapted to its present purpose" (Industrial Gloucestershire, 1904: 20).

Similar examples abound, such as the pin making concern of the Critchley Brothers operating from Wimberley Mill. This had formerly been a cloth mill, dye works and latterly, a walking stick factory, just one example of the constant successive reuse of former mill buildings in the post-woollen phase.

Thus, even when the cloth industry was in decline, the Stroud area was fortunate that through a combination of circumstances, there were distinct attractions that encouraged successor industries to move in and fill some of the voids created through woollen's gradual demise. As a consequence, the rate of reuse of former woollen cloth mills was high, the new trades and industries proving to be of significant and on-going importance to the local economy.
Decline and Reuse in the Remainder of the West of England

Like Gloucestershire, the woollen industry settled predominantly in Wiltshire and Somerset dwindled gradually as the 19th century wore on. Many of the more important manufactories were situated in urban locations as opposed to the numerous semi-rural-based sites operating in and around Stroud. Under these conditions it might have been expected that a high degree of reuse would automatically follow the cessation of cloth manufacture, however this was not always the case. In fact, the degree of reuse of former cloth-making premises was decidedly patchy throughout the region. In some locations such as Frome, little reuse appears to have taken place, whilst in others such as Trowbridge and Bradford-on-Avon, significantly more occurred.

Table 34. Frome Area - Former Woollen Mill Sites not Reused (after Rogers, 1976)

<table>
<thead>
<tr>
<th>Location</th>
<th>Date of closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adderwell Mill</td>
<td>1853</td>
</tr>
<tr>
<td>Friggle Street Mill</td>
<td>c1860</td>
</tr>
<tr>
<td>West Woodlands Mill</td>
<td>c1870</td>
</tr>
<tr>
<td>Town Mill</td>
<td>1880</td>
</tr>
<tr>
<td>Spring Gardens Mill</td>
<td>c1883</td>
</tr>
<tr>
<td>White Mill</td>
<td>c1890</td>
</tr>
<tr>
<td>Vennells</td>
<td>1896</td>
</tr>
<tr>
<td>Welsh Mill</td>
<td>c1900</td>
</tr>
<tr>
<td>Broadway Mill</td>
<td>1904</td>
</tr>
</tbody>
</table>

Many mills in the area were demolished although a few other sites saw limited reuse for trades such as dyeing, iron founding and corn milling, although the impact on the local economy as a replacement for woollen cloth manufacture must have been fairly minimal. As noted, a few other areas fared somewhat better. In the case of Trowbridge, long an important centre for cloth manufacture, there was a higher degree of reuse, probably approaching that of the Stroud region.

Thus, many of the Trowbridge mills saw at least a limited second life although some such as Courts Mill, Victoria Mill and Ladydown Mill appear to have remained unused until their demolition (Table 34).

Similarly, Bradford-on-Avon was also marked by a higher degree of reuse than was general in the region as a whole (Table 35).
Table 35
Trowbridge Area - Former Woollen Mill Sites Reused (after Rogers 1976 + site visits)

<table>
<thead>
<tr>
<th>Location</th>
<th>End of Cloth Manufacture</th>
<th>Successor Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashton Mill</td>
<td>1963</td>
<td>Multiple occupancy</td>
</tr>
<tr>
<td>Cradle Bridge Factory</td>
<td>1905</td>
<td>Bedding materials</td>
</tr>
<tr>
<td>Castle Court Mill</td>
<td>c1888</td>
<td>Brush manufacture</td>
</tr>
<tr>
<td>Castle Factory</td>
<td>c1894</td>
<td>Warehousing</td>
</tr>
<tr>
<td>Brick Factory</td>
<td>1905</td>
<td>Warehousing</td>
</tr>
<tr>
<td>Stone Mill</td>
<td>1908</td>
<td>Warehousing</td>
</tr>
<tr>
<td>Studley Mill</td>
<td>1967</td>
<td>Multiple occupancy</td>
</tr>
<tr>
<td>Bridge Mill</td>
<td>1897</td>
<td>Corn milling</td>
</tr>
<tr>
<td>Innox Mill</td>
<td>c1954</td>
<td>Bacon factory</td>
</tr>
<tr>
<td>Yerbury St Mill</td>
<td>1915</td>
<td>Tyres, corn milling</td>
</tr>
<tr>
<td>Duke St Factory</td>
<td>1883</td>
<td>Brewing, corn milling</td>
</tr>
<tr>
<td>Union St Factory</td>
<td>1861</td>
<td>Bedding</td>
</tr>
</tbody>
</table>

Table 36
Bradford Area - Former Woollen Mill Sites Reused (after Rogers, 1976 + site visits)

<table>
<thead>
<tr>
<th>Location</th>
<th>End of Cloth Manufacture</th>
<th>Successor Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenland Upper Mill</td>
<td>1905</td>
<td>Multiple occupancy</td>
</tr>
<tr>
<td>Greenland Middle Mill</td>
<td>1862</td>
<td>Flock and shoddy</td>
</tr>
<tr>
<td>Greenland Lower Mill</td>
<td>1850</td>
<td>Rubber</td>
</tr>
<tr>
<td>Kingston Mill</td>
<td>1848</td>
<td>Rubber</td>
</tr>
<tr>
<td>New Mill</td>
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Here, the situation was somewhat analogous with, for instance, the manufacture of walking sticks in the Stroud valleys, as a number of the most important sites became specialised in the production of rubber components; this became a local speciality. Precisely why this occurred is not clear although it clearly formed an important source of employment in the post-woollen phase. Even though the rubber industry has contracted significantly in the area, a number of sites remain in use. In contrast, until recently, the extensive Greenland Mill site stood derelict until swept away to make room for housing development.

Apart from a few locations, in most parts of the former West of England woollen districts where mills
were reused, a variety of occupations succeeded cloth manufacture. Amongst these there were few "speciality" trades, most comprising the usual mixture of corn milling, saw milling, paper making, leather working and brewing and malting. A few others spent a limited time in the silk trade and a number of others were converted to dwellings. Throughout the region, many more were simply demolished.

Thus, even where a high degree of adaptive reuse occurred, there was little consistency in terms of successor industries. Whereas one area, such as Trowbridge, saw its redundant mills demolished or turned over to a variety of uses, Bradford’s mills were occupied predominantly by a single successor industry. Mills in the Stroud region were characterised by a combination of these two sets of circumstances, some areas coming to depend largely on a single replacement for woollen cloth, such as silk throwing or walking stick manufacture around Chalford and pin making in Painswick, whereas others, like Trowbridge, were dependent on a wide assortment of small-scale, and sometimes short-lived, successor activities.

Thus, overall, apart from the few locations noted above, there was a significantly lower rate of adaptive reuse compared to that achieved in the Stroud region. The attractions of the Stroud region have already been noted however, why was the situation apparently so different in much of Wiltshire and Somerset? Reuse in the latter region was at best patchy; this may have been at least in part due to the much greater geographical region that originally formed the woollen districts. In contrast, many of the centres of manufacturing around Stroud were tightly packed into the five valleys plus a few other locations, forming areas of intense commercial and industrial activity. In such a situation, industries have a tendency to be self-generating; for instance, more activity equates with greater power requirements and this leads to an increase in the extent of steam power required. Hence, more steam engines are needed, which impinges on local engine suppliers, maintainers and engineers. In addition, a greater quantity of coal is required in the region which may necessitate increased activity in terms of importation of coal via road, canal and railway, etc. In only a few parts of Wiltshire was this density of industrial activity to be found. Consequently, outlying districts found themselves increasingly isolated with a tendency to drop permanently out of industrial manufacturing.

The much wider dispersion of mills throughout much of the Wiltshire/Somerset region inevitably impacted on transport and communication systems. Many outlying parts had frequently suffered problems in obtaining reliable coal supplies, a situation that continued into the post-woollen phase. Apart from this, important markets such as London and beyond, were that much further away than the Stroud region, an added drawback. Although, like much of the West of England, the Stroud
region had in its earlier days, suffered as a result of its poor transport system, by the second half of the 19th century it was well served by the Stroudwater and Thames & Severn Canals, a network of new and improved roads and the presence of major rail links. This combination of options was instrumental in the formation of an efficient industrial organisation, a luxury that was not often available to much of the former Wiltshire and Somerset woollen districts.

Ironically, the fact that the main manufacturing centres of the region were almost totally dependent on steam power may also have been a factor in this equation. Unlike many of the former cloth mills in the Stroud region, that still retained water power systems, many of the Wiltshire mills were totally steam-powered from an early date. As noted earlier, many successor industries required significantly less power than a cloth mill of the same size; at many Stroud sites, this power could be met from the existing water power systems whereas in Wiltshire, it may have been the case of operating a steam engine that was far too large for the actual needs of the new potential occupier, or possibly having no engine at all, the unit having been sold at the time of the cessation of cloth manufacture. Thus, what may have at the time been viewed as a somewhat antiquated system of providing power in the Stroud mills, may have in fact, proved to be an important factor in their subsequent reuse.

Apart from the importance of the infrastructure existing in the Stroud region for adoption by successor industries, individual entrepreneurs and the workers themselves played an important role. Industrial life in the Stroud region seems to have attracted an above average number of businessmen endowed with a good degree of business acumen and at a time when cloth mills continued to close, some of these, sensing a good business opportunity, were responsible for bringing manufacturing activity into the area. Not all were necessarily local men, however the attractions of the region were sufficient to induce such companies as Walkers to relocate from Nottingham to Dunkirk Mills. Of added importance was the fact that a number of individuals behind major successor ventures were not adverse to carrying on at least two separate types of manufacture, not relying on a single activity. Thus, the Walkers ran Dunkirk Mills as both a stick manufactory and a hosiery works. Similarly, William Dangerfield not only operated the biggest stick making empire in the region, he was also involved for a time in at least three silk throwing mills, in partnership with Sydney Foot.

Summary

An on-going theme throughout the past several centuries has been the succession of new uses to which individual Gloucestershire mills have been put. Thus, the process of reuse began much earlier than in some other regions. Although there have since been many demolitions, the extent to which former woollen mills in the Stroud region were turned over to other uses was high. The phenomenon of adaptive reuse was not unique to the region although it appears that even as the woollen industry began
the process of contraction, new uses were often found for the redundant industrial space created. Overall, the rate of reuse in the area remained higher than for many competing woollen districts as they too, declined.

The situation prevailing in Yorkshire was somewhat different as a result of the earlier and piecemeal decline in the West. In the former, the industry continued to thrive long after the West’s cloth trade was but a shadow of its former self, hence the problems of finding new uses for redundant Yorkshire mills generally came much later and was essentially associated with the 20th century, as opposed to the 19th century in the West.

One factor that undoubtedly compounded the problem for Yorkshire was the sheer scale of many of its mills. Often products of the present century, they were built on a grand scale of brick, steel and concrete. In contrast, typical businesses and mills in the West were more modest in size and this proved to be of clear advantage when it came to finding new uses for the buildings. The adaption and upkeep of a typical redundant Stroud mill must have been considerably less than the costs associated with many of its Yorkshire peers. Problems for mills in the North were compounded by a large number becoming redundant in a relatively short space of time. Thus, factory space became available on such a scale that it has proved difficult to find alternative uses; the result has been wholesale demolition in some regions. The results of the earlier decline of the cloth trade in Gloucestershire has been that a significant number of mills were reused and as a consequence, have survived the post-woollen era.
CONCLUSIONS

For several centuries, the woollen cloth trade was the major industry in a significant part of Gloucestershire. Its presence provided work and fed the local population, built the mills and changed significantly the face of the local landscape. Despite its tremendous importance to the region, relatively little attention has been paid to its origins, background and development, and the impact these changes had on the local economy. The present thesis, through the use of a combination of documentary research and fieldwork, has attempted to fill some of the gaps in the knowledge of the region’s mills and provide a clearer picture of how these came into being and developed in line with the changing needs of the industry. Although forming part of the West of England woollen region, the industry in Gloucestershire (primarily the Stroud valleys) developed in some ways that were different to those found in neighbouring counties.

The trade in the Stroud valleys developed over several centuries, the region gradually usurping Gloucester as the centre of the county’s cloth industry. The reasons behind this relocation were primarily twofold, namely an escape from the restrictive practices of the City’s guilds, but perhaps more importantly, the easy availability of water-powered sites, crucial for the construction of fulling mills. In areas of the county where there was a dearth of such sites, the industry simply disappeared. What is interesting about the developments taking place in the Stroud region was that, despite instructions to the contrary, increasing trading connections were established between guild-regulated City-based cloth workers and the Stroud fulling mills. Powerful Gloucester merchants such as John Sandford were probably the driving force behind many of these developments. Although this situation was not unique to Gloucestershire, such commercial links do not appear to have been common in the industry at large.

Gradually, the woollen industry grew in the region. However, interestingly, it did not necessarily develop in the same way as other clothing regions of the country or even the West of England. In the county, as in some other parts of the West, capitalism came early. In contrast, in the North, much of the industry was populated by extended family units, making use of family members and journeymen for labour and public mills for fulling. In the West, much of the trade came into the hands of a small band of all-powerful capitalists known as the "Gentlemen Clothiers.” Their businesses were based around their fulling mills, with other stages of manufacture being put out to cottage-based workers either in the immediate vicinity or farther afield. This system was adopted widely in the clothing districts of Gloucestershire and what came to be its traditional rival, Wiltshire. Even here, there were differences between the organisation of the industry in the two counties. In
Gloucestershire, clothiers almost invariably lived in or close to their mills, and were thus a constant presence, supervising their workers and tenter racks. In contrast, Wiltshire clothiers often preferred to build their residences in the towns of the region, sometimes leaving the operation of their mills to hired third parties who may not have been so committed to the success of the business. Thus, the business of the Gloucestershire clothier remained centred on his fulling mill and residence. These sites acted as nuclei, around which the local industry developed and grew. Unlike many others parts of the West and North, Gloucestershire mills were almost invariably in rural or semi-rural locations, with few being based in urban centres. The Gloucestershire woollen industry was almost entirely a country-based one, with the clothier himself in daily attendance.

Thus, many Gloucestershire workers became accustomed to the constant presence of their employer, a fact that may have influenced the workforce’s apparent propensity for hard work and compliance. Even in the face of substantial changes in their working patterns and the introduction of new job-threatening machinery, there was relatively little worker unrest in Gloucestershire, even during particularly depressed periods of trade. Only a few miles away in Wiltshire, violent opposition met virtually every attempt to change traditional ways of working. Similarly, in the North, riots and machine-breaking occurred on a large scale. Such acquiescence on the part of the Gloucestershire workforce undoubtedly smoothed the way for the gathering together of outworkers into centralised workshops and the trouble-free introduction of new machinery.

Who were the individuals that made up the Gloucestershire woollen industry? Many were doubtless of local origin although this was not always the case, especially with some of the clothiers who controlled much of the trade. In the Stroud valleys, a number of immigrant families were heavily involved in the trade, some building up long-running family dynasties that were particularly effective and responsible directly for a significant amount of cloth production in the region. In general, the presence and importance of such immigrant communities on the West’s woollen trade may not have been great and has sometimes over-emphasised. However, the impact of their presence in the Stroud region, although it may have been localised, was significant. Thus, some Flemish immigrants became integrated into the local society and actively involved in the trade from at least the 15th century, with family members acting in a variety of roles including that of clothier. Several such family-based businesses survived until the virtual cessation of cloth making in the county.

As the local woollen industry grew and developed, this was reflected in the changes taking place in the buildings themselves. From its initial phase, comprising fulling mills, clothiers houses and out-workers cottages, the industry began to impose new requirements. Thus, the Stroud clothiers gradually adopted new working practices and installed increasing amounts of machinery. Businesses
remained centred on existing fulling mills, although sites now grew to encompass new multi-storeyed blocks housing powered carding and spinning machinery and often, hand looms. Gloucestershire mill sites grew in a piecemeal manner and there was little consistency in the site layout adopted, even between adjacent sites. As a result of this often prolonged type of growth, many sites eventually came to comprise a "main" mill, often with additional wings added, and separate multi- or single-storey buildings, often spanning several centuries in date. Developments were site-dependent, the eventual configuration and layout often being influenced by the surrounding topography and other features. Many of the valley sites eventually consisted of jumbles of structures, apparently added in random fashion. There was little tendency for manufacturers to build completely anew, and even where perhaps a new main block was constructed, invariably, existing buildings were retained or subsumed into the new structure.

Little in the way of an overall examination of how these mills grew and changed in form in order to accommodate changes in technology and working practices has previously been carried out. Although documentary sources can be of great significance in respect, many of the present findings have been based on a combination of documentary research combined with site examination. The latter proved crucial in examining constructional techniques and materials of construction. Thus, it became clear that methods of construction were generally simple extrapolations of building practices used in the area for centuries. Similarly, materials used were combinations of local stone, brick (also produced locally) and timber, the latter coming initially from local supplies but latterly, primarily from imported sources via Gloucester. The extensive programme of site visits carried out as part of the present work also showed how the use of building materials had been influenced by both geographic location and date. For instance, early mills were stone-built, whereas later works were usually carried out using brick. Similarly, mills in the valleys were more often built of stone quarried near at hand, whereas those further down the watercourses towards the Vale of Gloucester, relied to a greater extent on brick, the area lacking building stone. Almost without exception, internal arrangements of all local mills were constructed of timber, in some cases, with the addition of iron columns. The uptake of well-established fire-proofing techniques used elsewhere, were almost entirely absent from the Stroud valley mills, only a single example being built in such a manner. Thus, Gloucestershire mills were generally simply constructed vernacular buildings, relying on tried-and-trusted building techniques. Unlike some mill sites in other parts of the West and particularly the North, they grew and developed gradually, in line with new requirements being placed on them; few were constructed during a single period.

As the buildings themselves were constructed in a conservative "traditional" manner, so were the power sources applied to them. The mills of the Stroud valleys were unusual in that water power still played a dominant role, even when competing woollen regions had switched almost entirely to steam
power. The cautious approach taken by most manufacturers resulted in a slow and patchy take up of steam power, water power, despite its drawbacks, being retained. In some cases, great efforts were made to wring additional power out of local streams and rivers, rather than install steam power. Examinations of local streams and rivers has confirmed that little, if any, of these now run in their natural configurations; most have been redirected and harnessed to supply power to mill sites. Even when steam power was adopted increasingly, this was usually as a backup in times of low water and not as a direct replacement. As a result, it became commonplace for Stroud mills to be powered by combinations of water and steam, an arrangement that allowed for the most cost-effective operation. As steam itself was eventually usurped by gas and oil engines and electricity generated on site, many Stroud manufacturers stuck doggedly with their sometimes anachronistic power sources, until they were eventually reached by the public electricity supply. With a few exceptions, there was little adoption of on-site generation systems.

The power transmission systems adopted in most Stroud mills were also based on early technology, with the majority of early mills being dependent on vertical shafts, driving line shafting on each floor via bevel gearing and/or belt drums. When many Northern textile mills were using more sophisticated individual rope drive systems, these older systems were frequently retained in Gloucestershire. Even when the vertical shaft was finally supplanted with electric drive on each floor, most Stroud mills stuck with overhead line shafting to take power to individual machines until their final closure. Thus, in many cases, water power systems and overhead line shafting continued in use well into the 20th century. What is perhaps remarkable is that many of the Stroud mills, operating with apparently such antiquated technology, managed to outlive most of their steam-driven counterparts in Wiltshire. However, despite the longevity of some of the Stroud woollen industry, most eventually withered and died, the survivors continuing in a handful of large, fully mechanised mills. This decline and contraction could have been disastrous for an area so dependent on a single trade. However, what was unusual about the Stroud valley mills that dropped out of the cloth trade was their early and extensive adaptive reuse. As cloth manufacture gradually came to an end at some sites, redundant mills were occupied by a number of successor industries that helped to fill the void created by woollen’s demise. Some of these were at least linked initially to the woollen trade. For instance, important trades, such as flock and shoddy manufacture, developed using waste materials generated by the woollen industry. Here, as local supplies dried up, materials were imported into the region, ensuring that the trades continued to prosper. This was but one example of successful adaptive reuse of the region’s redundant cloth mills and, as documentary research and site examination has confirmed, many new trades settled themselves in empty mills. Often, the latter were eminently suited to providing large working spaces that were flexible and inexpensive. In some cases, power sources and additional infrastructure such as power transmission systems were still in place from earlier uses, and this was reused by the
successor trade. Increasingly, multiple occupancy played an important role, with redundant mill sites developing into the precursor of the modern industrial/commercial trading estate. The fact that local mills closed gradually throughout the 19th century ensured that there was rarely a significant glut of available premises, allowing newer trades to move in and develop at a suitable pace. Some of the region's successor industries were primarily local in nature, although others became of national and even international importance. Such a high degree of adaptive reuse was unusual and ensured that a significant number of the region's former cloth mills survived in commercial use into the present century.

Thus, as in Britain's other woollen regions, overall, the cloth trade in Gloucestershire grew and developed with the passing centuries. In some respects, the processes occurring with the Gloucestershire trade were similar to those elsewhere. However, as noted, there were also some significant differences in the way it was organised, powered and housed. Similarly, in the wake of cloth's gradual demise, a significant industrial and commercial presence remained predominantly in the Stroud region, with new trades occupying redundant mills and sites. This was to be a major factor in the survival into the present century of many of the region's mills.
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