WILLIAM HAZLEDINE, SHROPSHIRE IRONMASTER AND MILLWRIGHT: A RECONSTRUCTION OF HIS LIFE, AND HIS CONTRIBUTION TO THE DEVELOPMENT OF ENGINEERING, 1780 - 1840

by

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ABSTRACT

The name of William Hazledine (1763 – 1840) is almost unknown, even to industrial historians. This is surprising, since he provided the ironwork for five world 'firsts', and he was described at the time of his death as 'the first [foremost] practical man in Europe'. The five structures are Ditherington Flax Mill, Shrewsbury (the first iron-framed building in the world), Pontcysyllte Aqueduct (still one of the longest and highest in Britain), lock gates on the Caledonian Canal, a new genre of cast-iron arch bridges, and Menai Suspension Bridge. This thesis aims to rediscover Hazledine's life and work, and place it in the context of social and industrial history. It particularly concentrates on the development of cast iron technology in Shropshire, which has been less studied than the work of earlier ironmasters, such as the Darbys and John Wilkinson. The thesis also examines Hazledine's relationship with Thomas Telford, with whom he collaborated on many projects, and Hazledine's contribution to the development of mills and millwrighting in Shropshire and surrounding counties. Having established an outline of Hazledine's life and work, there is ample scope for follow up studies in the fields of metallurgy, engineering, mills and local history.

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ABBREVIATIONS

DNB – Dictionary of National Biography

ICE – Institution of Civil Engineers

NLW – National Library of Wales

RCAHMS – Royal Commission on the Ancient and Historical Monuments of Scotland

RCAHMW – Royal Commission on the Ancient and Historical Monuments of Wales

SA – Shropshire Archives

SC – Shrewsbury Chronicle

SJ – Salopian Journal (this publication had various minor name changes during its existence; for the sake of simplicity all references are given the same name)

SMR – Sites and Monuments Record

TNA – The National Archives

Trans Shrops Archaeol Soc – Transactions of the Shropshire Archaeological and Historical Society

VCH – Victoria County History (Shropshire)

1. INTRODUCTION AND HISTORICAL CONTEXT

A previous Shrewsbury local history project had alerted the author to William Hazledine.[1] It was particularly intriguing that Hazledine's contemporary Charles Hulbert wrote that, *'His* biography would be *worth* compiling' (Hulbert's emphasis).[2] Preliminary research on Hazledine produced an entry in the *Dictionary of National Biography,* an article in a local magazine that is over 50 years old,[3] and mention of him in a biography on Thomas Telford.[4] Even this superficial overview indicated that he was an important figure in the history of ironworking and engineering, and also that he was much more than this, being among other things a millwright, property developer and local politician. Further study indicated why he is so little known, for example,

> *William Hazledine was an engineer and ironfounder of considerable importance and influence during the last decade of the eighteenth century and the first four decades of the nineteenth century, but he has not had the recognition he deserves due to the fact that information about him is fragmentary and widely scattered, and a biography of him is yet to be written.*[5]

Immediate questions that suggested themselves were –

- As a millwright, what was his significance?
- How did a man who trained as a millwright become such an important ironmaster?
- How did his life and work fit into the bigger picture of ironmaking in Shropshire?

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[1] Pattison 2004
[2] Hulbert 1837, p.308, footnote
[3] Anon, 1955
[4] Rolt 1979, p66ff
[5] John Powell, in Skempton and Chrimes 2002

- What was his link with Telford, and what influence did Hazledine have in the design and construction of Telford's works?
- How did his personality and life story influence what he did?

It was decided that this research had to be qualitative, so the thesis is written in narrative style. Establishing a biographical framework would then make it possible to ask more detailed and quantitative questions suggested by the study.

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William Hazledine's lifetime almost exactly coincided with the period which has traditionally been known as 'The First Industrial Revolution', and more recently as a 'Great Transformation' or even a 'Great Divergence'.[6] Whatever aspect of the process these labels may emphasise, there is no doubt that the Britain of 1840 was very different to that of 1763. During these years technological advances transformed many parts of manufacturing from being cottage or workshop based towards concentration in large factory units. In a similar way, the production and working of metals developed from small, often rural, units, limited in size and output by the supply of water power, to large complexes reliant on steam. Traditionally, furnaces and forges[7] were often located on separate sites, and ironmasters owned or leased both furnaces and forges, whose production they integrated in such a way as to secure supplies of pig iron and raw materials, chiefly charcoal, at favourable prices. Gradually, however, this integration became unnecessary as the supply of pig iron increased with the introduction of coke technology. An open market for pig iron developed, particularly in the Severn

[6] Hilton 2006, p.3ff
[7] See Glossary (Appendix 2) for definition of these and other terms

catchment area, with prices being regulated by ironmasters' meetings.[8] William Hazledine, however, largely bucked this trend – he operated forges and foundries at scattered sites using whatever power source was most economic. How he was able to do this profitably, while others were specialising and concentrating production, will be discussed.

Prior to the widespread introduction of coke technology in the 1780s and 1790s (and even for some time afterwards), ironmaking was more of an art than a science, the techniques of production being passed on by experience and word of mouth, often from father to son or other close relatives.[9] Ironmasters were similar, with dynasties handing down the business with its secrets through the generations. The best known Shropshire ironmasters of this era are the Darbys and the Wilkinsons, but others such as the Knights, Wheelers and Hallens were also significant. At first glance William Hazledine doesn't seem to fit into this pattern, being apparently the first of his family to follow the iron trade. This thesis will seek to demonstrate that he did follow the traditional path, albeit by a more circuitous route. Since all the records of his ironworks have been lost, details of exactly how these operated are sparse and second hand. However, some information that sheds light on how he operated can be examined. Most of Hazledine's wrought-iron work was made at Upton Forge. The history of this site has never been fully documented, so this thesis seeks to remedy that deficiency.

Taking advantage of John Wilkinson's invention of the cupola furnace in 1794, Hazledine developed the production of large cast-iron structures, such as

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[8] King 2003
[9] Evans 1998, Evans 1999

columns, beams, bridges and roofs. During his lifetime he supplied the ironwork for five world 'firsts'.[10] Ditherington Flax Mill in Shrewsbury (1797) was the world's first iron framed building. Hazledine collaborated with Thomas Telford on the other four innovations. The first of these were iron troughs for canal aqueducts, of which Pontcysyllte (1805) is the outstanding example, and was then the longest and highest elevated waterway in the world. The Caledonian Canal (1804-22) was

> *The largest and most technically advanced trans-sea summit level ship canal in terms of its design, execution and large scale...unsurpassed in scale for its class until completion of the Panama Canal in 1916.*[11]

Hazledine's contribution to this was the supply of the 14 pairs of lock gates for the western section with cast-iron heads, heels and ribs.[12] The use of iron for the lock gates was forced on the contractors by the shortage of timber, and was probably not the first use of iron for this purpose, but the size of the gates (23ft (7.01m) wide and up to 28ft (8.5m) high) was unprecedented.[13] The fourth major innovation was the development of a genre of lightweight cast-iron bridges with 'lozenge' or diamond-shaped lattice spandrels and spans exceeding 32m (105ft). These were originally designed for remote sites where the erection of masonry bridges was uneconomic or impractical, the first being at Bonar (1812).[14] The final 'world first' was in suspension bridge design and erection, with Menai (1826) (then the longest suspension bridge in the world) as the supreme example.

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[10] All these structures except the Caledonian Canal lock gates, are more fully described in the text
[11] ASCE/ICE international landmark plaque at Fort Augustus; Paxton and Shipway 2007, p.155
[12] Telford 1838, p.63;
[13] Commissioners' Report on the Caledonian Canal, *The Scots Magazine and Edinburgh Literary Miscellany,* Vol. 75, part 2, October 1813; *Encyclopaedia Britannica* 1824, p.575, states that 'lock gates of cast iron have been for a considerable time in use'.
[14] Paxton 2007, p.15

At the time, the Ditherington Flax Mill excited little comment – it was the first of many similar structures built for profit, not ornament, and it is only in recent years that its importance has been recognised. Pontcysyllte, however, was, and still is, regarded with wonder – the fact of its receiving World Heritage Site status is ample proof of that.[15] The praise for the design and erection of the Pontcysyllte aqueduct, the Caledonian Canal and iconic bridges such as Bonar has tended to focus on Thomas Telford, with the contractors, including Hazledine, merely a footnote to his genius. Consequently, Hazledine was little known outside the engineering community, but the Menai Bridge brought national fame to him and he became noticed by the nobility. For example the *Shrewsbury Chronicle* reported,

> *His Highness Prince Swartzenberg, a commander of the Austrian Army, stopped on Wednesday at the Lion Inn in this town and visited Mr Hazledine's iron foundry to gratify his curiosity respecting the manufacturing and mode of proving the strength of the chains at Menai and other bridges.*[16]

Hazledine also met Princess Victoria, who, with her mother the Duchess of Kent, visited Shrewsbury in 1832. The Duchess particularly wanted to hear about the construction of Menai Bridge (the Princess preferred playing in the tree house).[17] An observer wrote,

> *The royal party expressed great satisfaction at the lucid and instructive manner in which the explanations were given, and the tact and shrewdness displayed in Mr Hazledine's answers. Persons who were present described the interview as*

[15] Nomination document 2008, available online at http://www.wrexham.gov.uk/assets/pdfs/heritage/aqueduct/nomination_document.pdf
[16] *Shrewsbury Chronicle* (SC), 16.12.1825
[17] SC 2.11.1832

most interesting. Mr Hazledine received a present as a token of approbation; and the Duchess of Kent, when she passed over the Menai Bridge, examined every part minutely, according to Mr Hazledine's description, and even entered the caves in which the iron suspension cables were fixed.[18]

Pontcysyllte Aqueduct and Menai Bridge were just two of the most spectacular examples of the transport revolution that supported industrialisation. In 1763 England was ushering in the canal age, while in 1840 mass railway transport was about to begin. Roads also improved out of all recognition in this period. For example, in 1763 the journey from Shrewsbury to London by road took nearly two days,[19] but by the 1830s the coach that left Shrewsbury as the clock of St Julian's was striking 5am was scheduled to arrive in London by 9pm.[20] Much of Hazledine's work was involved in these transport improvements. The list is impressive, and comprises large and small cast-iron bridges for roads (including some over canals and docks), wrought-iron suspension bridges, canal aqueducts (both traditional and cast-iron), cast-iron canal lock gates, cast-iron work for docks, and iron rails and bridges for horse-drawn tramroads.

The construction of canals, docks, roads and other similar works was planned and supervised by a group of men who were mainly trained as artisans, but during Hazledine's lifetime began to call themselves engineers. James Brindley (millwright), John Smeaton (instrument maker), John Rennie senior (millwright), William Jessop (Smeaton's assistant) and Thomas Telford (stonemason) were some

[18] SC 30.10.1840
[19] The *Shrewsbury Chronicle* of 9.5.1778 announced that a coach that left Shrewsbury at 5am one day would arrive in London by 'dinner time' the next day.
[20] De Saulles 1986, p.85

of these men. Gradually these and others developed Civil Engineering into a profession, and the Institution of Civil Engineers was founded in 1818. Hazledine never styled himself as an engineer, but long experience of working with men like Telford, plus planning and executing other projects, such as the development of the Severn towpath and land drainage, inevitably meant that he knew as much about engineering as others who considered themselves engineers. At times this seems to have caused friction with younger members of the developing profession, and Hazledine's forthright character perhaps made such friction more likely. The building of Marlow Bridge is a notable example of this conflict, which will be described in detail.

On the whole, however, Hazledine was a team player. Before the building of the Bridgwater Canal (opened 1761) most civil engineering projects were on a reasonably small and local scale. Once canal (and later road and railway) building really got underway, those who engineered these projects had to develop a whole range of new skills to ensure that the works were built according to specification, on time, and within budget. We would now call these skills project management, and Thomas Telford is widely regarded as being the engineer who did most during Hazledine's era to develop this.[21] William Hazledine can be considered fortunate to have met Telford at the outset of both their careers, but perhaps Telford was also fortunate in having such a close friend who could advise him on the practical aspects of a material (iron) of which he had no personal experience. Telford was also fortunate that Hazledine shared many of his guiding principles, such as concern

[21] Gibb 1935, pp.186-7; Barnes 2007

for the workforce, an insistence on quality and accuracy, and a willingness to take carefully calculated risks. This relationship has been considered in some detail elsewhere, but the importance of William Hazledine for Telford's use of iron will be further considered.[22]

The world beyond the shores of Britain also changed radically between 1763 and 1840.[23] In 1763 the Treaty of Paris concluded the Seven Years' War, which greatly extended British influence abroad. The Royal Navy was essential in maintaining and extending this sphere of influence, and the Navy depended increasingly on technological development to stay ahead of its rivals. This was one of the factors that encouraged governments and private individuals to recognise the importance of supporting and encouraging technology. The defining event of the late 1770s and early 1780s was the American War of Independence (1775-83), not least because of its influence on the development of democracy. Not long after the Treaty of Versailles formally recognised American independence, the French Revolution began (1789). The revolution was initially welcomed by liberal-minded people such as Hazledine, but the excesses of the revolutionaries and fears of the same thing happening in Britain resulted in both a popular and legislative backlash in the early 1790s.

From 1793 to 1802 and 1803 to 1815 Britain was at war with France. Inevitably, this was a period of severe social and economic disruption due to men

[22] Pattison 2007

[23] Derry 1963, Castleden 1994, Hilton 2006; see also Appendix 1, 'William Hazledine Timeline'. These references have been used for most of the political dates and events in the timeline. Detailed references are not provided for the information that is readily available from standard texts or on the Internet.

being away for long periods, high prices, and the loss of continental trade. The obvious way to flourish as an ironmaster during these years was to be actively involved in war industries, such as the supply of armaments. Men such as Alexander Brodie (1733-1805) of Calcutt's ironworks in Broseley took this route and became very wealthy.[24] Hazledine, however, was not involved in armaments work, though he did his bit for the war effort by organising a troop of militia from his works, called 'The Vulcans'.[25] This thesis will demonstrate how he managed to make much money in more peaceful ways.

When William Hazledine was born, George III had been on the throne for just three years, and by the time of Hazledine's death, Victoria had been queen for the same length of time. Hazledine was a supporter of the monarchy, but this support went hand in hand with his desire to see greater equality between different elements in society. William Pitt the elder, the dominant figure in the politics of his generation, died on the day that William Hazledine began his apprenticeship.[26] Pitt presided over a parliament of shifting allegiances, but by 1840 politics was much more based on parties – Tories, Whigs and Radicals. Hazledine was a supporter of radical politics, and hence of political reform, since at least the early 1790s.[27] This thesis briefly describes Hazledine's importance in local politics during his lifetime.

During Hazledine's lifetime, agriculture went through many ups and downs. The late eighteenth century was a time of agricultural improvement, with large landowners seeking to become more efficient and apply the latest thinking to

[24] Brodie was worth £100,000 (over £3m today), Randall 1879, p.119
[25] SC 8.11.1901
[26] SC 9.5.1778; William Hazledine senior's record book, kindly lent to the author by his descendents
[27] *Salopian Journal* (SJ) 23.3.1831; SC 6.5.1814

maximise their crops. It was thus a good time for millwrights, with new mills being built and old ones upgraded or altered to new uses. Hazledine was trained as a millwright, and even after he found fame in the iron trade, he always referred to himself as such.[28] We are particularly fortunate in having a contemporary description of some of the mills Hazledine built,[29] but one of the aims of this thesis is to uncover as much evidence for his other mill work as possible, and make some estimate of his significance as a millwright.

For a man of humble origins, Hazledine moved in surprisingly exalted circles, for example he became friendly with the most famous sculptor of the day Sir Francis Chantrey, who drew and then sculpted him.[30] Hazledine's death was recorded in *The Athenaeum,*[31] and he was included in the first *Dictionary of National Biography.* So why was he so quickly forgotten and is almost unknown today? Perhaps the main reason is that soon after Hazledine's death, first wrought iron, and then steel, became the preferred materials for bridges, girders and other large works, with cast iron falling out of favour. The ability to make these structures in cast iron was largely forgotten, and their significance underestimated. However, this historical accident has meant that Hazledine's large cast-iron works have never been bettered. This is now beginning to be recognised, and understanding of their design, production and erection attempted. Part of this understanding is to rescue their maker from historical obscurity.

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[28] Shrewsbury Burgess Roll, Shropshire Archives (SA) 3365/67B
[29] Telford 1798; Telford and Burne 1936
[30] In his will Hazledine called Chantrey 'my friend'.
[31] November 14th 1840

2. ORIGINS

The fact that William Hazledine became such a significant ironmaster without any obvious training or background in the industry is surprising, and worthy of closer examination. That is the subject of this chapter and the next.

The first of William Hazledine's ancestors that we can identify with some certainty is another William Hazledine[32] who first appears in the Waters Upton parish records in 1628, on the baptism of his daughter Mary.[33] His wife's name was Isabel, and his occupation was recorded as 'mylnar' (miller). Unusually for records of such antiquity, the vicar also recorded places of residence for each person, the Hazledines being from Waters Upton itself. Waters Upton (SJ 633193) is situated about 16km north east of Shrewsbury on the River Tern, near the road from Shrewsbury to Newport (Shropshire). There had been a mill there since Domesday,[34] though it must have been demolished many years ago, since Trinder makes no mention of it.[35] It is, however, clearly shown on a map, which probably dates from 1635 (Figure 1). The mill was situated near the bridge carrying the road from Crudgington to Hodnet over the River Tern (SJ 631193). If the drawing is accurate, it was quite a grand L-shaped building, with three bays. William Hazledine and Isabel had five other children in Waters Upton – Margery (1629), Margaret (1631), Richard (1636), Thomas (1638), and John (1639).

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[32] For the sake of simplicity I have used the spelling 'Hazledine' throughout, though old records spell the name in a number of different ways
[33] Waters Upton parish records, SA S9/746
[34] Reed and Bennett 2005
[35] Trinder 1996

Figure 1 - Waters Upton Mill, c1635 (Shropshire Archives (SA) 972/7/1/41)

Shortly after this there is a long gap in the parish records, probably related to the Civil War.[36] So, after a recording gap of nearly a generation, Hazledines are again recorded, but now in both Waters Upton and the nearby village of Rowton (SJ 612199) (Figure 2). These were presumably descendants of William the miller. Some of the Hazledines of Rowton were well-known as clockmakers. Among them was another William Hazledine, who had an extensive practice throughout Shropshire. One of his works was to make a new clock for St Mary's Church Shawbury in 1672, the previous one having been 'spoyled by ye garrison' in the Civil War.[37] Richard Hazledine, though, stayed in Waters Upton, presumably as the miller, once his father had died in 1655.[38] Another William Hazledine, presumably Richard's son, was born in Waters Upton around 1665. He married Anne Hollyer of Rodington in 1687, and they had ten children.[39] The significant child of these ten

[36] Nearby High Ercall Hall (SJ 595174), home to the Newport family, was a Royalist stronghold, whose capture took three bloody sieges and over a year to effect. Hundreds of men were killed or wounded, and local life was obviously severely disrupted (Bracher and Emmett 2000, p.79)
[37] Elliott 1979, p.79; Lea 2005
[38] Richard Hazledine paid the hearth tax in 1672, as did 'Widdow' Hazledine, presumably his mother, SA C63
[39] SA Rodington Parish Records P230/A

for our story is John (labelled II for clarity on the family tree – figure 3), who was a millwright by training.[40]

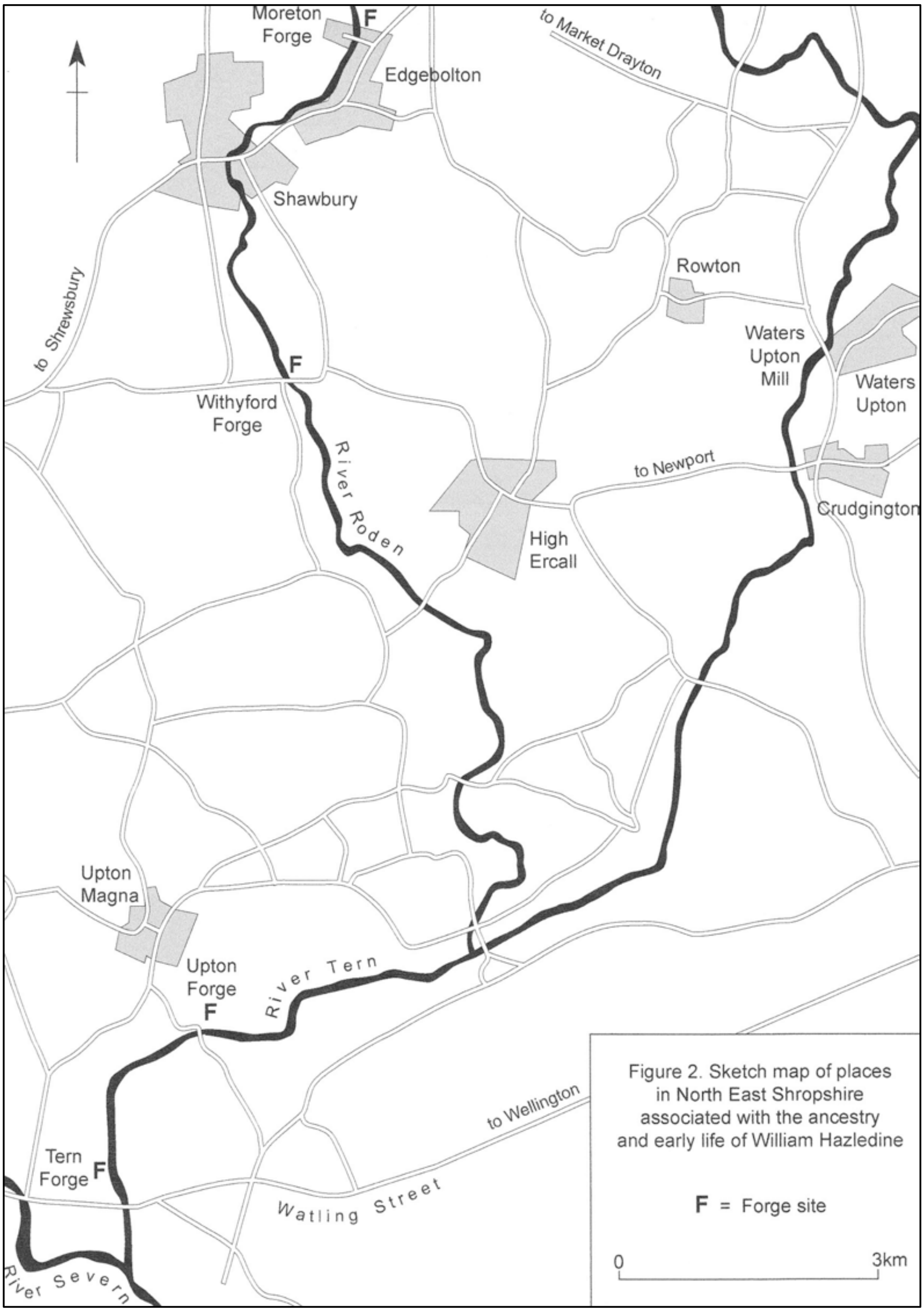
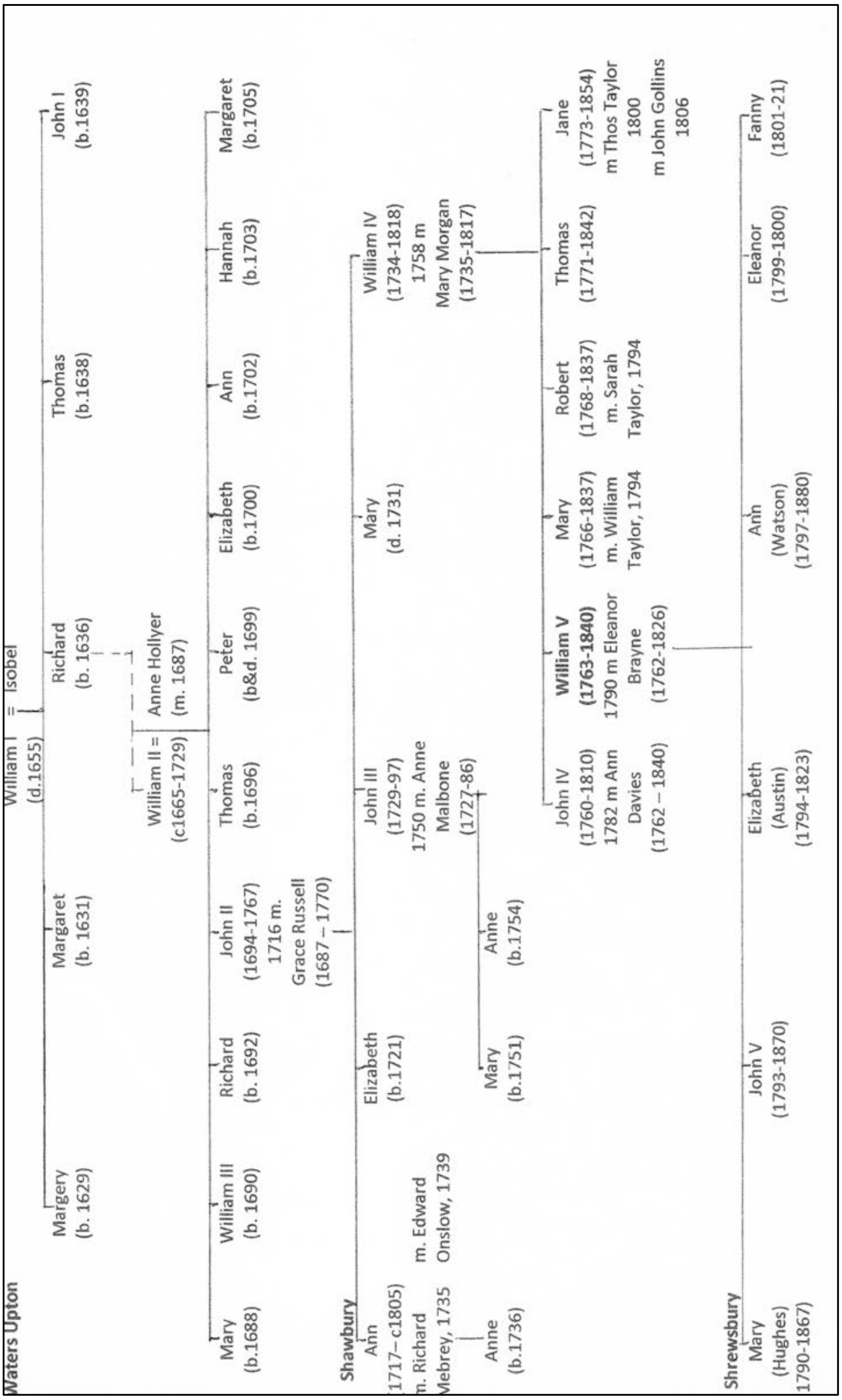


Figure 2. Sketch map of places in North East Shropshire associated with the ancestry and early life of William Hazledine

[40] SA 1396/3

Figure 3 – Simplified Hazledine Family Tree



A millwright needed an intimate understanding of corn milling and other processes that used mills to power them. His job was to build and maintain both watermills and windmills, which involved many different skills, such as harnessing water or wind power, and working with wood, brick and, later, iron. Millwrighting had been recorded as a separate trade since late medieval times, but with both the rapid expansion of agriculture and new industrial uses for mills in the 17th and 18th centuries, their skills become more valuable and diverse.[41] John Hazledine fitted this bill well, having been involved with mills from an early age; no doubt he also possessed both intelligence and practical skill, like other members of the family. He married Grace Russell in High Ercall church in 1716, she being 27, while he was just 20.[42] Their first child, Ann, was baptised the following year at High Ercall, but by the time their second daughter Elizabeth was born in 1721 they had moved to the parish of Shawbury.[43] Records show that they lived near Moreton Forge[44] (SJ 575228), which is situated on the River Roden a short distance to the west of the Shawbury to Market Drayton road, 2km northeast of Shawbury (Figure 4) and close to Sowbatch farm. The Forge was on the edge of the Parish of Shawbury, adjacent to the 'township' of Edgbolton (or Edgboulton), and also on the edge of the estate of the Corbet family (once of Moreton Corbet, then based at Shawbury Park), who owned the forge. For these reasons the forge was variously called 'Moreton Forge' or 'Sowbatch Forge', and the lands where the workers lived were sometimes referred to as 'Moreton Corbet' or 'Edgbolton', or 'The Grange', after a strip of

[41] Watts 2008, p.49
[42] Shropshire Parish Register Society SA S9/746, p.330
[43] SA Shawbury fiche P241/40
[44] SA 322/6/6

ground running from Stanton to Shawbury alongside the forge, called 'The Grange'.[45] To confuse matters even more, all these designations appear to have been interchangeable!

Figure 4 – Environs of Moreton Forge
(Greenwood 1827)
The Forge was situated 2 km north east of Shawbury, just off the Shrewsbury to Market Drayton Road. The road past Great Witheford (now Withyford) leads to High Ercall. (Staunton is now called Stanton-upon-Hine Heath).

So how did John Hazledine the millwright come to be living at a forge? The clue probably lies in his wife's maiden name, Russell.[46] This comes from the old French

[45] SA qC44.2

‘Rousel’, someone with red hair or a red face. The name was very common in the iron trade at that time, evidence of the fact that many ironworkers were descendants of men who came over from northern France to set up the new blast furnace technology in the Weald in the century or so after 1451.[47] As the new technology spread to other parts of the country, so the descendents of these French pioneers, such as the Russells, went with it. Iron production was heavily reliant on skills and experience passed down by word of mouth, usually from father to son or other close relatives, so iron workers tended to form tight-knit communities bound together by kinship.[48] They were also often surprisingly mobile, moving between forges when work became slack or the fancy took them. For example, one William Russell worked in no less than 15 different sites, mostly in the Black Country, but also in Shropshire, South Wales and the Forest of Dean, over a thirty-year period from the 1780s to the 1810s.[49] The Moreton Forge Russells, however, were more settled. A document of 1774[50] records three generations of Russells as having lived and worked at Moreton Forge, and it is likely that there was at least one further generation after these.[51] In the 1720s it is likely that the head of the family was John, and the assumption is that he was Grace’s father, so the Hazledines presumably moved in with the Russells. In 1728 John Russell died, and it appears

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[46] There had been a ‘William Hasseldine’ who was recorded as having a ‘tenement and yard’ at or near the forge in 1649 (SA 163/63), but there is no evidence that Hazledines were still there by the 1720s. This ‘William Hassledine’ could have been a relative of John, or he may have been unrelated.
[47] Awty 1981
[48] Evans 1998, 1999
[49] Evans 1998, p.146
[50] SA 112/5/17/1
[51] SA 322/6/9 (1796)

that shortly after John Hazledine took over the tenancy of the cottage.[52] So what was the role of the Russells at the Forge? The document already referred to, describes them as 'hammermen.'[46] The process of converting pig iron to bar iron required the removal of carbon from the iron (decarburisation) and took place in two stages,

> *In the first phase, pig iron was melted down...in a charcoal-fired hearth known as a finery. The mass of refined metal and slag which was pulled from the hearth was then beaten into a roughly shaped lump known as a bloom. This was the work of finers. The concluding phase was undertaken by a team of hammermen who presided over a second hearth, the chafery. Here, the blooms were reheated and drawn out under the forge hammer into the desired gauge of bar. Because hammermen were able to draw bars out of blooms faster than finers could produce blooms, it was conventional for two finery hearths to be teamed together with a single chafery* [which was the case at Moreton Forge[53]]...*A three-man crew laboured at each hearth. A master finer, a bloom maker and an apprentice worked at each finery, whilst a master hammerman, a 'hammerman's man' and an apprentice worked at the chafery.*[54]

[52] SA 322/6/6 (Rental of the Corbet Estate for 1730 records a blank next to Widow Russell, underneath which is written, 'John Hazledine £0 1s 0d')
[53] SC, sale of Moreton Corbet [sic] Forge, 18.4.1794
[54] Evans 1998, p.147

Figure 5 Chafery Hearth, with water powered bellows (Angerstein's Travel Diary 1753-55, 2001 Edition, p.150)

No doubt members of the Russell family worked together as a unit at one or both of the chaferies (Figure 5). The work was physically demanding, extremely noisy (due to the constant working of the mechanical hammers), and required a lot of skill to ensure that the iron was heated and worked to the correct degree (Figure 6). The quality of the finished product also varied depending on the amount of impurities in the original metal. The presence of sulphur made the metal brittle when hot (hot short), and so impossible to work, while an excess of phosphorus made the iron brittle when cold, or cold short.[55] Considering that the knowledge of metallurgy at this time was rudimentary, it is easy to see why iron production tended to remain in families who knew the tricks of the trade, learned both from upbringing and experience.

[55] Gale 1979, p.182

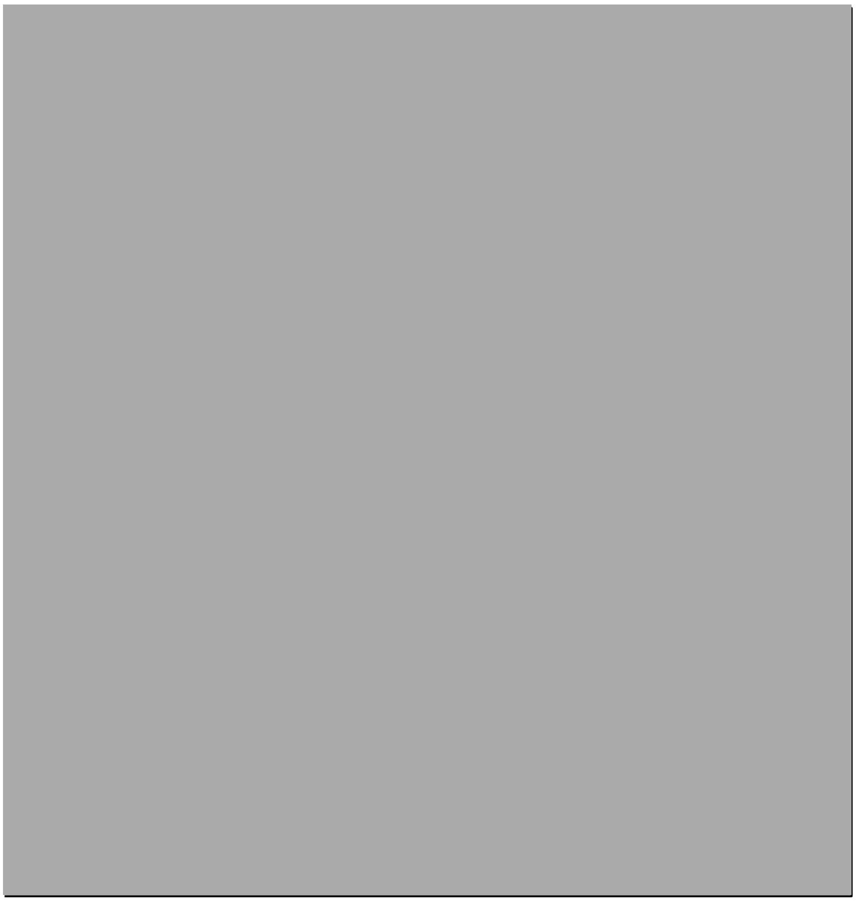

Figure 6

Hammerman at work. Detail from William Hazledine's millwrighting advert c1790 (SA 901/1). The illustration contains some artistic licence, but gives an idea of the process. Notice the chafery hearth to the hammerman's right in which he heats the bar, which is then positioned under the water powered hammer to be drawn out to shape.

Moreton Forge was certainly in operation by 1627,[56] and it is likely that it was built in the early 17th century,[57] presumably as a speculative venture by the Corbets, who sited it further up the River Roden to keep the noise and smoke away from the village.[58] The forge was rented in 1649 by William Browne and John Tenshopp,[59] and later in the century by the Payne family of Shawbury.[60] They employed a manager, often called a clerk. One such was Richard Knight (1659-

[56] SA 322/6/2
[57] Trinder 1996, p.16
[58] In this they were wiser than the Hills of Tern Hall (later Attingham Hall), who bitterly regretted setting up a large forge within sight and sound of their stately home (Coulton 1989)
[59] SA 163/63
[60] SA 322/6/4; see also Hearth Tax records for 1672, SA C63

1745), who married Elizabeth Payne, daughter of Andrew Payne in 1692.[61] Richard Knight managed the forge from about 1685 to 1700.[62] After that time he devoted his energies to the Stour Valley partnership of Worcestershire and Hereford.[63] The Knights continued to be in partnership with the Paynes at Moreton Forge, however, and the only surviving accounts for Moreton Forge (for the years 1721-23) are to be found amongst the Knight papers.[64] These show that for this 20 month period the profit was £538 19s 0d. At that time the annual output of the forge was about 140 tons,[65] so they were making about £2 6s a ton profit after all expenses had been paid. One significant expense was the salary and house for the clerk, which amounted to £121 16s for two years. Assuming the clerk was paid £60 a year salary, the other £1 16s matches almost exactly with the amount that another Russell, William, paid in rent to the Corbet estate for his house and adjoining ground. It seems highly likely, therefore, that William, presumably also a relative of Grace, was the clerk at this time. Among the other outgoings was payment to a 'carpenter', probably around £15 -20 a year, though as it is aggregated with other wages it is difficult to know the exact amount. Millwrights often worked as forge carpenters (for example William Hazledine later advertised that as one of his services[66]), so it is probable that John Hazledine was the forge carpenter. So what did he do?

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[61] Ince 1991, p.2

[62] Records of nearby Withyford Forge for 1687 (SA Apley Castle papers 625/Box 15) make mention of 'Mr Knight'; five of Richard and Elizabeth's children were baptised at High Ercall where they lived from at least 1692-1697.

[63] Page 1979; Ince 1991

[64] Hereford Record Office T74 431/2

[65] Hill 2003, Table 3

[66] SA 901/1

In 1754 Charles Wood visited a number of the Shropshire forges and wrote the following (a helve was a type of trip hammer designed to deliver 60 blows a minute (Figure 7)[67]).

> *The carpenter's business is as follows – to prepare keys and wedges etc, but if any key or wedge and any small thing is to be done in the night, or at any other time, the hammerman is not to wait to call the carpenter, but to do it himself. This is the custom in all these parts – the iron on the top and bottom of the helve is let into the helve, and a thin board is put upon the iron between it and the bray.* [The exact nature of the 'bray' is not clear; 'brays' is a dialect version of small coke or coal,[68] hence the bray may have been the bed of heated coke or charcoal on the chafery floor upon which the bar of iron was hammered]. *Likewise, a thin wedge next to the pole of the hammer and the iron. The iron to be 6 or 8 inches long, behind the bray. The iron not to be thicker than ¼ of an inch thick, and to be rolled.* [69]

[67] Gale 1979, p.155
[68] Jones 2006; interestingly, Angerstein recorded that at Tern Forge 'pitcoal is used in the chafery, although small charcoal is employed when dense or soft iron is made' (2001 edition, p.328)
[69] Hyde 1973

Figure 7
'An Iron Forge' by Joseph Wright (1734-97). The original is in the Tate Gallery.
Though perhaps 'sanitised', the picture clearly shows a belly helve – a helve hammer lifted in the middle by cogs attached to a water-driven wheel.

So it appears from Wood's description that the forge carpenter's job was to make wooden wedges and other pieces ('keys') to fit on the hammer head, which the hammerman could then use to produce bars of the required size and shape. Because they were constantly subjected to the pounding of the hammer, these pieces of wood didn't last long, so the carpenter would doubtless make up many at a time in various sizes. The fact that the hammerman was to make up his own pieces temporarily if they ran out when the carpenter was 'off duty', suggests that the latter would sometimes be away doing other work. For, in addition to the rather mundane work described above, 'The role of the forge carpenter appears to have been in organising the building of the forge, rather than [just] a more lowly maintenance role.'[70] Wood confirms this, stating that the carpenters at Sutton and Tern Forges 'do all the new and old work for 8s[hillings] a week, house and fire.'[71]

[70] Hayman 2003, p.75
[71] Hyde 1973

Eight shillings a week is £20 8s a year, which, with house rental and free coal, was a very adequate income for the time.

The Hazledine family, then, would be thoroughly immersed in the world of ironmaking. No doubt it was one of the major topics round the table and fireside, one as impossible to escape from as the relentless thumping of the forge hammers 6 days a week, and often at night, as Wood described. John Hazledine remained at Moreton Forge till he died in 1767, and there he brought up his family. He and Grace had another four children, though only Ann (born in High Ercall in 1717), John junior (b 1729) and William (b 1734) survived to adult life.[72] Both John junior and William followed in their father's footsteps and became millwrights (presumably they were apprenticed to their father). John senior appears to have prospered. By 1744 (but probably considerably before, since records were kept differently before that year) he was able to rent land on the Grange Ground in addition to his house (Figure 8).

Figure 8

Shawbury Parish Poor Law payments, 1744 (SA P241/L/4/4-5)

[72] SA Shawbury fiche P241/A/40 - 41 Ann married a Richard Mebrey just two months after her brother William was born. The Mebreys were another ironworking dynasty of French extraction like the Russells, and Richard, too, lived at the Forge. Richard and Ann had a daughter the following year, but Richard died the year after. Ann remarried in 1739 to Edward Onslow of Shawbury, and lived in some comfort judging by the size of their rentals (SA 322/6/9)

The tenancy of the forge changed several times between 1730 and 1759.[73] Presumably whoever leased it relied heavily on the workers such as the Russells and John Hazledine, and the production of bar iron at 150 tons a year, was, if anything, slightly up on earlier figures.[74] An estate map, probably dating from 1735, shows the forge with a number of houses dotted around it (Figure 9). From a later document it is possible to identify that the Hazledine's residence was just off this map beyond the forge.[75] Around 1752 the Corbets appointed a new Estate Steward (or manager), Joseph Steedman,[76] who instituted proper rent books for the tenants such as John Hazledine (Figure 10).[77] Perhaps it was Steedman who encouraged the Corbets to develop and modernise the Forge, for in 1757 they signed a lease with John Wilkinson, ironmaster of Wrexham, and Edward Blakeway of Shrewsbury.[78]

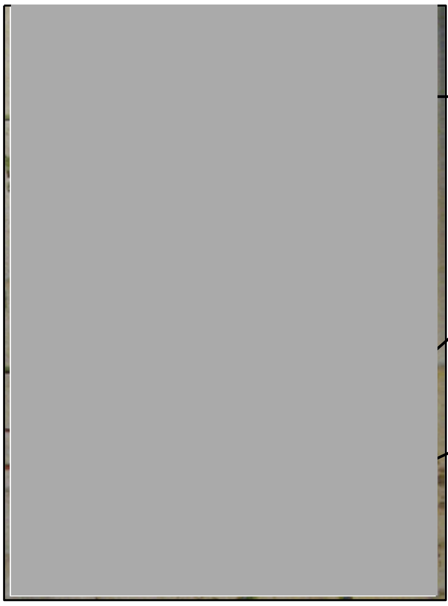
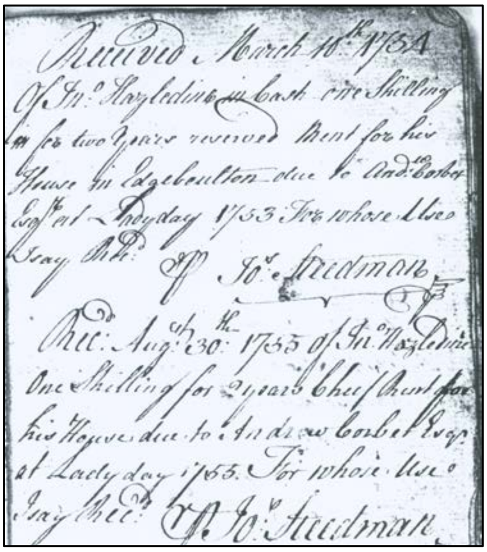


Figure 9
Moreton Forge c1735 (SA 2609/2)
The River Roden has been dammed by a long retaining wall to the north of the lane to form a large pool.
The forge is situated just to the south of the pool at the start of the leat. The original river channel carries excess water.
There are a number of cottages surrounding the forge
Probable position of Hazledine residence is just off the map.

[73] SA 322/6/6; P241/L/4/4-5; SA 6000/18287
[74] A List of Ironworks in Great Britain 1794, copied from W Wilkinson, Boulton and Watt Archive, Birmingham City Archives MS 3219/6/161
[75] SA 322/9/12
[76] P241/L/4/4-5
[77] Rent book kindly lent to me by the Hazledine family
[78] SA 1396/3

John ('Iron Mad) Wilkinson (1728-1808), who was to become a significant figure of the Industrial Revolution, had started his career in his father's ironmaking business at Bersham, near Wrexham. An ambitious man, he wished to expand into the rapidly developing industrial area of east Shropshire, which is presumably why his attention was drawn to Moreton Forge. He was financially supported by Edward Blakeway, a rich Shrewsbury business man, who would later become his brother-in-law.[79] The same year that he signed the lease for Moreton Forge he also entered into partnership with six others to develop the New Willey Ironworks. Perhaps he originally intended to run Moreton and Willey together; more likely, he had second thoughts about Moreton, recognising that Willey had far more potential, being near to the ironworking heartland, and especially the vital artery of the River Severn. In any event, he did nothing about developing Moreton Forge as he had promised, and in 1759 he assigned the lease to a new partnership, which consisted of Arthur Davies, George Perry, Isaac Colley, Richard Smith and Joseph Steedman.[80] Arthur Davies and George Perry were partners in the Lightmoor Ironworks,[81] Isaac Colley and Richard Smith were 'gentlemen' from Old Hall Wellington and Upton Magna.[82] Steedman has already been mentioned; he probably supervised the work while the others provided the financial backing.

[79] Braid 1991
[80] SA 1396/3
[81] Trinder 1981, p.271
[82] SA 1496/425



Received March 16th 1754
Of Jno. Hazledine in Cash one Shilling
for two years reserved Rent for his
House in Edgebolton due to Andw. Corbet
Esqr at Ladyday 1753 For whose Use
I say Recd.   P Jo. Steedman

Rec: Aug 30th 1755 of Jno Hazledine
One Shilling for 2 years Chief Rent for
his House due to Andrew Corbet Esqr
at Lady day 1755. For whose Use
I say Rec: P Jo: Steedman

Figure 10
Entry from John Hazledine's rent book, signed by Joseph Steedman, estate steward
(Rent book loaned by Hazledine descendents)

Figure 11
Moreton Forge - eroded date stone indicating that it was rebuilt in 176?
(Frost 2003)

Their lease required them *'to build...before 25th March 1761 at their own cost upon part of the old forge pool dam a substantial forge, with weirs, floodgates, bolts, troughs, soughs, penstocks and other conveniences for the use of forges.'*[83] This they evidently did, as the surviving building dates from this period, though, sadly, the date stone is too badly eroded to show anything more than 176?[84] (Figure 11). With John Hazledine and his two sons living next door it is hard not to believe that much of the work was done by them, but there is no documentary evidence for this. Whether or not they had a hand in the rebuilding of the forge, the Hazledines certainly benefitted from it, since John senior agreed to assign the lease for one of

[83] SA 1396/3
[84] Frost 2003

his houses to Joseph Steedman and the other proprietors of the forge.[85] In addition to the forge, the new partnership also built up to 10 extra houses for workmen, in two of which John Hazledine senior and junior (now married with young children) lived.[86]

Despite the rebuilding, the forge did not prosper. Joseph Steedman's first wife Emma died in 1760, shortly after giving birth.[87] Joseph soon married again, but he himself died in 1766, leaving his new wife Catherine to carry on the business.[88] Poor Law returns for 1769 record that the Forge proprietors were unable to pay the rate of £2 5s for 1768 or £2 8s 9d for 1769. Catherine Steedman also owed her own 3s 6d rate,[89] suggesting severe financial hardship. In 1775 William Hallen of Upton Forge was brought into the partnership, and in 1782 he was joined by his partner at Upton Forge, John Wheeler.[90] Wheeler became the managing partner, and presumably the idea was that the finance and expertise of Hallen and Wheeler would help to rescue the struggling business. This evidently did not work, as the output of bar iron for 1787 was estimated at just 80 tons, having been 150 tons 40 years before.[91] In 1790 Richard Watson joined the partnership, as he had at Upton Forge, for £250[92], but in 1794 his bankruptcy finally closed the forge. Advertisements failed to find any interested parties, and it appears that, unlike Upton, the bankruptcy commissioners made no attempt to find an interim solution.

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[85] SA D3651/D/5/28
[86] Poor law accounts (SA P241/L/4/4-5) show an extra 10 dwellings in 1759; SC 18.4.1794 advertises 6 workmen's houses
[87] SA Shawbury fiche P241/A/53
[88] P241/L/10/3
[89] SA P241/L/4/4-5
[90] SA 1496/424 & 425; details of Upton Forge in Chapter 8
[91] Birmingham, B&W Archive, MS 3219/6/161
[92] SA 1396/3

John Wheeler remained the nominal lessee, but as he was charged no rent in 1796, the forge was evidently lying empty.[93]

Soon after this, the forge was converted to a corn mill and later in the nineteenth century the site had both a corn mill and a saw mill, the latter surviving until well into the 20th century (Figure 12).[94]

Figure 12

Moreton Corbet sawmill (20th century), looking from the forge pool across the dam and the road towards the mill (Shrewsbury Museums Service)

[93] SA 322/6/9

[94] http://www.discovershropshire.org.uk/; SMRNO15659

3. MOULDING

As already stated, John Hazledine ('John II' on the family tree, page 14) had three children who survived into adulthood - a daughter, Ann, and two sons, John (III) and William (IV). This William was baptised at Shawbury on November 24th 1734.[95] School records for the period have been lost, but we do know that the children of the Corbet Estate attended a school at Moreton Corbet. This was supported by both the Church and the Estate, and in all probability was in existence long before 1800.[96] The education was basic, with a strong emphasis on the '3 R's', but was obviously effective as far as it went. The evidence for this is in William Hazledine's notebooks, which are written in a clear copperplate hand, with even a smattering of Latin, which demonstrate that he was also well versed in maths and book keeping.[97] He presumably left school at age 12 and was then apprenticed to his father as a millwright, the usual term for the apprenticeship being seven years.

By September 1754, aged just 19, he was forge carpenter at the Tern forge, where he earned the not inconsiderable sum of 8 shillings a week plus house and coals.[98] The Tern Forge complex (SJ 552099) was located in the grounds of Tern Hall (now Attingham), and comprised a forge for converting pig to bar iron, a rolling mill, a slitting mill, a wire mill, and a furnace for converting iron into steel. At its height in the 1730's over 80 men were accommodated on the site, but by the time William

[95] SA, Shawbury fiche P241/A/41

[96] Lea 2005, p32

[97] Two notebooks, kindly lent to the author by Hazledine descendants – one was originally his father's rent book. If not otherwise stated, all the information about William Hazledine senior in this chapter is obtained from this source

[98] Hyde 1973

Hazledine worked there the number was probably half that.[99] But even in 1754 there must have been plenty of work for a full time forge carpenter (Figure 13).

Figure 13 - Tern Hall and mill, c1701 (Coulson 1989, p.99)
Tern Forge was built on the site of the mill in 1710. Presumably William Hazledine senior lived in one of the cottages portrayed

The Hills of Tern Hall had long been looking for a way of evicting their noisy tenants, which they did at the expiry of the Forge's lease in 1756. By mid-May of the following year all the buildings, in which at least £10,000 had once been invested, had been demolished for the sum of £16 10s.[100] So all the workers, including William Hazledine, were dismissed. He set up on his own account as a millwright back at Moreton Forge, and it was presumably at this time that he started his notebook, which begins,

'*William Hazeldine [sic], his Eigust Liber 1755.'*[101] It then goes on –

> *If this be lost, and you it find,*
> *I pray you bear a [sic] honest mind,*
> *And so restore the same again,*
> *To him that answers to this name.'*

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[99] Chaplin, 1961, Denton and Lewis, 1977
[100] SA 112/12/Box 23/125
[101] Exactly what the Latin means is a puzzle. Presumably *liber* is 'book', and the best suggestion for *eigust* is that he meant *eius,* 'his', so perhaps the phrase is 'his own book'

This rhyme gives us an impression of a young man full of self-confidence with an ordered mind, but who was keen to hold tightly to his material possessions. On April 23rd 1758 he was married in Shawbury Church,[102] to Mary Morgan, members of whose extended family had been in the area for generations. They also seem to have been much better off than the Hazledines, judging by the fact that her wedding dress was of such quality that it was eventually donated to the Shrewsbury Museum (Figure 14). The young couple lived somewhere in Shawbury, perhaps with her parents.[103] Their first son, John (IV in the family tree), was born in 1760, but curiously there is no record of the event in the parish register.[104] William junior (V in the family tree) was born on April 6th 1763, and once again, the parish register does not mention the event, but attached to the register is the following written on a slip of paper,

> *William Hazledine, born April 6th 1763. The above extraction is taken from the family Bible of Mr Hazledine of Shrewsbury and was affixed to the register of baptisms in this parish at his particular request this 28th day of May 1837 by me, WS Marvin, Vicar of Shawbury. I have been given to understand that the family of the Hazledines lived for many years at Moreton Forge in this parish, WSM.*[105]

The occasion in May 1837 was probably when William Hazledine, now rich and famous, presented two chairs to the church where he was brought up, and in which he assumed he had been baptised (Figure 15). Perhaps he was curious and asked to

[102] SA Shawbury fiche P241/A/62, where he is described as 'millwright of this parish'
[103] SC 30.10.1840
[104] Joseph Morris, *Hazledine of Shrewsbury and Waters Upton*, in Genealogical Manuscripts connected with the County of Salop, Vol. 8 p.4010, SA microfilm 153; Obituary, *Gentleman's Magazine,* Vol. LXXX, Part II, 1810, p.659
[105] SA Shawbury fiche P241/A/53

see the parish register, and was surprised to find no reference to his baptism, hence the addition. Three years after William's birth, he and his brother were joined by a sister, Mary. The following year their grandfather John died, and after this William senior took over the rental of his father's house, and so the whole family moved in with grandmother Grace at Moreton Forge.[106] Later additions to the family were Robert (born 1768), Thomas (1771) and Jane (1773).[107]

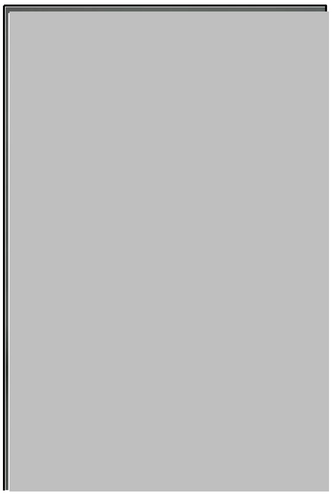


Figure 14 Mary Morgan's cream silk wedding dress (Shrewsbury Museums Service)

Figure 15 One of two chairs presented to Shawbury Church by William Hazledine in 1837 (the author)

The house where they probably lived is almost next to the Forge on the lane leading up to the Market Drayton road (Figure 9).[108] It has been much altered, but gives the impression of having been larger than average, even then (Figure 16). All the children went to the village school, where they received a sound, if basic, education. Though he excelled at practical subjects, William junior was an omnivorous reader of both prose and poetry. A contemporary wrote,

> *Although [he] did not possess all the advantages to be derived from a liberal education, he had been well instructed in his youth, and could converse with*

[106] SA P241/L/4/4; also Rent Book
[107] SA Shawbury fiche P241/A/53 (Robert and Jane), Thomas not recorded in Parish Register, details from Joseph Morris, op.cit.
[108] SA 322/9/12 – record of a survey prepared prior to an Enclosure Act

freedom and fluency on almost every subject connected with the arts and sciences; on religious subjects he was least at home. The books in which he chiefly delighted were the poems of Burns and Campbell, and works of Sir Isaac Newton...[109]

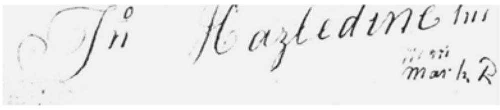
Figure 16
The house where William Hazledine probably grew up (the author)

Figure 17
The *Elephant and Castle*, Shawbury, still going strong after more than 275 years! (the author)

Presumably he left school at the age of 12 or 13, in 1775/6. From his father's notebooks, we know that he began his apprenticeship as a millwright on May 11th 1778, so what he did in the intervening two or three years is not clear. A likely scenario is that he worked with the Russells in the forge, which would explain why he had such an intimate practical knowledge of working with iron. He was apprenticed to his Uncle John, rather than his father, because his father already had an apprentice, John, William's older brother.[110] The contract of apprenticeship between John and his father is recorded in the father's notebook, and it reads,[111]

[109] Hulbert, 1839, Appendix, p.3
[110] His uncle only had daughters
[111] I have 'tidied' the spelling and punctuation

John Hazledine begun to work May 29th 1774 [he was 14]. To continue on till May 29th 1781 with God's help. But if he loses any time or does disobey his father or his mother, he shall upon such offence have his arse rubbed with a brick quite raw. This indenture to remain in full force till the time set as above.



These fierce words tend to give the impression of William senior as a rather hard and ruthless man. However, he was fair, keeping a record of the hours John worked, presumably with a view to calculating his pay, and recording payment of money owed to his other children. William senior was more than just a millwright. In 1761 his notebook records the death of one Robert Morgan, presumably his wife Mary's father or grandfather, and William Hazledine also recorded the receipt four days later of 'the investor's token'. The most likely explanation is that this was an investment made by Robert Morgan and now passed on to Mary. Later in his notebook, William lists various legacies that Mary received at different times, which totalled £140 (worth around £9,000 at today's prices).[112] Such riches enabled him to diversify from millwrighting into money lending. Often he charged 5% interest on sums of a few pounds lent mostly to neighbours.[113] During the 11 year period 1773-1784, he received £56 16s interest from this source, which means the total amount he lent must have been about £1,086 (around £69,000 in today's money). Sometimes individual sums were larger, for example he lent a Mr Turner £43 in 1788. There seems to have been a certain amount of ill-feeling between the two

[112] The National Archives Currency Converter has been used here and elsewhere in the thesis
[113] Many of the names are also recorded in the Parish Registers or Poor Law Assessments

men, for the notebook records that Turner 'ordered' Hazledine to meet him at *'ye Elephant, Shawbury'* [the Elephant and Castle pub], presumably to discuss the matter (Figure 17). But Hazledine got his own back for such behaviour, charging Turner two shillings for the loss of one day's pay! He seems to have charged for everything, and even his own brother had to pay 6 shillings *'for loss of time and expenses'*.

In time his money lending activities spread further afield. He placed the following advertisement in the Shrewsbury Chronicle in 1788.[114]

> *Notice is hereby given that all persons who stand indebted to Humphrey Morgan, clockmaker, late of Minsterley, deceased, are desired to pay their respective debts to William Hazledine of Moreton Forge or Mr Benjamin Withers of Minsterley by the 24th of June. And all persons having any of the working tools of the said Humphrey Morgan in their possession are desired to [return them to the] address as above, or otherwise forceable [sic] means will to taken to make them... N.B Any person as a witness, giving information of either the property or personality of the above, shall receive a handsome reward, and all reasonable expenses.*

One has visions of kind-hearted Humphrey Morgan lending his tools to all and sundry and getting into debt to the money lenders Hazledine and Withers, who would not hesitate to bring in the 'heavy mob' to get back what was owing to them. The wealth of William Hazledine is indicated by his ability to offer a *'substantial reward, and all reasonable expenses'*.

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[114] SC 14.4.1788 – I am grateful to Paul Luter for this reference

As well as money lending and his millwright's work, he was also involved in the running of a shop. This probably opened in 1785; there is no record of where the shop was, but one imagines it was in Shawbury village.[115] William's accounts differentiate between the stock that he himself owned and items that were under the jurisdiction of his daughters Mary and Jane, and later his wife, once the girls had married and left home. So it was perhaps some sort of general store, with the women overseeing clothing and other ladies' items, while he dealt with hardware (wood is mentioned in a otherwise unintelligible list of his stock). Whatever it sold, it evidently prospered, with the value of stock rising from £16 in 1786 to £210 12s in 1815. Each New Year's Day from 1777 until his death in 1818 he meticulously added up how much he was worth. This included his income from millwrighting, his money lending, and the shop, and shows a steady growth from £254 in 1777 to a maximum of £1009 11s in 1815, his 80th year (around £34,000 in today's money). Almost every year the turnover increased; not all of this was 'cash in hand', but considering that a skilled craftsman such as a mason would expect to earn around £50 a year,[116] the family must have lived in considerable comfort as compared with their neighbours.

So we may assess William senior's character as hard but fair. This is confirmed by a terse obituary in both the *Shrewsbury Chronicle* and the *Salopian Journal* after his death. *'A truly honest man'*, is all it says.[117] Rather different is the obituary of Mary, his wife, which reads,

115 The first record of it is a valuation of the stock on 1.1.1786
116 Skempton and Chrimes 2002, Appendix I, pp. 821ff
117 SC 30.1.1818; SJ 28.1.1818

Died, on the 5th last, aged 82, Mrs Hazledine of Moreton Corbet Mill, in this county, mother of Mr Hazledine, ironmaster of this town. A truly good Christian, a kind mother and sincere friend to the poor and all around her and whose name will long be held in grateful remembrance.[118]

The esteem in which she was held is perhaps further evidenced by the fact that death notices were inserted in two national magazines, one of which adds the phrase *'deservedly esteemed'*.[119] There is no notice in these magazines of William senior's death. Assuming that these death notices were inserted by their son William they speak volumes about his relationship with his parents. These family dynamics, however, do give us some insight into the young man's character. His father's honesty, business acumen, and meticulous organisation must have rubbed off on him, as did a ruthless streak when it came to making money. On the other hand his mother was warm-hearted and generous, both with her children and those less fortunate than herself. These qualities, too, the young William would demonstrate in his adult life.

Another significant influence on young William was his uncle John, to whom he was apprenticed on May 11th 1778. Uncle John was described as 'of considerable ability as a millwright and engineer,'[120] which is an indication that he was more than just a traditional millwright, but applied his knowledge to the infant field of mechanical engineering, like his contemporaries James Brindley (1716-72) and John Smeaton (1724-92). Information on Uncle John's professional work is

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[118] SJ 10.9.1817

[119] *New Monthly Magazine and Universal Register*, October 1st 1817; *Monthly Magazine*, October 1st 1817

[120] SC 30.10.1840

unfortunately scanty, but it is likely that he was engaged on similar work to his brother, who listed major work at four sites in his notebooks – Shinewood, Ryton, Marston and Linley. Shinewood (SJ 605036) is near Sheinton, and his commission there was to rebuild the water corn mill, probably in the late 1770s when the estate was taken over by a new owner.[121] For this he was paid £95. The village of Ryton is south of Shifnal, and there were a number of mills and forges in the area. Which one he worked on is not clear, as he only mentions a 'new mill' powered by water, and the date is not recorded. Marston is near Northwich, Cheshire, and the forge is now obliterated by the Lion salt works.[122] William Hazledine senior worked there for 15 weeks in 1776 and a further 8 weeks in 1782. Linley lies between Broseley and Bridgnorth, and it is possible that William, with his son John, who was then his apprentice, worked on one of the Wren's Nest Forges (SO 701981 and SO 706983). In 1777, when William was employed there for 51 days and John Junior for 47, the site had recently been taken over by John Wright and Richard Jesson, who modernised it for their new 'stamping and potting' process.[123]

It is likely that 'Uncle' John had an even more widespread practice than his brother. In May 1781 he was contracted to repair Ffatri Forge, in the parish of Llanfihangel Genau'r-glyn (otherwise known as Llandre), Cardiganshire. Obligingly, the forge's owner, David Morgan, wrote to John Hazledine that if he couldn't stay for the whole time he could leave 'a good careful hand to direct the remainder of

[121] Andreae 1990
[122] The owner of the forge at that time was Nicholas Ryder, who made boiler plates for James Watt, among other things. Birmingham Public Library, Boulton and Watt collection, General Correspondence 'R', 73-75
[123] Trinder 1996, p.127

the work.'[124] Young William, by then aged 18, must have been the ideal candidate for the job, since he had already drawn attention to his precocious ability. A year earlier he had been entrusted by his uncle to erect some new machinery at Upton Forge, which he did to everyone's satisfaction.[125] This sort of generosity and personal encouragement seems to have been the hallmark of Uncle John. In 1752 he and his wife Ann took as 'apprentice' Ann Cartwright, who was the responsibility of the parish poor law overseers.[126] Ann Hazledine was responsible to train her in domestic duties so that she would be suitable to go into service. In the same way John taught his young apprentice many of the skills he would need for his future career. These included technical drawing, carpentry, building and masonry work, surveying, and learning how to channel water for mill work, as well as working with iron, with which he was presumably already familiar. William proved a ready pupil, and by the time he finished his apprenticeship in 1785 at the age of 22 was ready to make his own way in the world.

As well as technical ability, his appearance and personality were also impressive.[127] Tall and broad-shouldered, he was immensely strong. His facial features were heavy and rather forbidding, but he had a ready smile when pleased or amused. He was a man of few words, with a bluff manner and unpolished Shropshire accent, but he had a ready wit and was convivial in company. He had considerable ambition, but this was always tempered with caution in business

[124] National Library of Wales, Cwrt Mawr file 823D, Iron Forge letter book
[125] SC 8.11.1901
[126] SA P241/L/16/28
[127] This list is compiled from the tribute in SC *Notes and Queries,* Nov 8th, 15th, 22nd and 29th, Dec 6th 1901. There is a copy in Phillips, W, *Shropshire Men,* Vol. 5, pp.268, SA Microfilm 167

affairs. This enabled him to build up a successful business while many other people went to the wall in the turbulent political and economic circumstances of the day. He could be ruthless in business, like his father, but, he was sympathetic to the needs of his workers, unlike many of the employers of the day. Above all, he was a man of immense energy, throwing himself into a bewildering array of different branches of work. But this was balanced by attention to detail, which enabled him to generally maintain a reputation for accuracy and promptitude in his business dealings.

4. THE YOUNG MILLWRIGHT[128]

Assuming that he completed his full seven-year apprenticeship, William Hazledine was free to set up on his own in May 1785, when he was 22. To further his ambition in both the iron and millwrighting trades he decided to move to the county town of Shrewsbury. His progress in the iron trade will be considered in the next chapter. To establish a millwrighting business must have been a challenge, since many other experienced men, such as his father and uncle, were already well known. However, agriculture was developing rapidly, stimulated by the 'improvements' of large landowners and the progress of enclosures. The increase in cereal production and improvements in transport enabled landowners to concentrate their milling activities in fewer, but larger, mills. As a result, many mills were enlarged or improved, and a number of new ones were built in the late eighteenth and early nineteenth centuries.

Evidence for this is provided by the following advertisement for the mill at Sheinwood (SJ 615027), *'lately [1806] erected...under the directions of Mr Hazledine*.'[129] The mills comprised both a longstanding watermill, which William senior had worked on 30-odd years before, and which his son presumably modernised, and a windmill, which appears to have been designed and built by Hazledine junior (Figure 18). The advert further explained,

> *The above mills, which drive six pairs of stones, have been lately erected, upon the most approved principles, under the directions of Mr Hazledine, and no expense spared to make them as convenient as possible. The situation for the*

[128] I am grateful to Tim Booth for his comments on this chapter

[129] SJ, 12.2.1806

purchase of corn, as well as the sale and delivery of flour, is very eligible, not being more than one mile distant from the River Severn, ten from Shrewsbury, seven from Wellington, and the iron and coal works in that neighbourhood, and two from Wenlock, all capital wheat markets, and to which places there are good turnpike roads from the mill...

In summary, the landowner who redeveloped the mill expected the new tenant to buy wheat and other cereals in significant quantities from the markets in the surrounding towns. From this he would produce flour which he would sell on to bakers in the nearby populous industrial area of East Shropshire. Things had moved a long way from mills being used almost entirely by local subsistence farmers for their own use.

Figure 18

Shinewood Mill, as reconstructed in the 1990s (the author)

In 1785 the young William Hazledine needed to establish his reputation to share in these developments. Being of an entrepreneurial nature he realised that one thing that Shrewsbury lacked was a maker and supplier of millstones, especially the French burrs that produced the finest white flour then becoming popular. The young William had heard that a cargo of French burrs had recently arrived in Bristol, and were up for auction. But he certainly couldn't afford the £80 or so that would be needed to buy them, so he asked his mentor Uncle John for the loan of the money. John, generous as always, agreed. What he said next made a deep impression on the young man.

> *"Have you any security," asked his uncle, "that you will repay me the money?"*
>
> *"None," said William, "except my own conduct."*
>
> *"That's enough lad," said the generous donor, "but one guarantee I shall require, which is this – name your day for repayment, but let it be distant or near as best suits you; for if you wish to please me, or succeed in the world, attend punctually to your promise, and you will never lose a friend and very seldom require one."*
>
> *The borrowed money was punctually returned on the promised day, and the advice of his uncle was the rule of his conduct through life.*[130]

Having bought his stones and transported them to Shrewsbury, he had to make them into the finished article. French burrs had been known to produce the finest millstones for centuries, but it was only in the previous hundred years that they had been imported into Britain in significant quantities. The stone is an unusual form of chert (a quartz-like rock) that occurs most commonly in the Paris basin, especially around La Ferté-sous-Jouarre.[131] The stone mostly occurs in quite small pieces buried in clay, which means that the standard millstone of between 4 foot and 4 foot 6 inches diameter has to be made up of smaller pieces. The reason this stone is so good is that it is 'porous' (having small holes), which means that, even

[130] SC 8.11.1901
[131] Watts 2008, p.31; Ward 1982

untreated, the surface will grind satisfactorily. The stone is also so hard that the amount of surface stone ground off with the flour is negligible. If the surface of the stones is worked on, the furrows so produced will last without further attention for weeks.

> *The consequences of these qualities were that the best millstones, well maintained, could operate quite subtly on the grain so that the bran would be sliced and travel separately through the stones instead of being churned up with the white flour, and thus it could subsequently be sifted out.*[132]

Hazledine's French millstone making workshop was near the English Bridge in Shrewsbury. His trade advertisement shows how they were manufactured (Figure 19).

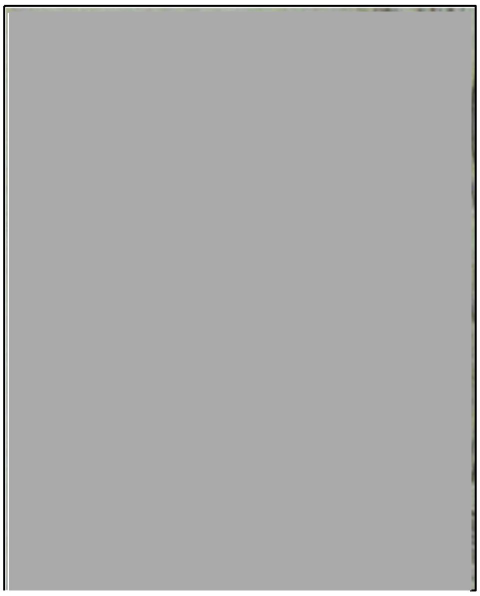

Figure 19
French millstone making
(SA 901/1)

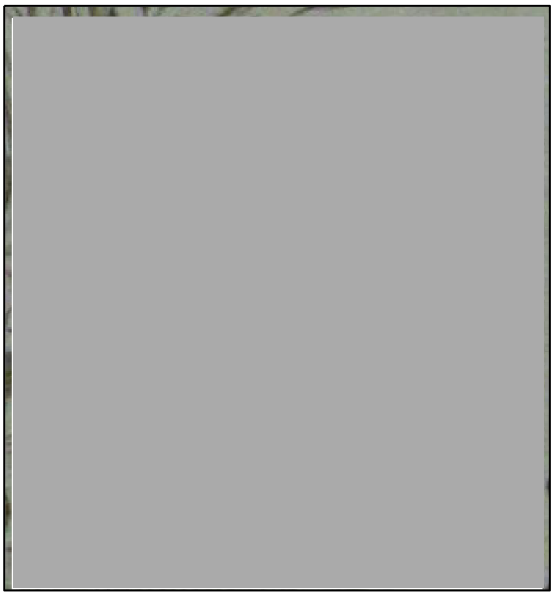

Figure 20
Preparing the milling surface
(SA 901/1)

[132] Ward, 1982, p.205

The millstone was made in an upright position, perhaps leaning against a wall. The pieces were fitted together like a jigsaw, in two concentric circles, starting at the centre or eye of the stone. The stone illustrated has about 19 pieces, quite a usual number. The pieces were joined with plaster, and the whole was tightly bound around the outside with two iron hoops, applied hot, like a blacksmith making a wagon wheel. The lower (or bed) stone had its underside set in a layer of plaster, flattened to fit on the floor of the mill. The upper stone (or runner) had its upper surface finished with a convex layer of plaster, which made it run better, since there in more weight in the middle. The runner also had pieces of stone set into it to achieve balance. Both stones were pierced centrally for the spindle on which the runner turns. The runner also had fixing holes for the rynd, the iron pieces that fix it to the spindle. Making French millstones was slow and laborious, and it is estimated that one man would probably have made only 8-12 of these in a year.[133] Once the stones had been made, their grinding surfaces were prepared. Hazledine's trade advertisement also shows this being done (Figure 20). This involved incising the surface with sharp pick-like instruments called 'bills'. This made a pattern that had been found from long experience to work best for both grinding the corn and separating it from the bran (Figure 21).

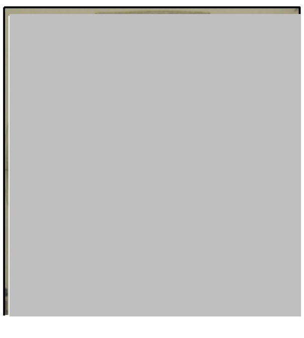

Figure 21

The finished bedstone

(Telford 1798, plate XIII)

[133] Tucker 1987

The cost of burrs at the time depended on quality, but was probably around £15-20 a hundred.[134] Hazledine paid £80 for his initial consignment; if they cost £15 per hundred, it follows that he obtained around 600 stones. If he used 20 pieces per stone, this produces 30 complete millstones, or 15 pairs. In 1785 the cost of these stones was around £25 a pair (though by 1816 he was charging £40 for a pair to be delivered on site[135]), so he would have sold his original millstones for about £375. Taking into account transport, labour (men earned around £15 a year) and wastage, he must still have made a handsome profit on his initial outlay of £80 (his father made around £50 profit a year from his millwrighting work). No wonder he could afford to pay his uncle back promptly.[136] He certainly prospered, for in November 1789 he was able to take over the shop and workshop of a whitesmith in Wyle Cop.[137] He presumably transferred his millwrighting and millstone making business there, as well as maintaining the whitesmith's shop. The property comprised a good sized house (in which he probably lived), another smaller house, a brewhouse, workshops and other outbuildings. The whole site was on the north side of Wyle Cop at the western end of the English Bridge, adjoining the river Severn (SJ 495124). In 1805 he purchased the freehold of the two houses and the rest of the site for £200.[138] In the autumn of 1804 he was also able to purchase Jones' Mansion next door for about £5,575, with a mortgage of at least £4000. This medieval property was quite run down, especially since the level of Wyle Cop had

[134] Aplin 1984, p.15; Farries 1981, p.120
[135] Estimate for a new mill at Longdon-on-Tern, Staffs Record Office, D593/L/4/7
[136] Figures from William Hazledine senior's notebooks and Tim Booth
[137] SC 27.11.1789 – I am grateful to Paul Luter for this reference
[138] SA 311/39, 40,41

been raised after the building of the English Bridge in 1769. After May 1805, Hazledine made both Jones' Mansion and his original property one site. He and his partner, the builder John Simpson, demolished Jones' Mansion and in its place built several houses, workshops, a laundry, stables, and warehouses, and this became the hub of his growing business.[139] During this rebuilding they also demolished whatever was left of the old town wall that ran across the site.[140]

But William Hazledine would not become significantly wealthy just by making millstones and repairing and renovating mills like his father and uncle. He needed connections with large landowners to have any success in obtaining the contracts to build the new mills that would bring in big money and make his reputation. Progress in this direction arrived from an unexpected source, Thomas Telford. Telford was appointed by Sir William Pulteney, reputedly the richest commoner in England, to rebuild Shrewsbury Castle as a family home. Telford probably arrived in Shrewsbury in late 1786.[141] Not long after this he was appointed County Surveyor for Shropshire through the influence of William Pulteney, and he quickly began to mix with large landowners through his surveying and architectural work. When Telford met Hazledine we do not know. One writer, having described Telford's arrival in Shrewsbury, wrote,

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[139] SA 311/10,11,12, 13, 14

[140] http://www.discovershropshire.org.uk/html/search/verb/GetRecord/CCS:MSA4671 .This website unfortunately confuses this Jones' Mansion with a building of the same name in Butcher Row, which was demolished in 1829.

[141] Rolt 1979 p.32ff; Burton 1998, p.19 – I have used these sources for general information on Telford

Telford and Hazledine soon made each other's acquaintance, much to their mutual advantage. They were both thoroughly practical men who had risen from the ranks by the force of character and mental endowments.[142]

In time this acquaintance became a lifelong friendship, details of which have been described elsewhere.[143] Rolt suggests that they met when Hazledine was accepted as a Freemason in 1789, though it was probably earlier than this.[144] At the time of his arrival in Shrewsbury, Telford was an enthusiastic Freemason, becoming a very early member of the Salopian Lodge in July 1788.[145] Hazledine was accepted into the Lodge in June 1789, but he seems to have been an infrequent attendee, only being present at one more meeting for the rest of that year, and just three times the following year. The members of the Lodge were mostly men like Telford and Hazledine – skilled craftsmen, shopkeepers and the like, with the odd surgeon and army officer. There were none of the men of influence to provide introductions to large landowners that Hazledine needed. By March 1791 Hazledine was being chased for non-payment of his subscriptions, which he repeatedly refused to do until 1795, after which the Lodge presumably expelled him (Figure 22). Telford meantime resigned as Lodge Treasurer at the end of 1790 and seems to have stopped attending two years later.

[142] SC 8.11.1901
[143] Pattison 2007
[144] Rolt 1979, p.66
[145] Freemason details are from the original minute books of Salopian Lodge, then numbered 525, kindly lent by the Secretary

Figure 22
Minutes of Salopian Lodge, Jan 6th, 1795
(Courtesy of Shrewsbury Lodge Secretary)

William Hazledine probably obtained the contacts he needed via Telford's access to Sir William Pulteney and other landowners. Hazledine himself also worked directly for Pulteney, who numbered among his estates the Manor of Deytheur in Montgomeryshire. In 1788 Pulteney obtained a parliamentary act to enclose 2600 acres on this and neighbouring estates.[146] Much of the area required drainage, which was done by damming or rerouting existing watercourses and digging new 'trunks'. For this the commissioners who oversaw the act appointed Hazledine as the surveyor, which meant he was responsible for doing both the original drainage work and also maintaining it for five years.[147] How much he was paid we do not know, but his contract stipulated a bond of £700, so considerable sums of money were involved.

At the same time as he was doing this work, Hazledine was beginning to obtain contracts to build new mills. This is documented in a treatise that Telford wrote for the Board of Agriculture in 1798, entitled *On Mills,* which appears never to have been published.[148] Presumably Telford got the writing commission via Pulteney, but quite why he was considered expert enough to advise landowners

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[146] SA D3651/B/9/5/8/16; Kain et al 2004; approximate grid reference is SJ 260180
[147] SA D3651/D/14/120
[148] Telford 1798, Telford and Burne 1936

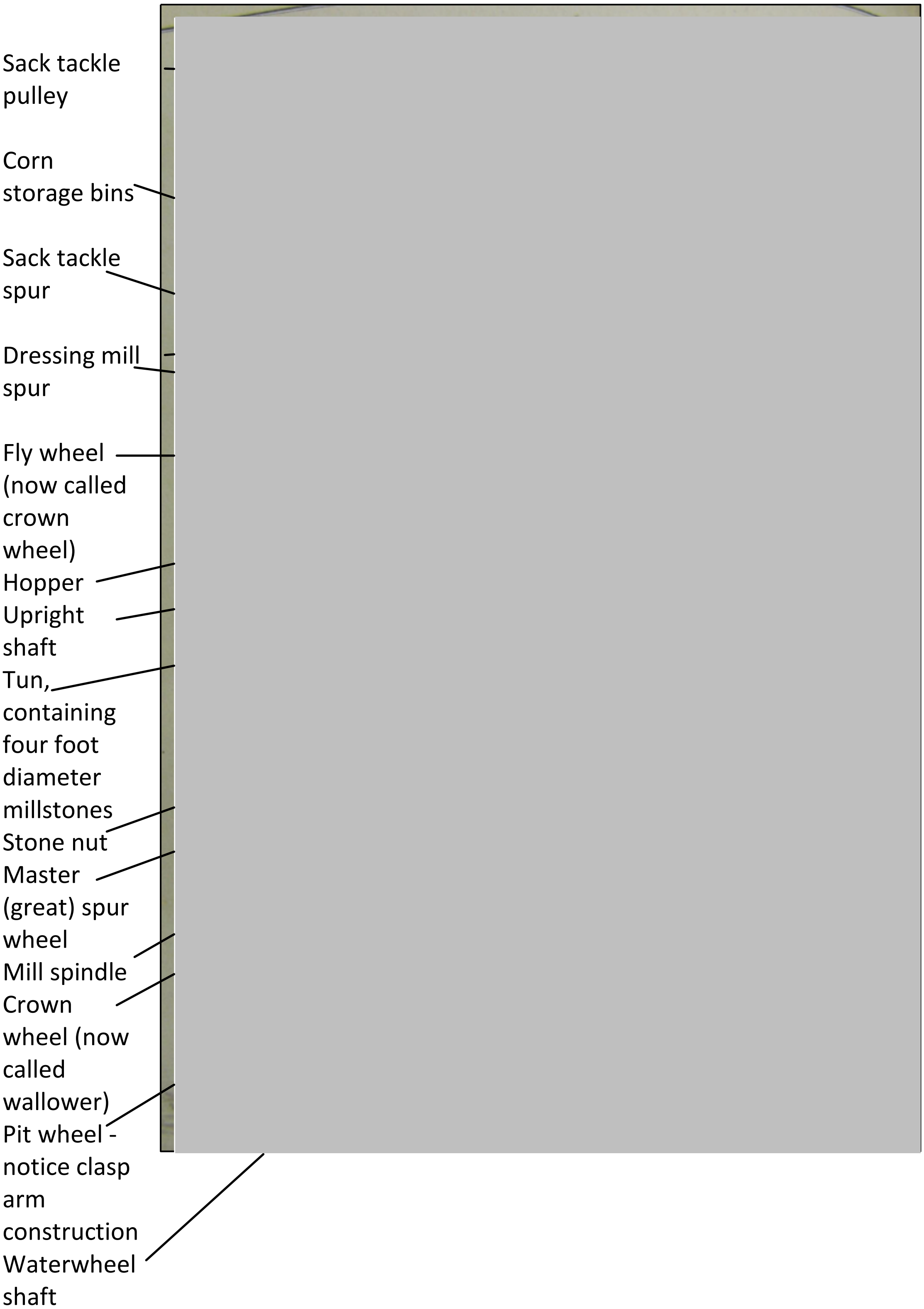
and others on the current best practice in relation to mills is obscure. At that time Telford was as much an architect as an engineer, and there is no evidence that he was ever involved in agriculture, far less mills. So he must have been heavily reliant for his information on his friend Hazledine, a fact that he freely recognised, calling him *'a very ingenious practical millwright'*, in whose designs the reader could have confidence, since his *'mills were sanctioned by experience*.'[149] Telford and Hazledine must have had many conversations on the subject, and so the treatise gives a good insight into Hazledine's knowledge. The subjects Telford covered included a detailed history of mills of all types, and the theory and practice of millstones. He also discussed waterwheels, including John Smeaton's experimental work[150], tables of size, velocity etc, and the latest thinking of William Strutt. The latter half of the treatise covers windmills, and includes further reports of Smeaton's experiments, and finally there is a description of Andrew Meikle's thrashing machines. He also gave detailed information, with drawings and measurements, on both watermills and windmills designed and built by Hazledine. Assuming that Hazledine had a significant input into the treatise, this supports the view that he was not just a practical millwright, but was thoroughly versed in the history and theory of the subject as it was then understood. Telford described three sample watermills and four windmills that Hazledine had built by 1798, and stated that this was not an exhaustive list (Figures 23 and 24).[151]

[149] Telford 1798, pp.38ff and 120ff
[150] Watts 2000, pp. 67-8
[151] Full details of Hazledine's millwrighting work are given in the gazetteer, appendix 3

None of the mills he built survives in working order, and any parts that do remain may also have been replacements or additions over the years. The most complete watermill survival is Broadstone, built in 1794. This is now a private residence, but the surviving machinery has been preserved, and the mill was well documented just prior to conversion.[152] All the gearing is of wood, mostly oak, but the stone nuts are of elm, bound by iron hoops, and the wallower is wholly of iron. The pitch (the distance between the centres of the cogs) is too fine for this to be original. The waterwheel has been missing for many years; it is possible that it was made of iron, since Telford refers to the 'practice now begun of making water wheels of iron'.[153]

[152] Boucher 1963, Tucker 1991
[153] Telford 1798, p.60ff

Figure 23
Vertical section of typical Hazledine water corn mill, with two pairs of millstones (Telford 1798, plate X)



During Hazledine's lifetime more and more components were made of iron.[154] This development can be seen in the estimate for the rebuilding of Long (Longdon-on-Tern) Mill in 1816.[155] This was a double mill, with two wheels working four pairs of millstones. Most of the two waterwheels (except the arms) were of cast iron, as were the pit wheels, wallowers, great spur wheels, and the spurs for sack tackle and dressing mills. The cogs of the great spur wheels, crown wheels and spurs for driving the sack tackles and dressing mills were, however, made of wood.[156] The reason for this is that, being slightly less hard than iron, wood tended to run more smoothly at high speed, and individual wooden cogs could be replaced if they got broken or worn.

These mills were well constructed and built to last. Their design incorporated the latest thinking, but on the other hand they used tried and tested technology, which would enable them to be maintained by any competent tradesman. The design was adaptable, for example everything could be duplicated by the addition of another waterwheel on the other side of the building, a common practice at the time. Their cost was also reasonable – if erected in Shropshire or Cheshire, Hazledine charged £350 for a mill like the one illustrated, or £650 for a double one. This included all the building work, also done by Hazledine's firm to a high standard.[157] In 1816, despite the inflation that had occurred during the French wars, Hazledine's estimate for the building of Long Mill was just £594 13s 9d, less than he charged 20 years before. Perhaps that reflected the amount of iron work

[154] Watts 2000, p.70
[155] Staffs RO D593/L/4/7
[156] I have used the more modern terms for the various wheels to avoid confusion
[157] Boucher 1963

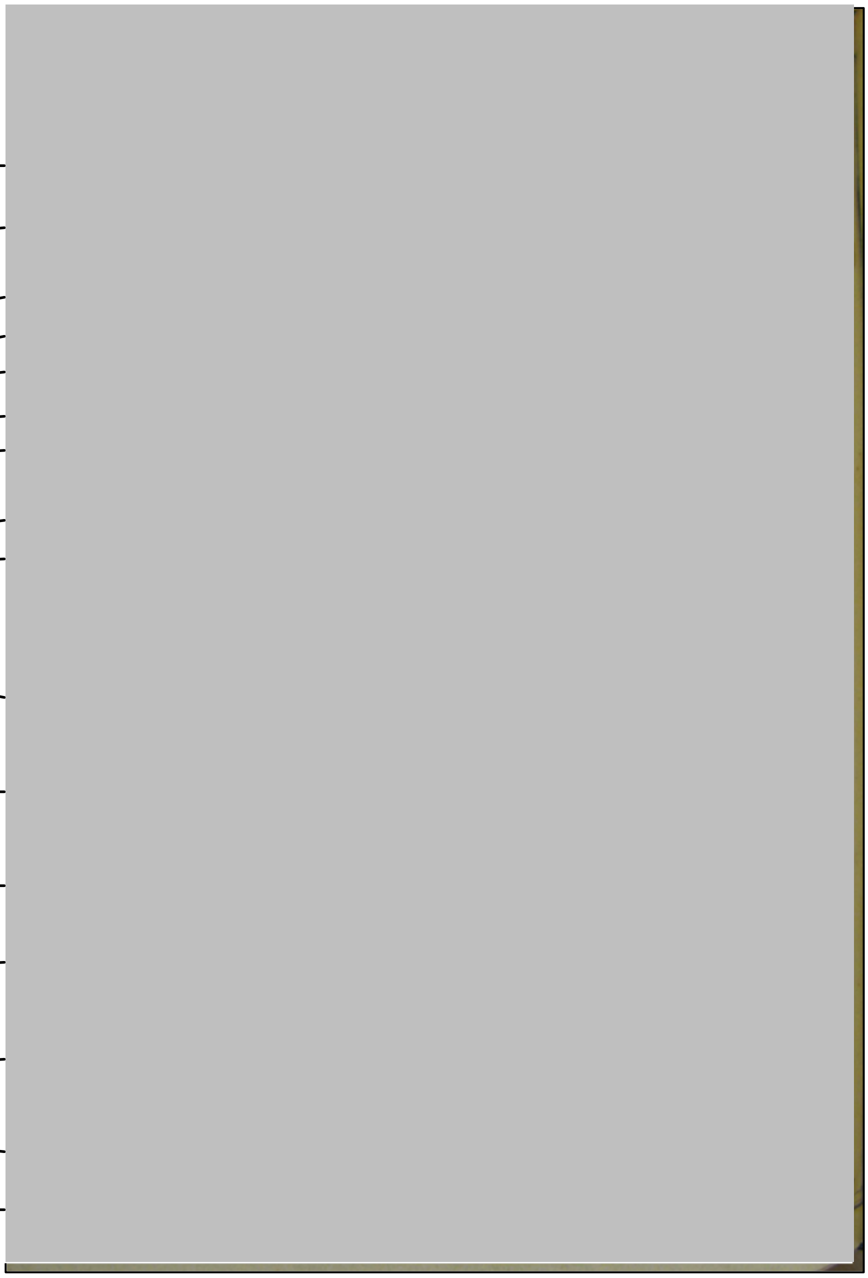
he then used, which was much less labour-intensive than making everything of wood, and the iron work for different mills could be reproduced from existing patterns. Being such a large firm he was able to undercut the opposition. For example the other quote that Lord Gower obtained for Long Mill came in at £677.[158] Evidence for the reuse of existing patterns is provided by the Garth Estate records. Richard Mytton of Garth Hall rebuilt both the Derwen and Pontysgawrhyd Mills around 1810.[159] There is no documentary evidence as to who designed these mills, but the surviving remains of Pontysgawrhyd (originally probably a double mill) are reminiscent of Hazledine's design and workmanship.[160] A further suggestion of Hazledine's involvement is provided by the fact that in 1829/30 both mills were rebuilt using replacement parts from Hazledine's foundry, presumably using existing patterns, which were then fitted by local millwrights Hugh Ellis and Son.[161]

The only windmill that is proven to have been built by Hazledine and is still standing is Hawkstone. This was built for Sir Richard Hill as part of the 'Follies' in Hawkstone Park. Its Dutch style made it a picturesque addition to the view beside the newly formed Hawk Lake, but the mill also served a practical purpose. Originally it was used to grind flax for linseed oil for cattle food and for pumping water from a nearby spring to Hawk Lake; later it became a bone mill for grinding animal bone for fertiliser.[162] Because there are no surviving examples of a linseed

[158] Staffs RO D593/L/4/7
[159] Wadley et al, 2004
[160] Barton, 2007
[161] Powys Archives, Garth Estate M/D/GA/1/1 (June 3rd, July 11th 1829; May 12th, June 3rd & 9th 1830)
[162] Morriss 1997, Rodenhurst 1803

oil windmill anywhere in the country,[163] it is impossible to accurately reconstruct the layout of the stones, but enough survives to demonstrate that the mill was well constructed using massive timbers and an enormously heavy iron wind shaft neck, or canister.

Figure 24
Vertical section of a typical four-storied Hazledine tower windmill (Telford 1798, plate XXI)



[163] Gregory 2005, p.24-5

The mill is now protected by a temporary cap (Figure 25), but the original cap was probably boat-shaped, as was the local fashion. Another local fashion was to use a continuous chain mechanism to turn the sails into the wind ('winding') by rotating the whole cap. The miller controlled this by standing on an external platform, or sail gallery, located at first floor level, which is not shown on Telford's drawings, but whose remains are clearly visible. This winding mechanism was preferred to a fantail, which automatically turns the cap to face the wind. This had been invented some years before, but had not become a practical proposition by the time Hawkstone was built.[164] The rotating cap required considerable skill to manufacture and fit – that some of this still survives at Hawkstone after two centuries of use, and latterly neglect, is a testimony to its original builders (Figure 26).

[164] Watts 2000, p.81

Figure 25
Remains of Hawkstone Mill.
Notice the massive cast-iron canister which pierces the temporary cap
(the author)

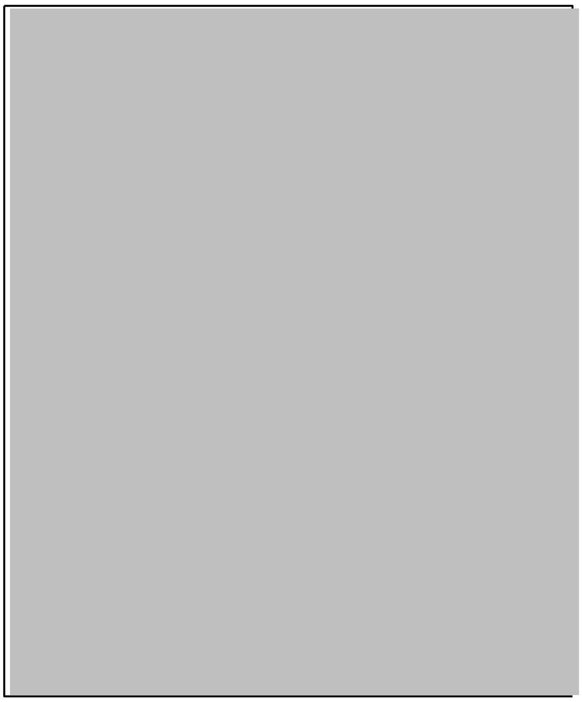


Figure 26
Hawkstone Mill, details of remains of cap circle
(Morriss 1997, Fig 8)

The list of Hazledine's involvement with mills in the gazetteer (Appendix 3) is probably only a fraction of the work his firm undertook in the period 1785 – 1840. Much of course is lost, but hopefully more research will identify other sites. What is certain is that once he was established he would have had little time to do the practical work himself. One of his skills, however, was building a team. Having done the initial survey, he passed on the detail of writing the contract to his clerk. This is shown in the estimate for the Toft Windmill at Trentham, where Hazledine just wrote the covering letter and added a detail that the clerk had missed.[165] He also employed a number of other millwrights on a permanent basis. Three such were Robert Lambert, William Townrow and Thomas Jones, who all lived in

[165] Staffs RO D593/L/1/19/3; Lead 1975, was clearly not familiar with Hazledine's handwriting, when he stated that the estimate was written by him

Coleham, Shrewsbury, and whose children were baptised in St Julian's Church in the period 1805 to 1812.[166]

When it came to the building work, Hazledine's style was not just to let the millwrights and other workers get on with it; he actively managed the work by ensuring that they had the materials they needed, and also gave them detailed practical advice as to how the job should be done. This he did both by frequent letters and also by visiting them on site. Hazledine's attention to detail is shown in a series of letters to Thomas Thomas, who supervised the building of the wharf at Market Drayton in the period 1834-37.[167] *'The mahogany hand rail must be cleaned off* <u>*and not*</u> [his emphasis] *varnished until you have cleaned the house down and done painting it,'* Hazledine wrote on April 11th 1837, as if Thomas was an apprentice. Perhaps Hazledine was getting pedantic in his old age (he was 74 at the time), and Thomas probably just smiled to himself, knowing the genuine concern his employer had shown for him and his family over the years. For example, when Thomas Thomas senior had been in Bath helping to build the Cleveland Bridge, Hazledine had written a PS to a letter on practical matters, *'I called on Mrs Thomas on Monday. She is well.'*[168] Clearly Hazledine knew what it was like to spend long periods working away and did his best to support his workers and their families. This genuine rapport with his workforce was noted by his contemporaries. For example, in a sermon on the day after his funeral the Vicar of St Chad's said,

[166] SA, St Julian's fiche 256/A/1
[167] SA 901/1
[168] Letter to Thomas Thomas senior, August 9th 1826, SA 901/1

"May I not refer to his love of industry and perseverance, of his delight in encouraging industrious habits among the hundreds who will long and deeply lament their beloved employer? His loss, they doubtless feel and acknowledge, to be a loss indeed!"[169]

[169] SC 6.11.1840

5. MAN OF IRON

At the same time as William Hazledine was making his mark in the millwrighting world, he was also taking his first steps as an ironmaster. Soon after he moved to Shrewsbury he entered into partnership with Robert Webster (1755-1832), and together they set up a small foundry for the production of cast iron near Mardol, Shrewsbury.[170] This was on the site of the mediaeval Cole Hall, off Knuckin Street (roughly where Hill's Lane is today, SJ 490126). Quite how the two men came to be in partnership is not clear, since Robert Webster was a well-known local clockmaker.[171] One author has suggested that Webster was Hazledine's uncle,[172] but as the two men were of a similar age, and there are no Websters in the Hazledine family tree, this seems unlikely. The more probable explanation is that Webster was looking for a partner to help him develop and manufacture a washing machine that he patented in 1792.[173] Sadly, this machine never caught on, and the only known example perished in a fire. As well as his washing machine, he also made spinning wheels of a new design, three of which were presented to Queen Caroline.[174] Items for the new St Chad's Church, the first of which was delivered in the late summer of 1792, can be dated to this period. Hazledine was paid £35 12s 4d for iron rails for the gallery and the tower and various lead castings for the roof.[175] But the main payment of £180 was for the railings around the churchyard

[170] SC 30.10.1840; location maps of ironworking sites are in Appendix 5
[171] Elliott 1979, pp. 129-130
[172] Lea 2005, p.3
[173] Elliott, 1979, p.6
[174] Ibid
[175] SA 1048/63, 67

and the banisters for the back stairs.[176] In 1793 he supplied railings round the vestries, and a final set of railings was made round the portico in 1807.[177] Most of these railings have now been removed or replaced, but there are probably some surviving ones still attached to the church (Figure 27). Hazledine's other involvement with St Chad's at this time was to lend the building fund £100 in April 1793 at 5% interest.[178] Presumably he had made this money from the proceeds of his millwrighting work, rather than iron work.

Figure 27
Railings beside St Chad's Church, Shrewsbury
(the author)

Perhaps the main significance of the rebuilding of St Chad's church for William Hazledine was that it was through this that he first met John Simpson. Initially the oversight of the building of the church was entrusted to local builder Joseph Bromfield, but by March 1790 the Trustees were so dissatisfied with his work that they

> *...resolved that the clerk inform Mr Bromfield that his assistance as surveyor...is no longer wanted, and that Mr Steuart* [the architect] *be wrote [*sic*] to desire he will send down a proper person to succeed him as soon as possible.*[179]

That person was John Simpson (1755-1815), a scot like Steuart, who arrived from building Erlestoke Manor in Wiltshire for Steuart in May 1790.[180] William Hazledine

[176] SA 1048/68
[177] Norton and Hill 1970, p.11
[178] SA 1048/63
[179] SA 1084/63, 11.3.1790

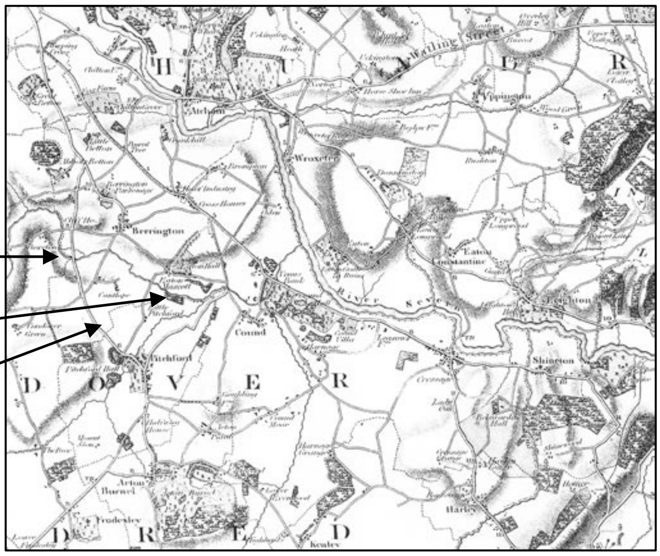
and Thomas Telford presumably met Simpson soon after he arrived, and the three became close friends and business partners in many enterprises.[181] Fittingly, Hazledine and Simpson are commemorated together in St Chad's church.[182] At the same time that Hazledine was working in partnership with Robert Webster producing cast iron in Shrewsbury, he also took his first steps into the production of bar (now known as wrought) iron. This was at Pitchford Forge (SJ 533056), which is situated about 10 km to the south east of Shrewsbury near the hamlet of Eaton Mascott, on the edge of the Pitchford Hall Estate. The forge was on the Cound Brook about 5km from its junction with the River Severn, and in close proximity to the route that passes from Shrewsbury to Acton Burnell, and thence to South Shropshire (Figure 28).

Figure 28
Pitchford Forge
(Greenwood
1827)

Cound Brook

Pitchford Forge

Turnpike road
from Shrewsbury
to South
Shropshire



[180] SA 1084/67; for full references see Appendix 6 (Simpson, John)
[181] Pattison 2007; Telford was one of Simpson's executors, SA Sprott, Stokes and Turnbull files, box 226
[182] Owen and Blakeway 1825, Vol. II, p.254, and Pidgeon 1851, p.60 state that both busts are by Sir Francis Chantrey. Despite these contemporaneous sources, the bust of Simpson is of inferior quality, and some believe it to be the work of local sculptor John Carline

The forge had been in existence since 1715, having been converted from a corn mill.[183] Hazledine's involvement with the area dated from at least 1786, when he auctioned off the workings of a nearby rye mill, presumably acting as an agent for the Ottleys, who then owned the Pitchford Hall estate.[184] At this time the forge was leased by the Gibbons brothers, but shortly afterwards they gave up the lease, presumably to concentrate on their other activities in East Shropshire and Staffordshire.[185] The forge had one finery and one chafery, and its output had declined from 150 tons a year in 1749 to 70 tons in 1787.[186] Hazledine took over the forge in May 1789, before signing a formal lease for 42 years at £40 a year in June 1790.[187] Always the realist, Hazledine included in the lease a clause allowing him to remove the machinery in the event of the enterprise not being a success, and the forge being converted to a different use.[188] Evidently Hazledine did make a success of the forge, which continued in operation till at least 1811.[189] In 1807 the ownership of the Pitchford Hall Estate changed hands with the death of father and son Thomas and Adam Ottley in quick succession without direct heirs. The relative who did inherit was Charles Cecil Cope Jenkinson (1784–1851), half-brother to Lord

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[183] VCH Vol. VIII, Ed AT Gaydon, pp. 116, 121
[184] SC 5.7.1786
[185] Smith, W, 1970-71, p.46
[186] Birmingham, B&W Archive, MS 3219/6/161
[187] National Library of Wales (NLW), Pitchford Hall collection 2103-4
[188] The list that details ironworks and their outputs quoted above (Ref 183) states that around 1794 Pitchford Forge was leased by 'Lawrence and Hazledine', which is a mystery, since the documents show Hazledine as the sole lessee, and no 'Lawrence' occurs anywhere else in Hazledine's story. Possibly a solution to this may be that a document similar to the above (Birmingham B&W Archive, MII/5/10) lists Lawrence and Hazledine as the lessees of both Pitchford and the Lizard Forge in East Shropshire. There is no evidence that Hazledine was ever involved at Lizard, so possibly his name and Lawrence's have been transposed by mistake.
[189] NLW Pitchford Hall, Vol. 1 139/6/13 – a survey of the Estate in 1807 details Hazledine as the lessee. The forge, buildings, houses, gardens, etc occupied 1 acre and 1 rood. The last entry relating to the Forge in the Parish Register is of Charles Morgan aged 5 from the Forge, who accidentally drowned in 1811

Liverpool, Prime Minister from 1812-27.[190] Jenkinson inherited the title of Lord Liverpool in 1828 on the death of his brother, but was also a significant politician in his own right, being an MP from 1807 till he was elevated to the House of Lords. He also served as a Junior Minister and Privy Councillor. Jenkinson took an active interest in the Pitchford Hall Estate, where he met Hazledine. He did everything he could to further Hazledine's career, eventually introducing him to the future Queen Victoria and her mother the Duchess of Kent.[191]

Pitchford Forge was the smallest of Hazledine's enterprises, and it seems slightly surprising that he should have been interested in leasing it. Perhaps the answer may lie in the fact that in November 1784 it was one of the earliest places where Henry Cort demonstrated his new 'puddling and rolling' method of making bar iron using coke in a reverberatory furnace.[192] It is not recorded if the Gibbons signed up for the Cort patent, but even if they did not, the selection of Pitchford as a trial site suggests that the workers there were of good quality. Prominent among these were many members of the ubiquitous Maybury and Mebrey families, who are recorded in the Parish Registers since soon after the Forge began until Hazledine's time.[193] These were the sort of workers he would need to ensure his iron making projects were a success.

Just after he entered into the lease for Pitchford Forge, Hazledine entered into another contract - marriage. On 14th January 1790 he married Eleanor Brayne

[190] Gash 1984, pp.33, 102-3
[191] SC 30.10.1840
[192] Staffs RO D695/1/12/36
[193] SA, Pitchford Parish Registers S9/297

(or Brain) at St Mary's Church, Market Drayton.[194] Eleanor's mother was also called Eleanor. She had married Samuel Brain, a farmer from the parish of Hodnet, on July 1st 1761, and her maiden name was Hazledine, so it is probable that William and Eleanor were distantly related.[195] Eleanor was baptised at St Mary's Market Drayton on June 1st 1762, so was about 10 months older than William.[196] They had probably known each other since childhood, but William waited till he felt he was well enough established in business to tie the knot. It is likely that they made their home in the house attached to his millwrighting business in Wyle Cop, which is in the parish of St Julian. The only description we have of Eleanor is that she was described as *'an uncommonly strong minded woman'*, when she organised the rescue of books, papers and other valuable items when her husband's foundry caught fire in 1804. This was after she had been awoken from sleep, while her husband was away.[197] She appears to have been an ideal helpmeet for her husband – strong and capable in her own right, and able to take responsibility for bringing up their family during his frequent absences. She was soon busy with domestic duties, since their first daughter, Mary, was baptised at St Julian's on 29th December 1790. Mary was followed by John (baptised 25.9.1793), Elizabeth (2.10.1794), Ann (17.4.1797), Eleanor (19.5.1799) and Fanny (20.5.1801). Eleanor died when she was

[194] SA Drayton-in-Hales Parish Records, fiche no P97/142
[195] SA Drayton-in-Hales Parish Records, fiche no P97/125
[196] SA Drayton-in-Hales Parish Records, fiche no P97/82
[197] SC 30.10.1840

about a year old, but the others all survived into adult life, though Fanny was only 20 when she died.[198] [199] Family life seems to have been very happy, since

> *His strong affections for the members of his family rendered his fireside one of the most happy round which an English family ever gathered. He was ever devising some simple means of increasing their enjoyments; and he attended personally to everything in which their comforts were involved.*[200]

But all this was in the future - in 1790 he had barely begun in the iron trade. By this time Hazledine's partnership with Robert Webster was becoming strained. Hazledine was keen to expand the business, but Webster was not. One writer stated that this was because Webster was *'cautious and timid,'*[201] but Webster was a clock maker, not an ironmaster, and the various changes of direction he made in his career suggest that he was quite willing to take risks if he felt inclined. So the partnership broke up, and Hazledine looked for a new site for his foundry. He found this in the Shrewsbury suburb of Coleham, beside the River Severn (SJ 495121) (Figure 29). He appears to have bought the land in four parts over a three year period from 1790 – 93.[202] The total cost of the four pieces of land was £1805, most of which was covered by a mortgage. The land already contained a number of houses and other buildings, most of which he appears to have retained, but some were demolished to make way for the foundry. This he built up gradually as

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[198] SA St Julian's Shrewsbury, fiche P256/A/49 for births; burial of Eleanor, SA St Chad's Shrewsbury (transcript) S9/230H, p.1625; burial of Fanny, SA St Chad's fiche P253/A/31

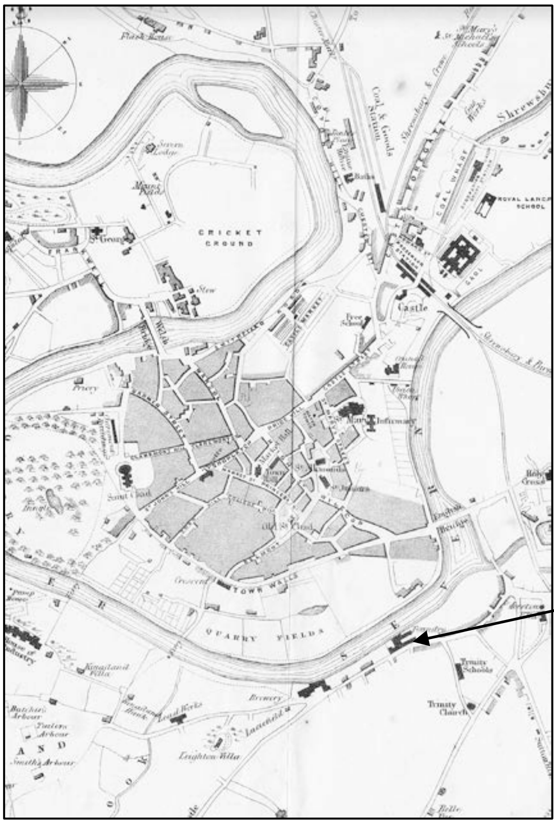
[199] More details of William Hazledine's descendents are in Appendix 6

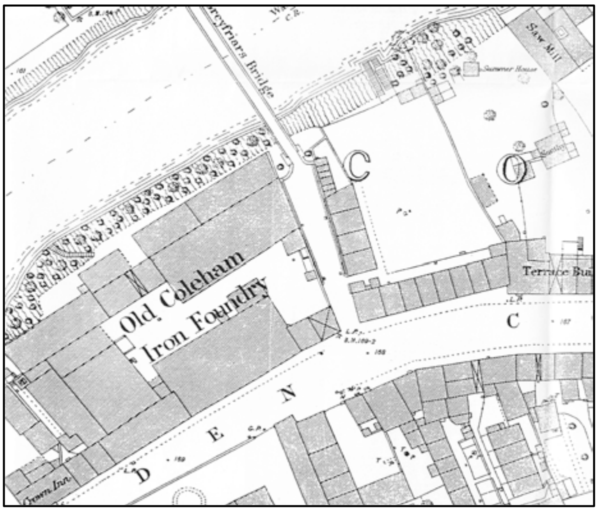
[200] SC 30.10.1840

[201] Ibid

[202] SA D3651/D/5/214, D3651/D/14/113, D3651/D/5/228 & 246; these documents are all draft deeds, which show a number of alterations. The first is dated 29.7.1790, in which Hazledine's name has been crossed out, but he has also signed it, so it may or may not be that this transaction happened at that time.

business grew, until it had a frontage onto Coleham of 305 feet (92.96 metres), and spread over an area of 5204 sq yards (approx 4350 square metres).[203] In addition to the foundry itself, there was a large timber yard, saw mill, storage areas for ironwork, a smith's shop, a landing stage from the river, offices and other associated buildings (Figure 30).





Figures 29 and 30 – Coleham Foundry
Left - Location just south of the River Severn in the suburb of Coleham (Thomas Tisdale 1860)
Above – Foundry detail (1st edition OS map 1880 - Greyfriars Bridge was not present in Hazledine's time)

The foundry was used for the production of cast iron, which is essentially the same as the pig iron produced from iron ore in a furnace. Pig iron, however, tended to contain impurities, and pouring it directly from the furnace made it difficult to cast. Despite these drawbacks, the latter years of the eighteenth century saw a steady increase in the production of cast-iron items, particularly armaments, but also such large items as cranks and pistons for steam engines, tram wheels, and rollers, as

[203] Sale notice in SJ 20.10.1841

well as smaller domestic items such as pots and pans and fire grates.[204] The production of cast iron was greatly boosted, however, by the invention of the cupola furnace, patented by John Wilkinson in 1794.[205] A cupola is a brick-lined furnace charged from the top with pig (or scrap) iron, coke (or charcoal) and limestone (Figure 31). The coke or charcoal is lit and the temperature is raised by means of an air blast introduced through tuyeres. The molten metal is then run off into moulds, either directly or via ladles (Figure 32).

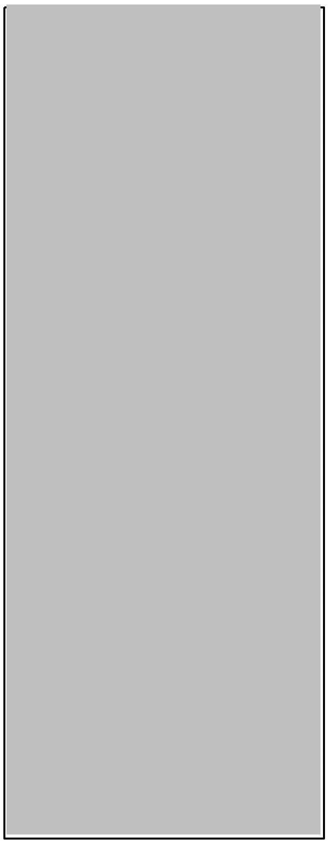


Figure 31 (above) – Cupola furnace at Blists Hill Museum (notice the external charging platform) (the author)
Figure 32 (right) -Early cupola, from Wilkinson's 1794 patent
A – Cast-iron plates forming outside of furnace
B – Fire brick
C – Cavity for fuel and iron
D – Tuyere hole for air blast
E – Blowing pipe for air blast
F – Taphole for liquid metal
(McCombe 1981, p.3)

Coleham foundry had a number of cupola furnaces. In 1821 a visitor noted that two cupolas were employed doing just one order for the Dublin docks, the assumption

[204] Hayman 2005, p.86-7
[205] Skempton and Chrimes 2002, p.785

being that there were others doing other work.[206] The air blast was produced using a steam engine – the first engine that Hazledine probably used had an interesting history. In October 1791 Hazledine wrote to the Boulton and Watt works in Birmingham enquiring about the purchase of a steam engine with a sixteen inch diameter cylinder '*for a company in this town*.'[207] The enterprise in question was the new woollen 'manufactory' then being built in Coleham for Rev Edward Powys and his brother in law William Hodges.[208] This was almost next to the land Hazledine was purchasing, and he presumably supplied ironwork for the factory, as well as building a 25 feet diameter water wheel which supplied power for some of the machines. The steam engine was for a separate fulling mill, but it was not powerful enough to do the job, so in 1793 Powys and Hodges started a lawsuit against Hazledine.[209] Charles Bage and Thomas Telford were appointed arbiters, but there is no record as to who won the dispute. Perhaps Powys and Hodges were seeking to find a scapegoat for the failure of their enterprise, since by 1795 a combination of their inexperience and the economic hardships brought about by the war with France had brought their unrealistic plans to ruin. Hazledine, though, profited from their failure, since he put up all the equipment for auction.[210] In the list of equipment there is no mention of the steam engine with a 16 inch diameter piston, so presumably Hazledine kept it for use in his foundry to provide blast for one of the cupolas.

[206] Institution of Civil Engineers (ICE), Thomas Telford correspondence, T/EG 96, 21.12.1821
[207] Birmingham, B & W Correspondence and Papers, MS 3147/3/392/38 (microfilm reel 243)
[208] Hulbert 1837, pp. 307-8
[209] SA D3651/D/5/237
[210] *St James Chronicle*, 6.10.1795

So what was made at the Coleham foundry? The answer is almost anything that could be made of cast iron! Many years after Hazledine's death, when the foundry was taken over by Arthur Lowcock, the new owners advertised that they still had the patterns used by the foundry in Hazledine's time. Among the items they advertised were the following – gearing, bevel and spur wheels and pinions, pulleys, brackets, flywheels, pedestals, columns, caps and brasses, roof castings, builders' girders, complete sets and sizes of outlet pipes, drain pipes, well covers, tidal valves, sluice valves, trolley, tram and barrow wheels, sash weights, range castings, street curbings, fire irons, firebars, and gratings. Hazledine drain pipes (thought to be some of the earliest recorded cast-iron rainwater pipes in the world) are still in use is at the Old Market Hall in the Square, Shrewsbury (Figure 33).[211]

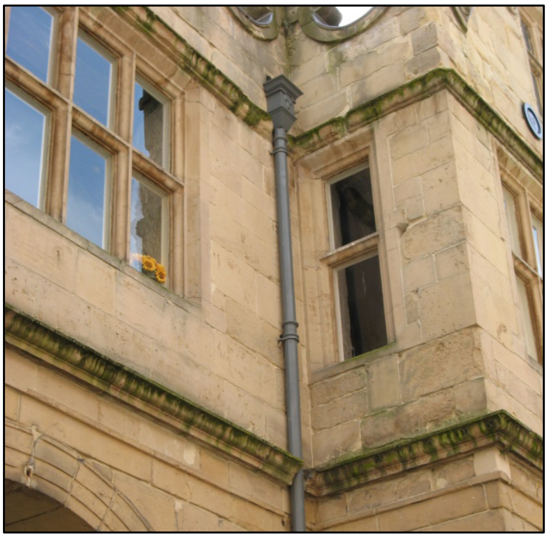


Figure 33

Old Market Hall, Shrewsbury, showing original Hazledine downpipe (the author)

As well as these 'off the shelf' items, the foundry provided all the cast-iron and brass items for Hazledine's millwrighting business, and made many things to order. Some of these are unfamiliar to us, such as a clay mill, fitted up and provided with

[211] http://www.oldmarkethall.co.uk/Accessible/AboutOMH/repairs.htm

all its parts, which the Earl of Powys ordered in 1826.[212] (Clay mills were horse powered, and were used for mixing and tempering clay prior to making bricks.) Coleham Foundry employed 300-400 people at its height. Nothing of it now remains, except some buildings at the front which were probably offices, and are now incorporated into shops, and there is evidence of a landing stage from the river at the rear (Figures 34 and 35).

Figure 34
Remains of Coleham Foundry offices or workshops incorporated into modern shops (the author)

Figure 35
Rear of Figure 34 (partly obscured by modern houses), showing foundry access to the River Severn (the author)

[212] SA 552/12/386

6. A WORLD FIRST

Cast iron is a rather unfamiliar material to us, and it is especially difficult therefore now to understand the way that ironmasters like Hazledine worked with it. Did he rely on experience, intuition, and even trial and error, or did he try to apply the latest thinking of the then infant discipline of metallurgy to his work? The metallurgical differences between the forms of iron were just beginning to be understood when Hazledine was starting his career.[213] In 1786 a number of continental chemists realised that the basic difference in the types of iron was due to the amount of carbon they contained.[214] During Hazledine's lifetime, further strides were made in understanding iron, which can be illustrated from the writings of David Mushet (1772-1847) (Figure 36). It was said of Mushet that

> *He was far in advance of the period in which he lived, and to the results of his researches, the world is indebted for many of the improvements introduced in the iron and copper trades.*[215]

Mushet began his experimental work in 1793, the results of which were published in the *Philosophical Magazine* from 1799.[216] These articles were later brought together into a book, published in 1840.[217] Being an ironfounder himself, Mushet was essentially a practical man. His explanations for some phenomena, such as why iron might sometimes be brittle when hot (hot short) or cold (cold short), were wide of the mark, but from practical experience he knew how to remedy these defects.

[213] See Glossary (Appendix 2) for definitions
[214] Day and Tylecote 1991, p.261
[215] Obituary in Minutes of Proceedings of ICE, 1848, Vol. 7, p.11
[216] Osborn 1952; www.electricscotland.com/history/men/mushet_david.htm
[217] Mushet 1840; the importance of the book is highlighted in a review in SC 27.11.1840

Another of his contributions was a method of producing steel direct from bar iron, and the beneficial effect of manganese on iron and steel production (William Reynolds of Ketley had earlier done some experiments with manganese[218]).

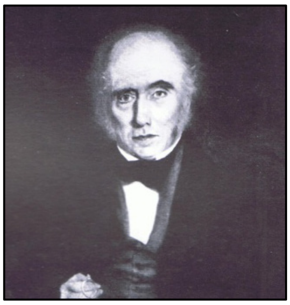


Fig 36
David Mushet,
1772-1847
(Osborn 1952)

But did this sort of information find its way down to William Hazledine, or did he just rely on experience? All the evidence we have suggests that Hazledine was up to date with the work of Mushet, and others. During his time in Shrewsbury Thomas Telford studied chemistry avidly, and as he was close to Hazledine they must have discussed such matters between them.[219] Hazledine was also acquainted with David Mushet, doing work for him when Mushet moved to the Forest of Dean.[220] In addition, among the books auctioned after his death were said to be 20 volumes of the *Edinburgh Cyclopaedia* (subtitled *'The Universal Dictionary of the Arts and Sciences'*), which contained all the most up to date information on every subject imaginable, including iron.[221] Hazledine's contemporaries also remarked that, despite his lack of formal education, he was extremely well read, enjoying such authors as Isaac Newton.[222] This joining of intellectual curiosity,

[218] Trinder 2008 p.20
[219] Letter to Andrew Little, 1788, quoted in Smiles 1861, chapter IV
[220] Gloucestershire Archives D2646/62 & 97
[221] SC 12.11.1841; this title does not exist, but presumably refers to the *Edinburgh Encyclopaedia*, which has 18 volumes, to which Telford contributed a number of articles
[222] Hulbert 1839, appendix

technical knowledge and practical experience enabled him to excel at iron making and push the boundaries of cast iron production forward. A contemporary wrote that *'the strength [of cast iron] depends on the skill and experience of the founder'*,[223] and history was to prove Hazledine one of the best.

Because he left no records of his procedures, we can only pick up some hints as to how he did this. The first thing he did was to be very careful in the source of his materials. The quality of pig iron could vary considerably, depending on the source of the iron ore, the fuel used in smelting, and the expertise of those who produced it. For much of his career he did not make his own pig iron, but bought it from others. For example he bought large quantities from the Botfields at Old Park in Dawley between 1812 and 1817, with a maximum of 250 tons in 1813.[224] At other times he purchased pig iron from the Lilleshall Company, which was transported via the Shrewsbury Canal.[225] However, during the period when he leased the Calcutt works near Ironbridge (c1817-31), he did produce his own pig iron, for example 1,822 tons in 1823.[226] In 1818 James Thomson, a visitor on behalf of Thomas Telford, wrote that

> *At Calcutt, the materials from which the iron is made are those called the best all over that quarter. And from examinations I made the iron is certainly the strongest I have met with.*[227]

Thomson then went on to Upton Forge, where, he wrote,

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[223] Tredgold 1824, p.10
[224] Hayman 2003, p.106
[225] SC 28.6.1839, records the theft of Lilleshall pigs bound for Hazledine's Coleham Foundry
[226] Trinder 1981, p.143; Hulbert 1837, p.343
[227] ICE, letter from James Thomson to Thomas Telford, 8.5.1818, T/EG 306

From the trials I made on several bars of different sizes, I have no hesitation in saying I would prefer this iron for the fitting up on such work [as Telford proposed] to Swedish iron.[228]

Finally Thomson moved on to Shrewsbury, where he reported that

The foundry at Shrewsbury is extensive, and the castings are principally made from Calcutt iron, using the weakest for small and general castings.[229]

It is clear from this last remark that Hazledine's iron founders were well aware of the different qualities of the iron they were using, and used it appropriately. Another visitor recorded that, even with Calcutt's in full production, the Coleham foundry still had to buy in pig iron from elsewhere.[230]

Hazledine purchased coal for ironmaking from the East Shropshire Coalfield, which he brought to Coleham via the Shrewsbury Canal.[231] In 1813 he formalised an agreement with the Lilleshall Company for the provision of 20,000 tons of coal yearly 'free of slack'.[232] Hazledine also leased 100 tub boats from the Lilleshall Company, which were based at Donnington Wood.[233] Such large quantities of coal suggest that these arrangements had been going on for some time prior to 1813. The agreement also specifies the types of coal to be supplied – Hazledine was well aware of coal and its varying qualities. He set up in business as a coal merchant, presumably using the best coal for his own use and then selling on the remainder for the domestic market.

[228] Ibid
[229] Ibid
[230] Smith E 1932
[231] Transporting it from Plas Kynaston (see Chapter 6) would have been uneconomic
[232] IGMT Lilleshall Company Collection 1998.320 (DLIL/3/236)
[233] IGMT, DLIL/3/247

He was also involved in the limestone trade. From the wording of an advert in the *Salopian Journal* in 1798 it is clear that he and other partners had been involved in the extraction of limestone and its conversion to lime for a number of years.[234] Most limestone (calcium carbonate) was converted into quicklime (calcium oxide) by burning at 900°C and used for agricultural improvement,[235] but a good quantity of limestone was also used for iron production. Hazledine's company extracted the limestone at Llanymynech (Shropshire), where some was burned at their base at Five Kilns (SJ 274218).[236] The rest was transported along the Montgomery Canal, and Hazledine's firm burned more limestone at various places along the canal, including Porthywain in Llanyblodwel parish, and the wharf at Welshpool, where the firm had a base.[237] From Welshpool it was easy to transport limestone down the River Severn to the Coleham Foundry.

Wood was also a significant raw material for the ironmaster, being a source of both timber for pattern making, and charcoal for iron production. Early in his career Hazledine had himself been in the timber trade, but by 1795 withdrew from this, presumably because of pressure of time.[238] Subsequently he bought in both cordwood for the production of charcoal, and ordinary wood.[239] Much of this charcoal came from the Wenlock Edge area.[240] Charcoal was used as a fuel at

[234] SJ 2.5.1798
[235] Williams 2004, p8ff
[236] http://archaeologydataservice.ac.uk/catalogue/adsdata/oasis_reports/archenfi2/ahds/dissemination/pdf/archenfi2-31202_1.pdf
[237] NLW, Powis Castle Deeds (5) 7635 – May 22nd 1810; Pigot's North Wales Directory, 1829
[238] SC 19.4.1795
[239] SA D3651/D/5/486, 1807
[240] VCH Vol. X, http://www.british-history.ac.uk/report.aspx?compid=22879

Upton Forge in 1825, and so it is likely that Hazledine employed it regularly.[241] It is often thought that when coke technology really took off, and especially with the introduction of Henry Cort's puddling and rolling technique around the turn of the nineteenth century, charcoal rapidly became obsolete as a fuel. It has, however, been demonstrated that this was not entirely the case in Shropshire. Wrought iron made with charcoal was used to produce wire (and products made of wire), tinplate, gun barrels, scythes and other articles of the best quality.[242] David Mushet confirmed this when he wrote that

> *There is still no question of the superior effects of charcoal in the iron trade, in producing through the whole process a more perfect metallic result.*[243]

This was presumably also the case with cast iron, since the purer the form of carbon (charcoal is virtually pure carbon) used for re-melting pig iron, the less the impurities that will be introduced.

Hazledine was also able to benefit from considerable improvements in casting techniques. The cupola furnace meant that much more liquid iron of purer quality for casting was available at one time, and hence much larger structures could be produced.[244] Traditionally, liquid iron had been cast into the required shape using a wooden pattern smeared with 'loam', a mixture of sand, clay, straw and horse manure, which then had to be thoroughly dried to avoid the production of steam when in contact with the hot metal.[245] Later dry sand was used, and later

[241] Hayman 2003, p.106
[242] Hayman 2008
[243] Mushet 1840, p.65
[244] Hayman 2005, p.88
[245] Ibid, p.87

still 'green' sand, which is sand with a small proportion of clay and 'sludge'.[246] Using this type of sand enabled much larger structures to be cast on the foundry floor, rather than just using a wooden box to enclose the casting material (Figure 37).

Figure 37
Casting a small ornament with green sand in a box at Blists Hill Museum (the author)

Iron casting is a highly skilled occupation, with pattern makers forming the required wooden pattern just a little larger than the final article, and moulders or founders actually doing the casting. Evidence for the existence of these trades in Hazledine's foundry is provided in the St Julian's Parish registers, which records the occupations of those recorded in the register.[247] Occupations detailed include 'iron founder', 'brass founder' (Hazledine also produced brass goods), 'cast iron moulder', 'model maker', 'pattern maker' and 'moulder'. One man who fathered three children was called 'iron founder' in 1822, 'moulder' in 1826, and 'brass founder' in 1829, so evidently the terms could be interchangeable. The most intriguing one is a lady, Mary Hill, who died in 1805, and is termed an 'iron founder', so the work was not limited to men.

Many things could go wrong with the casting process, such as the following[248] -

- Blow holes due to poor venting of the moulds

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[246] http://en.wikipedia.org/wiki/Sand_casting
[247] SA St Julian's fiche 256/A/1 and transcripts St Julian's 5b
[248] Baxter 2006, main report, section 3

- Residual stresses caused by differential cooling rates
- Contamination by sand becoming detached from the mould
- Weaker and coarser material at the centre of the casting
- Cold joints due to interruption of the casting
- Variations in section thickness
- Surface defects caused by damaged moulds
- Cold-spots where earlier splashes of molten iron have cooled and solidified without subsequent absorption
- Impurities trapped in the body of the metal can act as stress raisers
- Incorrectly repaired castings

William Hazledine himself evidently was fully acquainted with these processes. This is illustrated by the fact that in 1819 he took out a patent for 'a new method of casting boilers, pans and other vessels of iron'.[249] Prior to this, such vessels had been cast with the open end downwards, which tended to result in *'defects which are commonly found in the bottoms of such vessels.'*[250] What Hazledine did was to make a 'core pan' of the same dimensions as the casting but of smaller size and containing holes to allow for the escape of gas. The core pan could also be made of several pieces bolted together to allow for easy removal afterwards. The core pan was then coated with loam or other casting material, and filled with *'loam, sand, or anything else appropriate*'. The molten metal was then poured around the core pan to form the finished vessel. Considering that this patent was taken out when

[249] Patent documentation, SA 6000/18119 (15.1.1819); patent specification Birmingham Central Library, patent no 4333, enrolled 12.3.1819

[250] Patent specification

Hazledine was busy with many other major works, it is clear that he had an almost obsessional interest in the small details of his foundry's processes, an interest he needed as he tackled his biggest challenge to date.

This challenge was to produce the castings for a new Flax Mill at Ditherington, just north of Shrewsbury (SJ 499139). This was the first totally iron framed building in the world (and hence the forerunner of skyscrapers). Since its acquisition by English Heritage in 2005 its story has become well known, so it will only be outlined here.[251] John Marshall (1765-1845) was a flax mill owner from Leeds, and in order to increase his capital in 1794 he introduced the brothers Thomas (1762-1833) and Benjamin (1763-1834) Benyon into the partnership. The brothers came from Shrewsbury, and were keen to set up a flax mill in their home town. So in 1796 the partnership purchased land in Ditherington, close to the site of the proposed Shrewsbury Canal (opened in early March 1797).[252] In 1796 a mill owned by Marshall and the Benyon brothers in Leeds caught fire, resulting in a loss of around £5,000. Fires in mills were common at that time due to the inflammatory nature of the materials used in spinning and weaving, and especially since the introduction of steam engines to power machinery. The partnership therefore decided to make the new Shrewsbury mill as fireproof as possible by constructing it of iron and brick, not wood. To oversee this new type of construction they turned to a Shrewsbury man, Charles Bage (1751-1822), the new mill being finished by late

[251] Malcolm Dick, http://www.search.revolutionaryplayers.org.uk/engine/resource/; Baxter 2006, Main Report, Section 2; unreferenced material is from these sources.
[252] SJ 1.3.1797; Trinder 1992

summer 1797.[253] At first sight Bage seems a most unlikely choice. He was probably born in Derby and moved as a child to Elford near Tamworth, where his father Robert (1728-1801) set up a successful business as a paper and cardboard manufacturer.[254] Charles Bage moved to Shrewsbury sometime in the early 1770's, where he made his living by a curious combination of being a wine merchant and a surveyor.[255] Quite how he became interested in iron as a structural material is a mystery. One clue is that, as well as being in the paper trade, his father was also a partner in a business making high quality ironwork at Wychnor, Staffordshire, which opened in 1764.[256] One of the other partners was Erasmus Darwin, a leading light in the Lunar Society, whose members included Matthew Boulton and James Watt. After Erasmus Darwin moved from Lichfield to Derby he set up the Derby Philosophical Society in 1784, whose members included Robert Bage, who joined in 1788.[257] Darwin's deputy in the Philosophical Society was William Strutt (1756-1830), a mill owner from Belper, Derbyshire, who was *'the first to utilise iron components as a means of making textile mills fire-resistant.'*[258] Charles Bage and Strutt became friends after Bage had initiated a correspondence in 1796 asking for advice about the construction of the Ditherington mill.[259] From the content of these letters it is clear that Bage was already conversant with the most up-to-date thinking on using iron as a structural material in textile mills.

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[253] SC 1.9.1797

[254] Unreferenced material on Charles Bage is from Gameson 1954, and Dictionary of National Biography (DNB) articles on Charles and Robert Bage

[255] For his surveying activities, see, e.g. SA 103/3/77 1780

[256] King-Hele 1999, pp. 52-3

[257] King-Hele 1999, p.198

[258] Tinder 1992, p.193

[259] SA 6001/2657/2; the letter, though undated, was almost certainly written in the Summer of 1796 (Skempton and Johnson 1962, p.180)

The second major influence on Charles Bage was 'The Shropshire Enlightenment'.[260] This was a loose group of liberal-minded men who were all active in the Shropshire area in the late 18th and early 19th centuries. At this time Shropshire was at the forefront in the development of iron technology, which was fostered by men such at the Reynolds family from Coalbrookdale and Ketley, Thomas Telford, and William Hazledine. Bage knew Telford well, and so would have been fully aware of the latter's use of iron in the construction of Longdon Aqueduct on the Shrewsbury Canal, and Buildwas Bridge, both of which were completed in 1796 using ironwork from the Coalbrookdale Company. Indeed, Joseph Reynolds of Coalbrookdale passed on to Bage the results of tests they had done on the ironwork for the Aqueduct.[261] Bage and William Hazledine were also acquainted, perhaps because of the latter's friendship with Telford.[262] Apart from collaborating professionally, the two men worked together in other contexts. For example, in 1809 Bage and Hazledine were both on the Board of the Shrewsbury House of Industry, as was Benjamin Benyon (Figure 38).

Figure 38
Signatures of Directors of Shrewsbury House of Industry, 1809.
Charles Bage is top left, William Hazledine bottom left, and Benjamin Benyon top right
(SA PL2/2/1/1)

[260] Trinder 1983, p.70
[261] Trinder 1992, p.193
[262] SA D3651/D/5/237

The evolution in the use of structural cast iron in mills has been well documented.[263] Bage's part in this is that, in addition to the cast-iron columns and brick arched floors that Strutt had pioneered in Derby, he was the first to also use cast-iron beams. His other major contribution was the development of theories and mathematical formulae to test the strength of cast-iron columns, which turned out to be remarkably accurate.[264] He developed these theories partly by experiments. Some of his later experiments were carried out at William Hazledine's works,[265] but it is not known whether he performed any experiments before the building of the Ditherington Flax Mill. He may just have relied on Strutt's experience, the experiments at Coalbrookdale, and his own mathematical work. If the appointment of Bage as architect and engineer appears a gamble to us, commissioning William Hazledine to do the ironwork would also seem to have been rather risky. The foundry at Coleham had only been in operation for 3-4 years, and there is no evidence that he had attempted anything on this scale before.[266]

The original Ditherington Mill has five storeys, and measures about 54 x 12 metres (177x39ft)[267] (Figure 39).

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[263] Johnson and Skempton, 1955; Skempton and Johnson 1972; Macleod, Trinder and Worthington 1988; Trinder 1992

[264] Skempton and Johnson, 1972, p.179; Baxter 2006, Appendix F, has a useful explanation of Bage's work

[265] http://www.bygonederbyshire.co.uk/famousresidents/Strutt-William-sky-s-limit/article-1763814-detail/article.html

[266] The only possibility is that he may have made the iron columns that support the balconies at St Chad's church. The St Chad's archives have no record of who made the columns, but similar columns at All Saints' Church Wellington (also designed by Steuart) were cast at Coalbrookdale (SC 6.9.1788). However, the difficulty of transporting such large structures from Coalbrookdale, even by river, suggests a local foundry might have been used, possibly Hazledine's original foundry at Cole Hall

[267] All descriptions from Baxter 2006, main report, p.5 ff

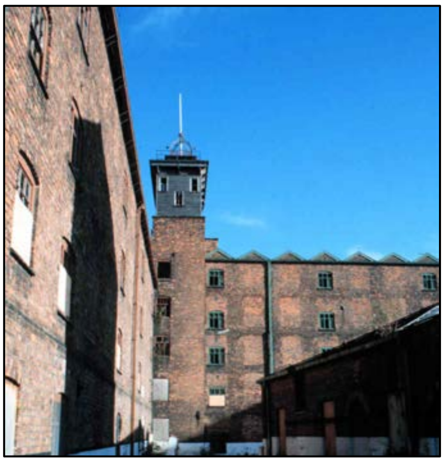
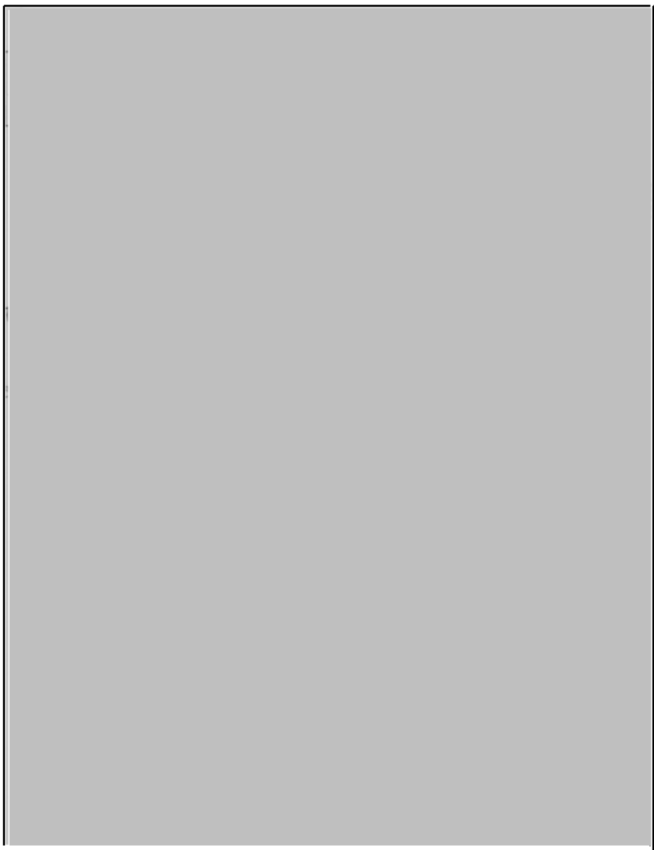
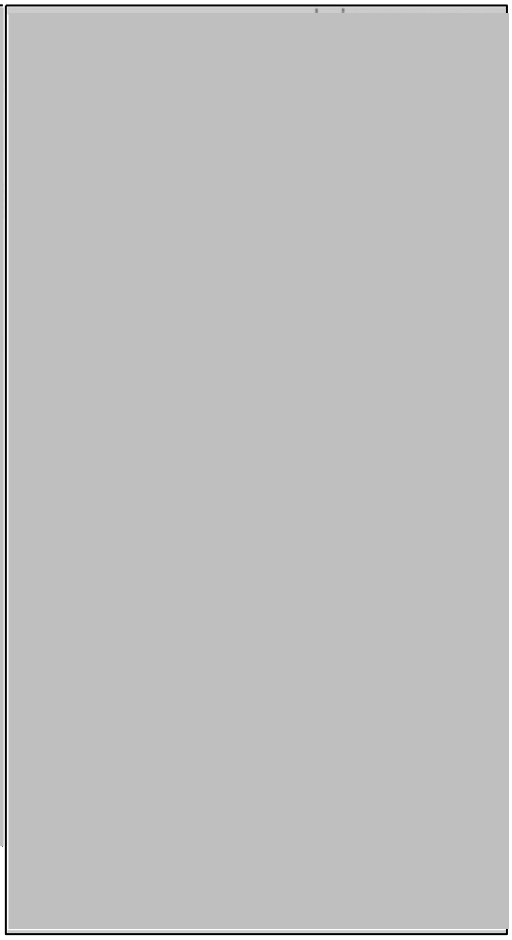


Figure 39
Ditherington Flax Mill, general view. Notice the 'saw-tooth' roof profile. Many of the original windows are now bricked up
(the author)

The external brick walls are load-bearing, and the internal structure is supported by a grid of columns, spaced at equal intervals, with 17 rows of three columns along the length of the building. Thus each floor has 51 columns, making a total of 204 columns in the first four storeys. For the attic storey, just the central columns from the fourth floor (not the side ones) extend up to roof level, which gives the roof its distinctive 'saw-tooth' appearance. The columns at each level support brick jack-arches (which in turn support the floors), and cast-iron beams. The jack-arches are strengthened by the insertion of wrought-iron tie rods (Figures 40 and 41).





Figures 40 (above) and 41 (right), showing details of the beams and columns, and how they join together and to the brick jack-arch floors
(English Heritage)

The columns are of cruciform cross section and are wider in the middle than at the top and bottom for maximum strength (Figure 41). The columns at ground level are wider (127mm/5in at mid-height) than those at the upper floor levels (114mm/4½in), and the capitals of the central columns at the ground and fourth floor levels are cast in the shape of a rectangle to accommodate drive shafts for machinery that ran the length of the building (Figure 42).

Figure 42 shows how the capitals of the central columns on the ground floor are cast to allow drive shafts for machinery to pass through and along the building. Note also the brick jack-arch floor above and the wrought-iron tie rod (the author)

Each floor has 17 lines of beams, each cast in two lengths bolted together in the middle. There are thus 34 separate beams on each floor, a total of 136 in the whole building. The beams run over the side columns, to which they are connected via cylindrical sockets in the beams and spigots in the tops of the columns (Figure 40). The beams are of an inverted T cross section with a skewback, and have a slight hogback, varying in depth from 175mm (7in) at the external walls to 250mm (10in) over the side columns and 275mm (11in) where they join at the middle columns. The beams are also perforated at different points to allow drive shafts to run between the different floors (figure 42). At the wall end, the beam is shaped into a plate which sits between two timber pieces, the whole being bolted together with wrought-iron rods. These timber pieces, though covered with other materials, were a potential fire risk, as was the roof, which is really a series of pitched roofs based on cast-iron beams that slope up from the valley of each section to the points of the columns that reach from the centre of the floor below. The ceilings are brick jack-arches like the floors, and these are covered with timber rafters and battens to which the slates are attached. In addition, all the windows and doors were made of iron, though none of the originals now remain.

This description of the ironwork is brief, but it does give us an indication of the scale and complexity of the castings needed, which were all done at Coleham.[268] In summary, there were 204 columns of a number of different patterns, and 136 beams. The beams in particular required precise and complex casting, especially where they fitted with the columns, the walls and the machinery. The pairs of beams also required bolts to join them together. Assuming there was originally a window at either end of each bay, there would have been 136 windows in the whole building, each of which required casting, as did an unknown number of doors.[269] There were 19 separate roof sections (one for each bay, and one for one end); each of these was supported by cast-iron trusses. The wrought-iron tie rods supporting the jack-arches and wall plates were presumably done at Pitchford, and also required careful forming. There must also have been many smaller wrought-iron pieces – door furniture, banisters, and the like. The whole complex structure

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[268] Minshull 1803, pp.47-8

[269] Angerstein noted 40 years earlier that 'the people [of Shrewsbury] use window-frames of iron. These are welded at the corners and then riveted together with a thin piece of sheet-iron, to make them safer for the window-glass panes. For high windows, espagnolettes [hooked bolt-rods that engage in slots at the top and bottom of the main frame, so locking and tightening the opening light] are also used in order to make it possible to close them tightly and uniformly both at the top and the bottom. On the outside there is a spring that supports the weight of the window when it is opened, and which is also provided with a catch to hold the window in position' (2001 Edition, p.329). Presumably the large factory windows of the Flax Mill, which were needed to let in as much light as possible, were of the latter type.

needed to fit together like a giant Meccano set, and also to fit precisely with the brickwork. We do not know who the brickwork contractor was, but in all probability it was Hazledine's partner John Simpson, since he is credited with later work on the site, such as the Apprentice House and Clerk's House, both built before 1800.[270] One can imagine the two friends spending many hours planning and puzzling how they could bring Charles Bage's scheme to reality!

So how has history judged the ironwork? This first observation is that the building, after over 200 years of use (and sometimes misuse), is still standing. This is definitely an achievement for a structure that was in some ways a prototype. As for the ironwork, recent surveys have provided an opportunity to examine both its composition and how it has stood the test of time. Samples from various parts of the mill have been tested (Table 1). The carbon equivalent value is based on the amount of carbon, silicon and phosphorus present in the sample; higher values suggest less tensile capacity.

> *As much historic cast iron used in structures has been found to have a carbon equivalent value above 4.3%, many of the results show the tensile strength of the iron tested is higher than is typically found.*[271]

Alternatively, one can try to directly measure the tensile strength of the material; in the samples tested this varied between 200 and 230 N/mm^2 (Newtons/square millimetre).

[270] Trinder 1992
[271] Baxter 2006 section 5, p.12

The current recommendation for assessing historic cast-iron structures is to adopt a tensile strength of 123N/mm^2 when no other data is available. This shows that the iron is of above average quality.[272]

In summary, the weaknesses of the building in its present condition are due primarily to the slender design of the iron frame and the decay of the structural timber, not the quality of the original ironwork.

Table 1 – Metallurgical tests on iron from Ditherington Flax Mill[273]

Sample origin	Carbon equivalent value %	Tensile strength N/mm^2	Carbon %	Sulphur %	Silicon %	Mangan-ese %	Phos-phorus %
Column	3.8	230	2.88	0.063	2.04	0.63	0.73
Beam	4.1	200	3.18	0.057	0.98	0.68	1.77
Beam	4.02	215	3.48	0.039	0.95	0.69	0.67
Beam	3.86	230	3.29	0.064	0.87	0.73	0.84
Beam	4.01	215	3.43	0.041	0.82	0.76	0.82

Later two other large buildings were erected on the site. These were the Flax Warehouse (1805) and a flax dressing building. The former was made in the same way as the Main Mill, but, perhaps for reasons of economy, the latter was a traditional wooden construction. It is likely that the ironwork for The Flax Warehouse was made by Hazledine, since in 1812 he was responsible for a chain bridge which linked the upper part of the flax dressing building to the warehouse.[274] Making the flax dressing building of wood proved a false economy, for in October

[272] Baxter 2006 section 5, p.12
[273] Baxter 2006, Appendix H
[274] SJ 30.10.1812

1812 it was completely gutted by fire. As was the custom in those days, many local people, among them William Hazledine and Benjamin Benyon, turned out to help to put the fire out, a risky occupation, since two or three men were seriously injured and one died when the building collapsed.[275] Shortly afterwards, the flax dressing building was rebuilt in the same style as the Main Mill, and is now known as the Cross Mill. There is no documentary evidence as to who made the ironwork, but there is no reason to believe that it was not William Hazledine.

In 1804 the partnership between Marshall, the Benyons and Bage split up, and in 1810 the Benyons and Bage built their own factory, again designed by Bage, not far away in Castlefields (SJ 497131).[276] The factory was relatively short-lived, and most of it was demolished in the 1860s, but a small part was converted to houses, which remain in Severn Street. These houses still contain some of the original columns, whose design is exactly the same as at Ditherington. For this reason, Green attributes them also to Hazledine.[277]

Though it was recognised locally as a significant development in the design and building of factories,[278] the Ditherington Flax Mill was quickly forgotten, and did not even figure in later lists of Hazledine's works.[279] His next major project, however, would be very different.

[275] SJ 30.10.1812
[276] Green 1981
[277] Green 1981, p.123
[278] SC 1.9.1797
[279] For example, SC 30.10.1840

7. 'THE SPIRITED FOUNDER OF THE DUCT ITSELF'

Sir Walter Scott described the Pontcysyllte Aqueduct as a 'stream in the sky', and 'the most impressive work of art I have ever seen'.[280] It is still the highest aqueduct in Britain, and a stupendous monument to those who created it, chief of whom was Thomas Telford. In recent years an attempt has been made to play down Telford's role in favour of the engineer in charge, William Jessop.[281] However, there seems little doubt that Telford should take the primary credit for the structure, which is celebrated in his formal portrait (Figure 43).

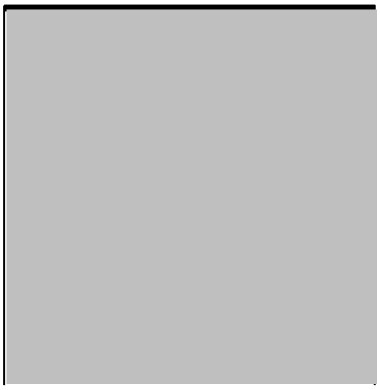

Figure 43
Thomas Telford, 1831, with Pontcysyllte Aqueduct, by Samuel Lane (Institution of Civil Engineers)

Local landowner Rowland Hunt, who had been involved in the project since its inception, was chosen to give the oration at the opening of the Aqueduct. He said,

> *We will mention, as concerned in the scientific and practical construction of the works, our General Agent* [Resident Engineer] *Mr Telford; who, with the advice and judgment of our eminent and much respected Engineer, Mr Jessop, invented, and with unabating* [sic] *diligence carried the whole into execution...In such a history will be found deservedly mentioned, the names of Mr Hazledine, the spirited founder of the Duct itself; of Mr Simpson, the accurate mason, who*

[280] I have not been able to find the original source for this quotation
[281] Hadfield 1969, 1993

erected the pillars; the well-computed labours of Mr Davies, who constructed the mound and tunnels adjacent; and the careful and enlightened inspection of Mr Davison [sic], *who overlooked the whole.*[282]

This, then, was a collaborative enterprise, and this chapter seeks to discover the contribution that William Hazledine made to the project.

Among many canals being promoted in the early 1790's was one that was projected to join the Rivers Severn, Dee and Mersey, and which would also link the important towns of Shrewsbury and Chester. After an initial survey, public meetings quickly galvanised support for the idea, and an organising committee was set up, which first met on June 28th 1791.[283] They formed the Ellesmere Canal Company, and later that year William Jessop was appointed consulting engineer and asked to draw up detailed plans for the route.[284] After considerable discussion a route was agreed and the relevant bill guided through Parliament by Jessop in 1793. Once this was done Thomas Telford was appointed in October 1793 as

General Agent, Surveyor, Engineer, Architect and Overlooker of the Works, and, when appointed, to make drawings and submit them for the consideration and correction of Mr Jessop or their principal engineers[285]

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[282] Oration to mark the opening of Pontcysyllte Aqueduct 26.11.1805, published by J&W Eddowes, 1806, SA WD25.7

[283] Details of the progress of the project can be found in many sources, e.g. Gibb 1935, p.26ff, Rolt 1979; www.rcahmw.gov.uk/HI/ENG/Heritage+of+Wales/World+Heritage+Wales/Pontcysyllte+Aqueduct; Hadfield 1993, p.20ff provides more details on certain items, but does not give a strict chronological sequence. The originals of the Ellesmere Canal Minute Books are in The National Archives (TNA) RAIL 827/1-7. Some of these are on microfilm in SA Mic. 94. The author is grateful to Peter Brown for references from the National Archives, and also for comments on this chapter

[284] RAIL 827/1-4, 7.11.1791 & 9.1792

[285] RAIL 827/5, 23.9.1793 – General Committee, agreed by General Assembly 30.10.1793

Both the most famous ironmasters in Shropshire, William Reynolds and John Wilkinson, were involved in the project – the former as Banker and the latter on the committee. In February 1794 Telford secured the appointment of his old friend Matthew Davidson as Superintendant of the Works.[286] Work started immediately, originally on the northernmost section across the Wirral, and also a branch linking the line of the proposed canal to the limeworks at Llanymynech. Both these works were fully opened in 1797 (Figure 44). At the same time as the Llanymynech section was being built, another canal, the Montgomeryshire, which was approved by Parliament in March 1794,[287] was being constructed to link Llanymynech to Welshpool, and eventually, Newtown.[288] The main purpose of both canals was to transport heavy goods, such as coal, iron ore, limestone and timber, from where they were mined or produced to the centres of agriculture and population. Local landowners hoped to make a great deal of money from the Ellesmere Canal. For example, in September 1795 the Plas Kynaston estate, which is adjacent to the Pontcysyllte Aqueduct, and which contained coal, iron and clay deposits, was offered for sale. The advert stated,

> *It is not to be calculated how great an extent the works are capable of being carried, or to what amount the demand may be increased, when the Ellesmere Canal, which will unite the Severn, the Dee and the Mersey, passes through it* [the Estate], *and opens a way to all the markets of the world. There is a vast rock of light-coloured*

[286] Rolt 1979, p.58
[287] TNA, Montgomeryshire Canal Minute Books, RAIL 852/11
[288] Hughes 1988; Ball 1980

free-stone [i.e. sandstone], *through the centre of which the canal is intended to pass, and which thereby will become an object of very great consideration.'*[289]

Figure 44 – Ellesmere Canal, as proposed and finally built (Hadfield 1993, p.21). Arrow indicates Weston Lullingfields, the nearest point to Shrewsbury.

[289] SJ, 16.9.1795

Despite the enticements of the advert, it appears that there were no takers, since the estate was offered again the next year, this time to rent.[290] There were probably two reasons for the initial lack of interest in the estate. The first was the ongoing economic difficulties resulting from the war with France, and the second was that the building of this part of the canal was running into difficulties. William Hazledine, however, always alert for a money-making opportunity, took up the lease on a part of the Estate and the collieries sometime before 1799, probably in 1796.[291] His long term plan was to export the coal via the Ellesmere and Montgomeryshire Canals to the markets of Welshpool and Newtown and their surrounding areas, and also in the other directions to Shrewsbury, North Shropshire and Cheshire. But in the meantime, he had to be content to supply the local area until the canal building got going again. Not that he was idle. The first structures on the Montgomeryshire Canal to be built were aqueducts over the Rivers Vyrnwy and Rhiw.[292] The contract for building the Vyrnwy Aqueduct (SJ 254197) was given to William Hazledine and his partner John Simpson.[293] This five-arched aqueduct was built in the style of canal pioneer James Brindley, with massive masonry foundations supporting a canal bed of puddled clay. The foundations, however, were built on the soft gravels of the broad River Vyrnwy Valley, and the season was exceptionally wet, so part of the parapet and towpath walls gave way soon after it

[290] SJ 14.9.1796
[291] Davies 1964; Hazledine took out a formal lease in 1799, but this document states that the land is 'now or late in the occupation of William Hazledine' SA D3651/D/31/85
[292] Ball 1980
[293] Hughes 1988, p.15ff, 152

was built.[294] As a result the Canal committee called in William Jessop for advice.[295] He sympathised with the engineer John Dadford, having had similar problems himself on the Cromford Canal, and repairs made the aqueduct serviceable. But this was not the end of Hazledine's involvement with the structure. In 1823 further repairs were undertaken, during which the Aqueduct nearly collapsed completely, and it had to be strengthened with wrought-iron rods and tie bars supplied in an emergency by Hazledine's foundry (Figure 45).[296]

Figure 45
Vyrnwy Aqueduct, built by Hazledine and Simpson in 1797, and strengthened with wrought-iron rods and tie bars supplied by Hazledine in 1823 (the author)

Jessop probably didn't need a reminder, but these troubles would no doubt have concentrated his mind on the problems he faced in routing the Ellesmere Canal over the steep valleys of the Dee at Pontcysyllte and the Ceiriog at Chirk. The plan of the earliest surveyors was to take the canal up and down the valleys by means of locks, with low level aqueducts of the traditional type over the rivers. Jessop and Telford soon realised that this was impractical (not least because of water supply problems), and so looked for other solutions, particularly using an iron trough.[297] Both Telford (at Longdon on the Shrewsbury Canal) and Jessop (on the

[294] RAIL 852/11
[295] Hughes 1988, p.22
[296] RAIL 852/5
[297] For discussion of alternatives see Hughes 1988, p.19ff

Derby Canal) were getting acquainted with the idea of using iron in this way, and so, no doubt after much discussion, this is what Jessop recommended to the Canal Committee in July 1795.[298] The Committee wasted no time in approving the plan and the foundation stone of the Pontcysyllte Aqueduct was laid on 25th July 1795.

James Varley of Colne, Lancashire, was given the contract to build the piers in 1794, so he had already been at work cutting stone and preparing the site for some months when the foundation stone was laid.[299] But by the end of 1795 it became clear that Varley was not up to the job, so Telford arranged for his friend John Simpson to partner Varley.[300] The two worked together till 1797, when work stopped on the piers and Varley decided he had had enough, and left Simpson to it. Simpson was joined in this work by another exceptional mason, John Wilson of Dalston, Cumbria.[301] Simpson was also jointly responsible for the section of canal from Chirk Bank to Pontcysyllte. This included the digging of two tunnels (one a quarter of a mile long), and making stone bridges and culverts.[302] In December 1795 Simpson built a house for Matthew Davidson, just to the north of the Pontcysyllte Aqueduct, which is still there and is now known as the Thomas Telford Inn (Figure 46).[303]

The foundation stone for the Chirk Aqueduct was laid on 17th June 1796, and the contract for building the piers was also awarded to John Simpson, this time in partnership with William Hazledine. Hazledine's involvement initially had nothing

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[298] Hadfield 1993, p.33
[299] Rolt 1979, p.62
[300] IGMT 1981.3587, letter from Telford to Davidson, 25.12.1795
[301] Rolt 1979, p.64-5
[302] RAIL 827/7 – final accounts
[303] Rolt 1979, p.64; Rail 827/7 – final accounts show that Simpson built all the houses along the canal

to do with the ironwork, but was a recognition that, in addition to all his other accomplishments, Hazledine is described on legal documents as a 'master builder.'[304]

Figure 46
Matthew Davidson's house near Pontcysyllte, built by John Simpson in 1795 (the author)

His training as a millwright meant that he was familiar with wood and stone – part of the millwrighting job was to construct whatever buildings were necessary.[305]

The team of Telford, Davidson, Simpson and Hazledine provided the essential core for a highly disciplined and creative workforce. The four men were close friends, whose mutual respect and trust would carry them through the many challenges ahead. Telford and Davidson had known each other since childhood. Telford persuaded Davidson to leave their native Eskdale and go first to Bath to benefit from the building boom there, and then join him in Shrewsbury to supervise the construction of Montford Bridge, Telford's first foray into bridge building, which was built between 1790 and 1792.[306] John Simpson arrived in Shrewsbury to build St Chad's Church at the same time, and Davidson and Simpson quickly became close. They were also united in tragedy, for Mary Simpson, who died on 26th

[304] SA D3651/D/5/228
[305] See, for example, SA6001/16915, estimate for rebuilding Platt Mill
[306] Rolt 1979, pp.40 & 47

October 1792 aged 1 year and 4 months, and Thomas Davidson, who died on 14th February 1793 aged two years, share the same burial plot at Swan Hill Congregational Chapel, Shrewsbury.[307] After his work on the Ellesmere Canal Davidson moved back to Scotland to superintend the building of the Caledonian Canal, and later his son Thomas returned to Shropshire to be apprenticed to an apothecary in Oswestry. During this time John Simpson kept a fatherly eye on the young man.[308] No wonder that when Simpson died unexpectedly and prematurely in 1815, Matthew Davidson wrote to Thomas that '*I mourn him [Simpson] deeply indeed.'*[309] The friendship between Telford, Hazledine and Simpson has been described elsewhere,[310] and doubtless they and Matthew Davidson had many discussions about how the aqueduct could be constructed.

Telford's relationship with Hazledine is illustrated (and perhaps has been misunderstood) by an incident in early 1796. Telford was in London helping to get a new bill to amend the line of the canal through Parliament, and he wrote to Matthew Davidson,

> *'The moment I was conjuring about a spring for the coffee house door this morning, who should make his appearance but the Arch Conjuror himself Merlin Hazledine. This was one of the most singular instances I have met with. We have been considering about the arch over the roadway...'*[311]

[307] SA transcript of Swan Hill Independent Chapel records
[308] IGMT 1981.3588, letter from Matthew Davidson to Thomas Davidson, 29.4.1809
[309] Ibid, letter from Matthew Davidson to Thomas Davidson, 24.8.1815
[310] Pattison 2007
[311] IGMT 1981.3587, letter from Thomas Telford to Matthew Davidson, 19.2.1796

This is popularly taken to indicate that Telford had such a high regard for Hazledine's skill as a manipulator of iron that he regarded him as a magician like Merlin. In reality in early 1796 Hazledine had never made anything in iron for Telford. In the author's view all Telford is saying is that Hazledine's unexpected appearance was that, like Merlin the magician, he seemed to appear out of nowhere.

In the meantime work on the aqueducts stopped and started. In February 1797 the committee asked William Reynolds and John Wilkinson

> *...what terms they will either jointly or individually agree to furnish the ironwork for Pontcysyllte and fix up and compleat* [sic] *the same.*

There is no evidence that this was forthcoming, so in June it was agreed that newspaper advertisements should be placed for executing the ironwork.[312] But because of the escalating cost work was halted, and the committee dithered as it tried to decide what to do next. During this break Hazledine was able to concentrate on the Ditherington Flax Mill in 1797, and Telford and Simpson spent the whole of the 1798 construction season building a splendid new bridge at Bewdley. If Telford wasn't convinced already of Simpson's excellence, this project demonstrated to him that his friend was *'a treasure of talents and integrity.'* [313]

The committee, if not the contractors, had cold feet about the whole iron aqueduct idea. As Hughes has written,

[312] RAIL 827/2, 10.2.1797 & 28.6.1797; the advertisements probably never happened, since a search of the relevant newspapers has failed to find them
[313] Rolt 1979, p.48

All the previous and relatively experimental iron aqueducts, such as Longdon (completed in 1796) and Outram's [William Jessop's business partner]...*Holmes Aqueduct at Derby, were fairly small and the trough of the high and long upper aqueduct at Cyfarthfa [the first and then the longest iron aqueduct] was only 3ft 6in (1.07m) wide and 16in (0.41m) deep.*[314]

When one considers that Pontcysyllte Aqueduct is 1007ft (306.9m) long, 11ft 10in (3.6m) wide, and 5ft 3in (1.52m) deep, one can understand their hesitation. In 1797 the committee looked at the possibility of substituting a railway for part of the canal, including using the piers designed for the aqueduct to take the railway over the river.[315] In the end the committee and the contractors decided on a compromise. Chirk Aqueduct would be built first and would have a base made of 1" (2.5cm) thick cast-iron plates bolted together transversely. These plates would tie the side walls together, which were to be made of hard burnt bricks, sealed with waterproof Parkers Cement, and the outside faced with stone blocks (Figure 47).[316] William Hazledine came in with the lowest tender for the ironwork, which was £10 10s a ton for cast-iron plates and 6d a pound for wrought-iron screws, exclusive of fixing. The tender was accepted in November 1799.[317] It has generally been assumed that Hazledine was able to tender more cheaply than the previous preferred bidders John Wilkinson and William Reynolds because he made the iron at his Plas Kynaston foundry (see below). In fact the foundry had not been built by

[314] Hughes 1988, p.21
[315] Rolt 1979, p.69
[316] www.rcahmw.gov.uk/HI/ENG/Heritage+of+Wales/World+Heritage+Wales/Pontcysyllte+Aqueduct+%26+Canal
[317] RAIL 827/2

then, but the Weston arm of the Ellesmere Canal was opened in 1797, so it was relatively straightforward to transport the iron the 8miles (12.9km) from Shrewsbury to Weston Lullingfields and then via the canal to Chirk (Figure 44).[318]

Figure 47
Still from 3-D model of Chirk Aqueduct, showing cast-iron trough and masonry walls covered in Parkers Cement, the whole faced with stone (RCAHMW)

Figure 48
Chirk Aqueduct 2010 (the author)

From then the work on Chirk Aqueduct proceeded rapidly, so that by May 1801 a visitor could write,

> *I found the canal much advanced and the fine aqueduct of ten arches, which traverse the vale beneath Chirk nearly finished...The other fine aqueduct over the Dee which will be a still grander object than the one before mentioned, has not advanced so much, but the canal is brought up to it, and the lime works above. There are 17 piers erected to bear the arches.* [319]

[318] Raven 2005
[319] Tour Journal of Sir Richard Colt Hoare, Vol. 1, 1801, NLW, Cardiff Library Deeds, 3.127; the lime works were presumably kilns for burning lime to make lime mortar. These were built by Hazledine (RAIL 827/7 , final accounts)

Chirk Aqueduct (Figure 48) was opened shortly after this, which meant that all the effort could then be concentrated on Pontcysyllte.

The ironwork at Chirk was a success,[320] and so the contractors were emboldened to take the next obvious step and make the whole trough for Pontcysyllte of iron. Hazledine's tender for this was accepted in March 1802, according to the following minute,

> *Mr William Hazledine of Shrewsbury having proposed to execute the cast-iron work at Pontcysyllte Aqueduct on the following terms (viz.) the castings at £11 per tons, the wrought iron at 8d per pound* [i.e. £74 13s 4d per ton]*, and being allowed £30 for cast-iron keys to connect the plates of the aqueduct over and above the price of £11 per ton upon the whole weight and to perform the work in every respect* ***according to the conditions and specifications now produced and signed by the said William Hazledine*** [author's emphasis] *... this Committee accept of the proposal...*[321]

The phrase emphasised in the minute can be read two ways. Either the conditions and specifications had been produced by the committee (presumably via Telford) and then signed by Hazledine, or, perhaps more likely, Hazledine himself had produced the conditions and specifications. Either way, Hazledine had a significant input into the detailed design of the ironwork.

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[320] In the longer term, Chirk Aqueduct tended to leak badly enough for the ironwork to be replaced by an iron trough in 1869 (Quenby 1992, p.108ff)

[321] Rail 827/2

Further light on the detailed construction of the aqueduct is shed in a report that James Thomson wrote for Thomas Telford in 1818 relating to work on the three aqueducts for the Edinburgh and Glasgow Union Canal. These

> *were designed by Hugh Baird (1770-1827)* [the engineer of the canal] *but modelled on Telford's aqueduct at Chirk on the Ellesmere Canal; Telford's advice was sought both before they were built and during their construction.*[322]

Telford himself stated in a letter to Thomson that '*the aqueducts* [were] *drawn by you under my direction'*,[323] and sent him to examine Hazledine's ironworks and also Pontcysyllte Aqueduct, presumably to help Thomson draw up detailed plans for the aqueducts on the Edinburgh and Glasgow Union Canal. Part of Thomson's report to Telford explained how the ironwork at Pontcysyllte was made watertight. He wrote,

> *The jointing is done with very coarse flannel in the state it comes from the loom, cut into pieces to suit the flanges, and well covered with white lead of the normal consistency for jointing. And more or less of the pieces are needed in according* [accordance] *to the inequality of the joints which come together. The one also cut a little narrower than the flanges so as to leave a space on both sides to be caulked firmly up with good hemp rolled in tar, and hence well caulked and pitched over. I know of no simpler or cheaper method of jointing for cold water...I have never seen a piece of cast iron work more watertight than this aqueduct.*[324]

Thomson also reported how the ironwork was installed. He wrote,

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322 Ron Birse, 'Hugh Baird' in Skempton and Chrimes 2002

323 ICE, Thomas Telford correspondence, T/EG 310, 1.5.1818

324 Ibid, T/EG 306; James Thomson was evidently so impressed with Hazledine's work that he joined him at Calcutt's, making lock gates for the Gotha Canal, among other things - see Thomas Telford correspondence IGMT 1982.471.19; Burton 2007

The scaffolding and centering [sic] was done by leaving square holes in the piers two courses from the top, and running beams along from pier to pier in these holes, supporting each beam by diagonal braces under, and raising trestles over the beams.[325]

This has been confirmed by recent surveys, and is shown in animation in a video (The animation does not show any centring to support the arches, so exactly what Thomson meant is not clear, as the ironwork would not need wooden centring in the way that a stone bridge does) (Figure 49).[326]

Figure 49

Still from animation showing the building of the lower ends of the piers by means of beams fixed into slots in the stonework, with trestles over them, and the whole supported by diagonal braces (RCAHMW)

The ironwork comprises the following,

The trough is constructed in 18 sections, each 44ft in length, and is 7ft 6" high and 11ft 10" wide. It is made up of ¼" thick plates bolted together along the flanges... Each section of trough is designed to imitate a flat stone arch, the side plates shaped to imitate the voussoirs. Supporting each section are four ribs, cast in three sections and bolted together with connecting plates, the outermost ribs having infill plates which give the impression of a solid span. These ribs sit on cast-iron springing plates built into the stonework near the top of each pier. The trough is not directly attached to the ribs or the piers, but is instead

[325] ICE, Thomas Telford correspondence, T/EG 306
[326] http://vimeo.com/2267361

prevented from moving laterally by a number of brackets and lugs cast onto the underside of trough base plates and which straddle the top edges of the ribs.'[327]

This is illustrated by Figures 50 and 51. Figure 50 shows an exploded view of the ribs, 'voussoirs' and infill plates, and how the ribs attach to the top of the piers. Figure 51 shows the trough and guard rail (notice how the lateral trough supports are angled to continue the lines of the 'voussoirs' below).

Figure 50 – Pontcysyllte Aqueduct, exploded view of ironwork (RCAHMW)

Figure 51 – Pontcysyllte Aqueduct, ironwork detail (the author)

The amount of iron that was needed was staggering. The 19 piers support 18 arches, each made up of four ribs cast in three sections. This is a total of 216 castings. Similar calculations give a total of 216 'voussoirs', 240 infill plates, and so on – literally thousands of major castings, before all the bolts, fixings, and so on are added. To do all this ironwork, Hazledine used his new works at Plas Kynaston. The Plas Kynaston foundry was built on the estate that he leased, and was about ⅓ mile (600m) from the Pontcysyllte canal basin. In 1803 it was proposed to build a 'railway' (tramroad) from the Pontcysyllte Basin to Ruabon Brook that passed near the foundry, but it took until November 1804 for the committee to organise Hazledine's contract for supplying the castings (at £11 a ton) for the double railway

327 www.rcahmw.gov.uk/HI/ENG/Heritage+of+Wales/World+Heritage+Wales/Pontcysyllte+Aqueduct+%26+Canal

(tramroad), and also laying down the tracks.[328] (Figure 52) In the meantime all the ironwork from the new foundry would have to be taken to the aqueduct by horse and cart.

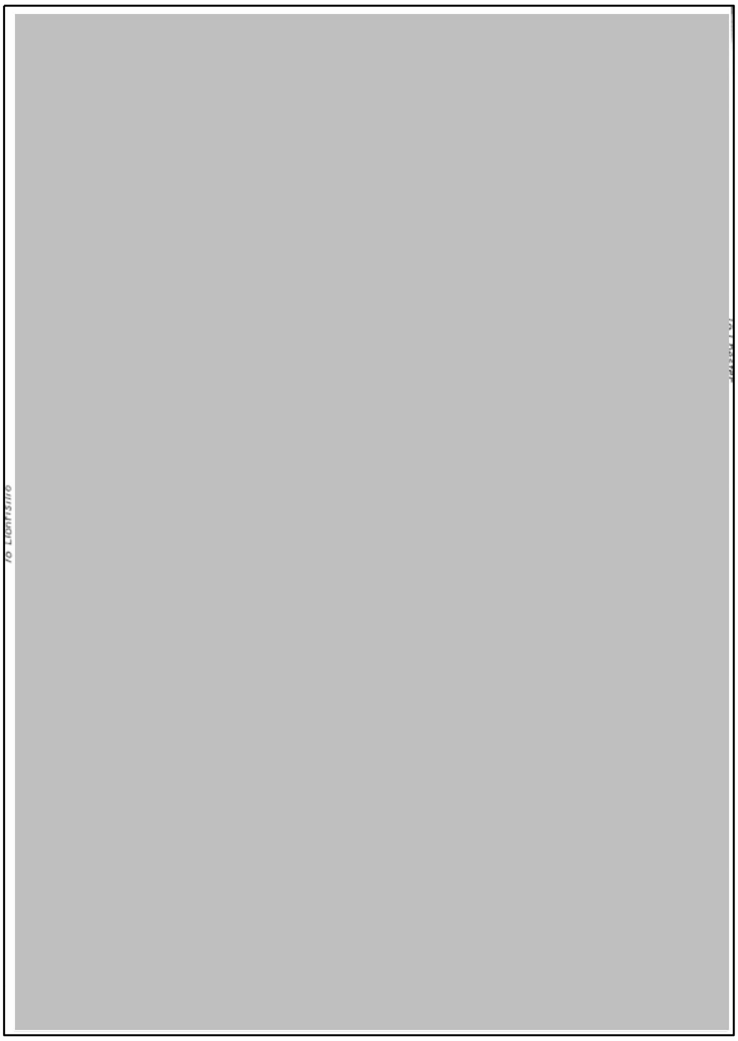

Figure 52
Pontcysyllte area showing Plas Kynaston foundry and the tramroad. Note the original proposed line of the canal to the collieries (Hadfield 1993, p.44)

Hazledine himself oversaw the casting and erection of the ironwork, but to assist him he was fortunate to recruit William Stuttle. Stuttle came from the Black Country, and had been the Manager of the Wednesbury (Hallen's) Ironworks. These were established in 1785 by Samuel and John Hallen, but they became bankrupt in

[328] SA Bridgwater Papers 212/Box 366; Rail 827/2

1794.[329] Over the next six years Stuttle managed the works for the assignees (receivers), as is recorded in two letters written by him concerning parts ordered by Boulton and Watt in Birmingham.[330] The works were put up for sale in 1800, but there were no takers, and so they were closed, and Stuttle was laid off.[331] Presumably he had contact with Hazledine through the Hallen family's connection with Moreton Forge and Upton Forge (chapter 8), and the latter would have been delighted to recruit a man of such experience to build up the new forge at Plas Kynaston. Hazledine and Stuttle were soon hard at work, and Telford was able to report in 1804 that,

> *The iron-work of the Trough-part of the Aqueduct of Pontcysyllte over nine arches is now put up, being nearly one half of the whole length. Many plates being now cast and brought to the bank at the north end of the Aqueduct – the workmen being familiar with the operations of putting the plates together and the operations at the foundry being in a very regular train, and well supplied with metal, there is reason to expect that the whole of the trough-part will be completed about Midsummer next.*[332]

This work necessitated much time away from home for Hazledine, though he was presumably able to stay at Plas Kynaston House, since this was part of the estate he leased. But while he was away, on Friday November 16th 1804 he suffered a near disaster through fire at Coleham. The *Shrewsbury Chronicle* reported,

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[329] Ede 1962; Gerhold 2009
[330] Birmingham Library, Boulton and Watt collection MS 3147/3/43/7&8 (letter group H)
[331] Aris's Birmingham Gazette 6th January 1800
[332] SA Bridgwater Papers 212/Box 366

Some timber kindling by the heat of the chimney of the fire [steam] *engine is supposed to have been its origin, and communicated to the shop, where the models for casting were deposited. Happening in the dead of night, it was not perceived till it had raged some time, when the roof fell in, and presented a grand and dreadful spectacle, for the whole atmosphere was reddened with the blaze! The watchmen's rattles, ringing of bells, and beating of the drum soon alarmed the inhabitants and Volunteers; many of the latter appearing accoutred and in uniform, and their Colonel, Sir C Oakeley, who was present, inspiring them with steadiness and promptitude, on occasions of this kind, as well as to the protection of the property that was removed. The night was fortunately calm; a quantity of salt added to the water in the engines was observed to have very great efficacy in extinguishing the fire. By the cheerful cooperation of all, it was prevented from spreading, and completely subdued by four o'clock. The damage is estimated at near £1500, about two-thirds of which are covered by insurance. Happily no lives were lost, nor any other kind of damage or injury sustained except the above. The proprietor is now rebuilding the premises with his usual resolution and dispatch.*[333]

Hazledine was also greatly indebted to his wife Eleanor, who, when roused with the rest of the locality, *'immediately getting up gave directions for saving the books, papers, and other valuables, which caused their rescue from the flames.'*[334] The mention of the 'Volunteers' is a reminder that in 1804 the country was at war with France. Hazledine was captain of a company of the Shropshire Militia, the

[333] SC 23.11.1804
[334] SC 8.11.1901

commander of the whole corps being Colonel Sir Charles Oakeley, Bart. Hazledine's company was chiefly drawn from his own workmen, and were accordingly given the nickname of 'Vulcans', after the Roman god of fire and metal working. Hazledine's enthusiasm for the militia was such that during the construction work he organised his workers at Plas Kynaston into another company. As Rowland Hunt remarked at the official opening of the Aqueduct,

> *Mr Hazledine, while engaged in an undertaking which would have absorbed the time, the attention and the capital of almost any other man – yet found resources, in an active and patriotic disposition, to lead and instruct the very artificers who craft the materials or erected this structure – in the practice of arms – for the internal defence of that country, which he was enriching by the result of his and their labours.*[335]

But military manoeuvres only took up a very small proportion of their time. Assembling the ironwork must have been both exhausting and frightening work for men unaccustomed to working at heights with no safety gear and up to 126ft (38m) above the stream below. Each arch rib section had to be lifted by means of pulleys attached to A-frames onto the trestles, manoeuvred into place, and then bolted first onto the piers, and then the middle section joined to the two ends, perhaps using wooden centring as a support. Once the ribs were in place it would have been easier to add the trough, but still an alarming experience when the weather was cold, wet or windy. The recent computer-aided simulation[336] is helpful in showing the sequence of construction, but the TV programme of the reconstruction of the

[335] Oration to mark the opening of Pontcysyllte Aqueduct 26.11.1805, SA WD25.7
[336] http://vimeo.com/2267361

erection of the Iron Bridge gives more of an idea of the effort involved.[337] The accuracy to which the piers were built is astonishing - there was almost no margin for error with fitting the precast ironwork sections.

As regards the finishing of Pontcysyllte Aqueduct, it appears that Hazledine and Simpson were mostly left to their own devices. Telford had moved his base from Shrewsbury to the Salopian Coffee House in London in 1800,[338] and in the same year was busy producing designs for a new London Bridge, which involved a great deal of work.[339] In addition, in 1803 he was appointed, jointly with Jessop, to design and build the Caledonian Canal, and much of the summer of 1803 he was engaged in the work of surveying for the canal in Scotland.[340] Telford managed to persuade Matthew Davidson to return to Scotland to supervise the building of the eastern end of the Canal, so once the work on the canal was due to start, in late summer 1804, Davidson left Pontcysyllte for good.[341] Once he had moved, William Stuttle took over his house, from whence he could keep a close watch on the ironwork erection.[342]

While Hazledine was busy finishing Pontcysyllte, Simpson, in collaboration with John Fletcher (d.1820), the engineer for the Chester Canal, extended the Ellesmere Canal from Tilstock near Whitchurch to join the Chester canal at Hurleston, near Nantwich, finally completing the canal, though not on the line originally intended

[337] BBC 'Timewatch' 2002 – it is even more astonishing when one considers that the reconstruction was done at ground level at half linear scale, and the weight was one-eighth scale (Peter Brown, personal communication); De Haan 2004, p.16
[338] http://www.engineering-timelines.com/who/Telford_T/telfordThomas7.asp
[339] Skempton 1980
[340] Burton 1998, p.77ff
[341] Davidson last appears in the attendance records for the Ellesmere Canal subscribers in June 1804
[342] Rolt 1979, p.87

(Figure 44).[343] This section of the canal included several lift bridges, with castings provided by Hazledine.[344] Both the Aqueduct and the eastern extension of the canal were finished by the autumn of 1805, just in time for the whole country to be cheered by the news of Nelson's victory at Trafalgar on 21st October (Figure 53).

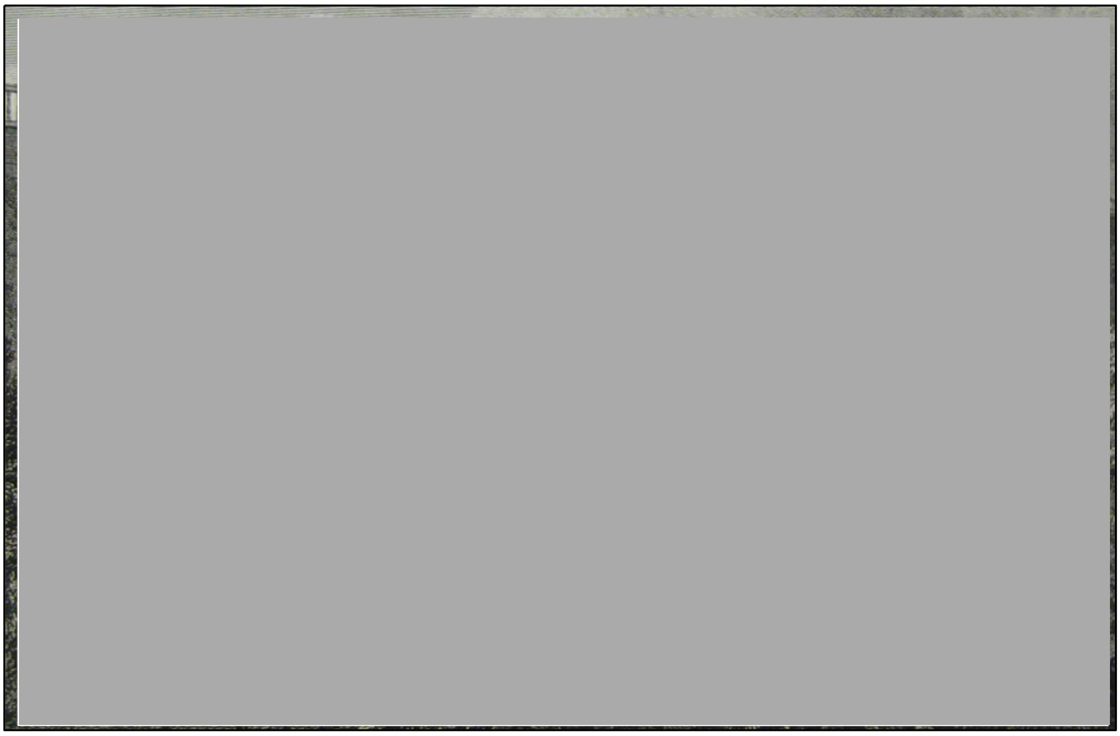

Figure 53 - A contemporary engraving of Pontcysyllte Aqueduct (SA 901/1)

The official opening of the Aqueduct was on Tuesday November 26th, a ceremony which was widely reported, both locally and nationally.[345] Early in the morning the Aqueduct was filled with water, and by midday the threatening clouds had given way to bright winter sunshine. Every road and path leading to the area was filled with onlookers, till the numbers swelled to an estimated 8000. Just

[343] Skempton and Chrimes 2002

[344] Rail 827/5, the final report, probably incorrectly, referred to these as swivel bridges

[345] For example, SJ 4.12.1805; *Gentleman's Magazine,* Dec 1805, p.1228; the same report, and the oration by Rowland Hunt at the formal banquet for dignitaries, was later printed (SA WD257). This description including quotations, is taken from the *Salopian Journal*

before 2pm six barges assembled at the Vroncysyllte Basin at the southern end of the Aqueduct (Figure 52). In the first were the Lords and Ladies and other notables, and in the second were the members of the committee, among them Thomas Telford. The third barge contained the band of the Shropshire Volunteers playing patriotic music, while all the contractors, supervisors and their families crammed into the fourth. Among them was William Hazledine, who took the opportunity for a bit of free advertising, having had a flag made with the inscription, '*Success to the iron trade of Great Britain, of which Pontcysyllte Aqueduct is a specimen*'. The fifth and sixth barges were filled with anybody else who could get aboard. When the first barge entered the Aqueduct the Artillery Volunteers let off the first of sixteen rounds from guns captured at the Battle of Seringapatam in 1799, and between the volleys the cheering of the workmen and onlookers echoed around the river valley. The dignitaries went off for their lunch and to hear the oration by Rowland Hunt, who had been chairman of the committee during most of its existence.[346] During lunch a train of five wagons, each loaded with two tons of coal, and the whole drawn by just one horse, trundled down the newly built railway from collieries on the Plas Kynaston Estate. Willing workers loaded this coal, together with more already waiting on the quay, into two empty barges which had followed the procession. These then tagged onto the barge procession as it returned to Vroncysyllte. The first of these coal barges had a banner which read, *'This is the first trading boat which passed the great Aqueduct of Pontcysyllte, loaded from Plas Kynaston Collieries of the 26th day of November 1805.'* Hazledine certainly milked

[346] SA WD257

the advertising possibilities of the day! But he also ensured that the workers, not just the dignitaries, were looked after, for while all the festivities were going on two sheep were being roasted nearby. Once they were ready, all those who had actually built the aqueduct crowded into the Plas Kynaston foundry to enjoy the feast, washed down with copious quantities of beer and ale. Hazledine knew how to look after his workforce, and they, in turn, rewarded him with loyalty.

Hazledine could afford such celebrations. Table 2 details what he was paid for his work on the Ellesmere Canal. In addition to this, he and John Simpson, as joint contractors, were paid £19,055 0s 10d for the masonry work on Chirk Aqueduct. If Simpson and Hazledine were equal partners in this firm, Hazledine's total income would have been around £35,000 (around £1,200,000 at today's prices[347]). As none of Hazledine's records survive, we do not know what his expenses were, and the whole contract took ten years to complete, but there seems little doubt that he made a handsome profit.

Table 2 – Payments to William Hazledine for work on the Ellesmere Canal[348]

Work performed	Cost (£ s d)
Castings for swivel bridges etc	70 18 08
Ironwork for Chirk Aqueduct	1843 11 11
Rails, wagon wheels etc for building embankment	219 19 00
Ironwork for Pontcysyllte Aqueduct	17284 17 05
Iron rails, nails etc for railway	3643 10 02
Ironwork for 'water line' (canal to bring water supply from Bala Lake via Llangollen)	98 07 10
Lime kiln building	683 10 00
Boats, weights and repairs	637 04 09
Total	**24481 19 10**

347 National Archives currency calculator

348 RAIL 827/5, final report; I have ignored halfpennies (but Hazledine didn't!)

He not only profited financially, but the building of the canal, and especially the Aqueduct, propelled him into the local, if not national consciousness, enabling him to gain other contracts. Also the canal enabled him to move his products – coal, limestone, building stone, slate, and possibly ironstone - from his mines and quarries, and ironwork from the Plas Kynaston foundry, to customers in Shropshire, Cheshire, mid-Wales and beyond (Figure 54).[349]

Figure 54
Receipt for coal delivery at Weston Wharf via Ellesmere Canal 1830 (the source of the coal is not recorded) (SA 6001/17891)

[349] For example, NLW Glansevern (3), Vol. IV Miscellaneous letters 1847 records an order for coping stones sent to Glansevern near Welshpool in 1810, and see also Chapter 5

8. UPTON FORGE

From about 1800 until his death in 1840, William Hazledine leased Upton Forge. During that time it became one of the most important of the few remaining rural forge sites in Shropshire. This chapter describes how Hazledine's tenure fitted into the long history of this site. Upton Forge (SJ 559113) is situated on the north bank of the River Tern about 2km from its confluence with the River Severn. This confluence lies just south of the Attingham Estate, whose northern edge is the south side of the River Tern, opposite the Forge. Upton Forge is about 5km north east of the outskirts of Shrewsbury by road, and 1 km south east of the ancient village of Upton Magna (SJ 555125) (Figure 55).

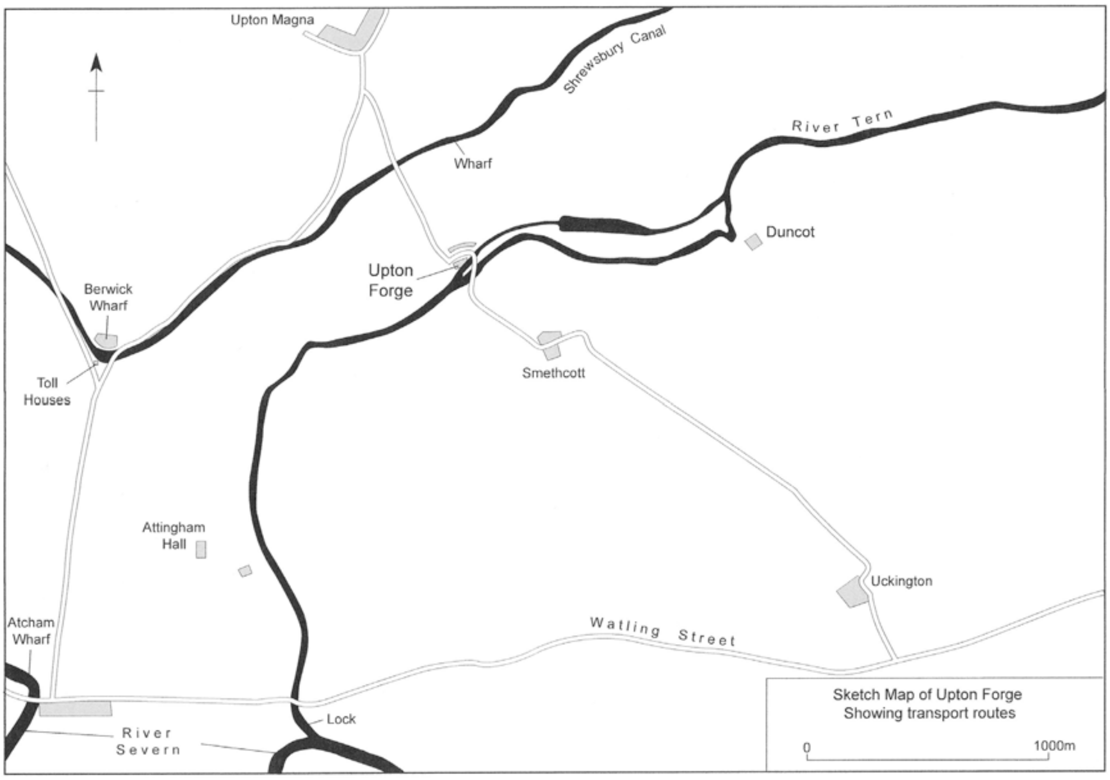

Figure 55 – The Environs of Upton Forge c1820

Half a kilometre further upriver and slightly inland from Upton Forge is Forge Farm (SJ 563115) (previously known as Lower Rea), and a further ½ km further upriver is Duncote (formerly Duncot) (SJ 573114) (Figure 56). All that remains of the latter is a farm situated on the south side of the river, but historically there was also a mill on the other side of the river.

The two basic requirements for any mill or forge site are good access (for transporting both raw materials and finished products) and power (water or wind) for working the machinery. Upton fulfils both these criteria. Access to Upton Forge now seems rather poor, but formerly there was a significant river crossing at the Forge. This allowed access to Watling Street, and hence the East Shropshire coal and iron producing areas via Smethcott and Uckington. In the other direction, the road goes to Upton Magna and from there to the north (Figure 55). The importance of the river crossing is indicated by the accidental discovery by workmen some years ago of sandstone blocks that appeared to be the foundations for a significant bridge.[350] This bridge was probably on a direct alignment with the road on either side of the river, whereas the modern road with its ramshackle bridge bypasses the forge site via a dogleg (Figure 56). In addition to easy access by road, Upton Forge could also be reached from the River Severn via the River Tern, which was navigable for boats of a significant size as far upstream as the bridge at Upton Forge. Prior to the building of the railways, the River Severn was the main way of accessing the West of England downstream, and upstream as far as Welshpool, which was the gateway to mid-Wales.

[350] Phil Roberts, personal communication

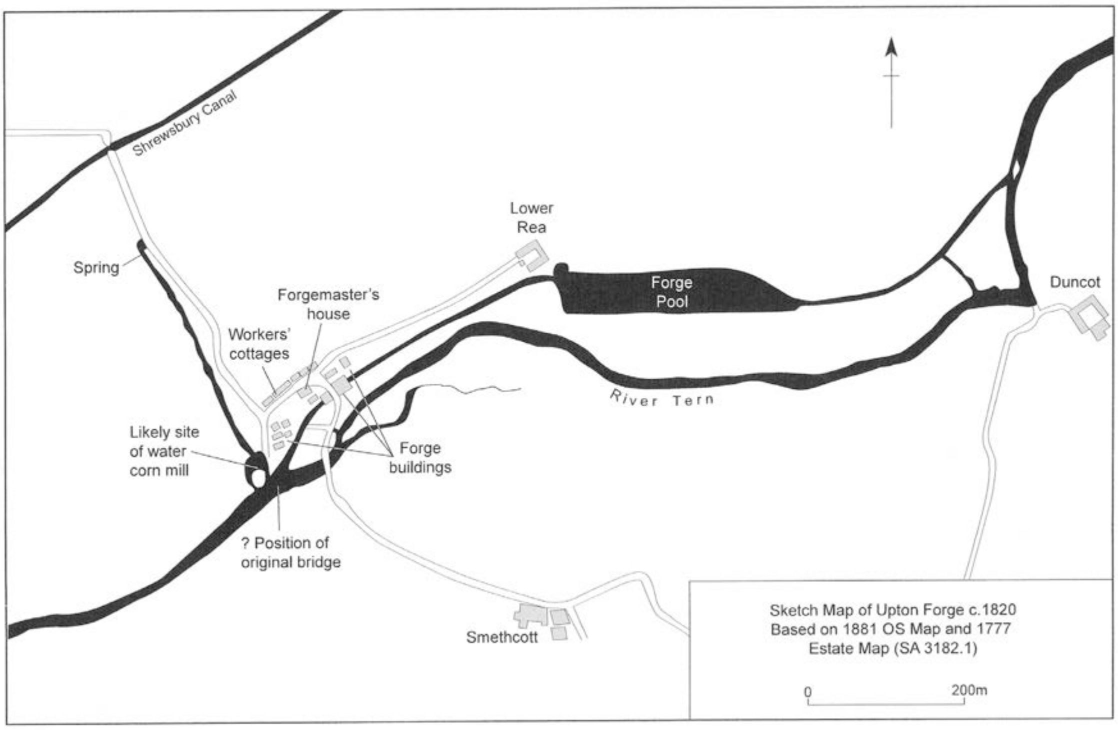

Figure 56
Detailed map of Upton Forge area c1820

During the eighteenth century, navigation on the Tern to Upton Forge depended on the goodwill of the owners of Tern (later Attingham) Hall, who had allowed the construction of a lock on the Tern at the confluence of the two rivers (Figure 55).[351] The primary purpose of this was to service Tern Forge, which was situated near the Hall, but Upton Forge also benefitted. During the eighteenth century there was wharfage at Tern Forge for timber and iron destined for Upton Forge. Presumably the materials were then transferred to other smaller boats to bypass Tern Forge, or else they made the last leg of their journey by road.[352] Tern Forge was closed in 1757, and when the river was extensively remodelled later in the century by Humphry Repton, the lock was bypassed and fell into disrepair, and navigation on

[351] Denton and Lewis 1977, pp.60-61
[352] SA Attingham Archives 112/11/box 15/65

the River Tern ceased.[353] However, in early 1797 the Shrewsbury Canal was opened.[354] This passed about 500 metres from Upton Forge to the northwest and linked the East Shropshire coalfield and industrial area with Shrewsbury. Thus it was easy to transport raw materials (coal and pig iron) to the forge. During Hazledine's time, Upton Forge had its own loading area on the canal.[355] As an alternative, Hazledine's lease freed him from paying tolls on goods sent by the turnpike road to Berwick wharf, situated on the canal, or goods could go direct to the River Severn itself to be loaded at Atcham Wharf (Figure 55).[356]

The Domesday Book records a mill at Upton.[357] Clark considers that this may refer to Duncot, but in the Domesday record there is no mention of a mill at Duncot or anywhere in the parish of Uckington, in which Duncot is situated.[358] In 1160 William Fitz-Alan gave the mill at Upton to Haughmond Abbey, and in 1313 Edmund, Earl of Arundel also gave some waste land nearby to the Abbey.[359] Duncot, however, was owned by Lilleshall Abbey, and its first surviving historical record dates from 1180, when it is stated that the Abbot had a watercourse cut to bring water to his mill from a local fishery.[360] The water supply for Upton was, however, less clear, since it is unlikely that the River Tern would have been used, since it is slow-flowing. One possibility for supplying water to the mill is that they dammed a small stream that arises from a spring nearby, which would then

[353] SJ 7.2.1798 records the finding of antiquities during this work
[354] SJ 1.3.1797; Morriss 1991, pp.27-34
[355] TNA RAIL 868/1
[356] SA D3651/D/9/6/1-8, 1819
[357] Domesday Book of Shropshire, Phillimore 1966, 4.3.24
[358] Clark 1990, p.2
[359] Eyton 1858, p.289, 296
[360] Eyton 1859, p.237

produce a mill pond (this stream has been observed by the author to run even in dry weather). This is suggested by the 1843 field name map, drawn when the forge had ceased operation (Figure 57). This stream arises from a spring at the Withy Bed beside Forge Meadow (490), and joins the River Tern at the Withy Bed numbered 493. This withy bed could mark the remains of a mill pond. There is still evidence of the pond today, and it appears to be separate from the later forge site.

Figure 57
Upton Forge - detail from 1843 Field Name Map
(Shropshire Archives, www.search.secretshropshire.org.uk)

After the Reformation, Upton Mill passed to the Haughmond (later Sundorne) Estate, initially owned by the Berkers (or Barkers). In 1563 James Barker leased the mill for three years to John London, whose payment was to grind Barker's corn, malt and grist and provide 40 sticks of eels a year from the River Tern.[361] With the development of blast furnace technology, the following century saw the establishment of a number of furnaces and forges in Shropshire. Often existing corn mills were converted for these purposes, and Upton was no exception. In 1653 the mill was leased to Francis Walker of Wooton, with a licence to convert it to a forge.[362] One Hiram Walker (presumably a relative of Francis) appears on the rent rolls for the first time in 1654, but then disappears until Lady Day 1660.[363] At that time he paid rent for the *'mill, house and flume'*, which suggests that between Michaelmas (29th September) 1659 and Lady Day (25th March) 1660 an effective water supply to power the new forge was developed. Later maps show that a weir at Duncot was used to divert water from the river above Duncot into a newly-dug leat.[364] The leat followed the line of the river on its northern side to a large pond, called Forge Pool, situated in Forge Leasow. The forge master could then control the outflow from this pond as he required (Figure 56). By 1666 the forge was in full operation, at a lease of £160 per annum.[365] Francis Walker was a member of a consortium headed by Hon Thomas Newport and Francis Boycott, which also ran iron works at Leighton Furnace, Willey Furnace, Sheinton Forge, and Longnor Forge.[366] In 1666 the resident forge master was Thomas Smith, who leased the mill house and adjoining lands. At that time Duncot Mill was leased separately at an

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[361] SA 6000/5912
[362] SA 6000/5920
[363] SA 6000/18289
[364] SA 3182/1
[365] SA 6000/5894
[366] SA 6000/3100; 6000/3230; Hill 2003; King 2003, p.85

annual rental of just £10, which indicates that it remained a corn mill.[367] Records of the Forge for the period 1st July 1680 to 26th March 1681 still exist, and confirm that the forge had both a finery and a chafery, perhaps run by two separate mill wheels on either side of the building.[368] The cost of making iron in this 9 month period was £1,896 3s 1d. The main expense was raw materials, and in addition a total of £110 16s 8d was spent on rents and the miller's wage, leaving a very modest 3% profit of £53 19s 3d (approximating to £4,500 at today's prices).[369] Three boats (worth £13) were owned by the partnership for transporting raw materials and finished products on the River Tern. Much of the cordwood for charcoal making was obtained locally from Haughmond Hill.

In the early eighteenth century the lease was taken over by Joshua Gee, who also leased Tern Forge.[370] Gee also leased Pitchford Forge and Sutton Forge in Shropshire, and had an interest in Bersham Furnace (near Wrexham) and iron ore mines in Cumberland.[371] In 1750 the lease passed to Francis Dorset, who also had other ironworking interests, such as Withyford Forge on the River Roden, a tributary of the Tern.[372] Upton forge was evidently in a run-down condition, since the landlord, John Corbet, was required to make extensive repairs and renewals, such as a new roof for the forge, a new chafery wheel and trough, and a new upper finery wheel. The latter suggests that there were then two fineries and one chafery, a common arrangement to ensure continuous working. As well as leasing Upton,

[367] SA 6000/5894
[368] Nat Lib of Wales, Cilybebyll 2, no. 202; see also Hill 2003
[369] National Archives currency converter
[370] SA 6000/18209; Coulton 1989
[371] King 2003, p.99
[372] SA 6000/18209; Shawbury Poor Law Overseers' accounts, SA P241/202ff

Dorset also leased Duncot, and the Forge Leasow, and Corbet agreed to further improve the water supply by making a weir at Duncot *'to the said forge and mill'* (presumably Upton and Duncot). He also agreed to *'cleanse the flume that brings the water from the River Tern to the said forge'*.[373] Archaeological evidence suggests ironmaking at Duncot, which may date from this period, but the documentary evidence is inconclusive.[374]

Dorset went into partnership with William Hallen and Ralph Vernon, and they may also have set up a furnace to make pig iron, though, considering that it cost almost as much to bring bar iron the few miles from Horsehay by wagon as it did to transport it to Bristol by barge, it seems unlikely that they would transport extra raw materials in for this purpose.[375] Dorset left in 1758, leaving Hallen as the resident manager. In the 1760s and early 1770s, the estate rent books provide some insight into the fortunes of Upton.[376] In 1762/3 the bridges [sic] at the forge were rebuilt, which required the partnership to pay £10 towards the cost. From 1763 Vernon and Hallen rented a warehouse at Norton, which is on Watling Street, which may have been to store bar iron before onward transport. From 1765 – 1770 they were continually in arrears with the rent, suggesting they were struggling financially. In 1772 Vernon left the partnership, and this seems to have enabled Hallen to pay off the rent arrears. There is no evidence from this source for ironmaking at Duncot at this period, which is always referred to as a 'mill' rather

[373] SA 6000/18209
[374] Clark and Horton 1989; Clark 1990
[375] Gerhold 2009, p.52; Trinder 1981, p.90
[376] SA 18223-18239

than a ‘forge’, which is supported by a record that in 1764 the estate sold two old millstones from Duncot Mill for £5 3s.

Around this time Hallen was joined by John Wheeler, to whom he was related by marriage.[377] The Wheeler family, like the Hallens, had been in the iron trade for generations. Wheeler became the overseer at Upton Forge, and by 1777 he was in partnership with William Hallen.[378] In 1780 the 17 year old William Hazledine, apprenticed as a millwright to his uncle John, was entrusted with the erection of some machinery at Upton Forge. He performed the task so admirably that it was still remembered at his death 60 years later.[379] In 1782 Hallen and Wheeler were joined in the partnership by other members of Hallen’s extensive family, including Samuel, who owned Wednesbury forge in Staffordshire.[380]

The 1780’s and 1790’s saw considerable changes in the way wrought iron was produced, with the introduction of ‘indirect’ methods of heating the iron with mineral fuel (usually coke), separate from the iron. One method of doing this was ‘stamping and potting’, where the iron was broken into small pieces (stamping) and then heated in large clay pots (potting).[381] Another, method was ‘puddling’, which used a ‘reverberatory’ furnace. In this, the flames from the fire caused by the combustion of the coke were reflected from a sloping roof onto the working bed. The molten iron thus formed had to be continuously stirred, or ‘puddled’.[382] In time puddling became the most popular method (Figure 58). There is evidence that the

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[377] On 30.1.1783 William Hallen and John Wheeler were witnesses at the marriage of Hallen’s son William and Wheeler’s daughter Hannah (SA Upton Magna parish records)
[378] SA 3182/1
[379] SC 30.10.1840
[380] Hayman 2005, p.45; SA 1396/2
[381] Hayman 2005, p.43
[382] Gale 1979, p.152

production of wrought iron at Upton at this time was performed in both these ways, as well as by the traditional charcoal method. In March 1786 twelve loads of charcoal were brought to Upton from Sutton, using two carts provided by Jonathan Scoltock, bricklayer and building contractor.[383] Archaeological excavation points to the presence of stamping and potting activity around Upper Rea in the late 18th century, which is perhaps not surprising, since Samuel Hallen introduced this method at Wednesbury in 1786.[384] The first documentary evidence of puddling occurs in 1792, when Scoltock's workmen were paid for '*taking down and rebuilding the puddling furnace'*.[385] The fact that it was being rebuilt suggests that it had been in operation for some time, which indicates the early adoption of the new technology, since puddling had only been patented by Henry Cort in 1783 and 1784.[386]

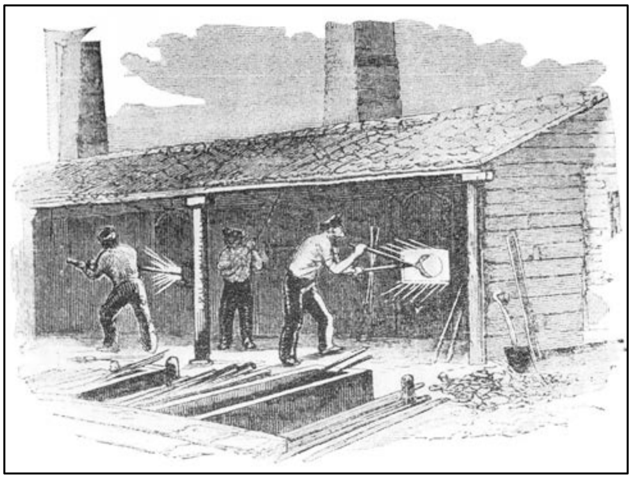

Figure 58
Puddling furnace
(From Tomlinson's 'Encyclopaedia of Useful Arts' 1852)

[383] Jonathan Scoltock's bricklaying book, SA Q/M/2, p.77-78. Since it is not known exactly when Sutton Forge closed, it is possible that this transaction was a 'closing down sale' of charcoal.
[384] Clark and Horton 1989, p.31; Hayman 2005, p.45
[385] SA Q/M/2, p.425
[386] Hayman 2005, p.46

In early 1790, John Wheeler and William Hallen (who had by then moved to Bridgnorth) brought Richard Watson, an ironmaster from Kidderminster, into the partnership. Watson moved into the Forgemaster's house at Upton, and set about major improvements to the house, grounds and forge. This included the rebuilding of the puddling forge, noted above.[387] Watson appears to have been also something of a self-publicist, since in early 1793 he placed in the local newspaper a declaration of loyalty in support of the king, the constitution and the government.[388] This was in response to the considerable unrest in the aftermath of the French Revolution, and was ostensibly signed by forty of the forge workers, though one wonders how much pressure they were under to do so! Whatever its merits, the declaration does give us an unusual window into the ordinary workmen employed at the forge, which included William Maybury, the clerk, or overseer.

But Richard Watson was soon in deep financial trouble, and was declared bankrupt in March 1794. This may have been partly due to the severe financial and business downturn that accompanied the beginning of the war with France. But in Watson's case it was probably exacerbated by reliance on borrowed money, for example he had taken out a loan for £2,000 with interest in September 1790.[389] Watson's bankruptcy resulted in Upton Forge being put up for sale, and the advert describes three fineries, two balling furnaces (chaferies) and two puddling furnaces and *'every accommodation for carrying out an extensive trade, plentifully supplied*

[387] SA Q/M/2, pp.261, 313, 369, 403, 425
[388] SC 11.1.1793
[389] SA 6000/3362 - on the back of this loan document is written 'At the Angel Inn in Kidderminster on Monday 3rd March 1794 exhibited to us under a commission of bankruptcy against Richard Watson.'

with water, and capable of making about 30 tons of iron per week'. There was also a dwelling house for a '*genteel family'* and 12 houses for workmen.[390] There was no buyer for the forge, so the Commission against Bankruptcy decided that in order to preserve the business, and thereby possibly repay the creditors, they would assign the estate and effects of Richard Watson to William Maybury, his clerk, described as *'ironmaster of Upton Forge'*.[391] For the nominal sum of five shillings Maybury promised to keep the business going and then assist a new buyer appointed by the Commissioners. This situation appears to have continued for the next six years, until 1800. Then an advertisement appeared in the press which reads as follows,

> *Whereas William Maybury, late of Shifnall [sic] in the County of Salop, ironmonger, hath by deed of assignment bearing the date the 28th of October last part, assigned over all of his effects to William Hazledine, of Shrewsbury, Ironmaster, for the benefit of such of his creditors who shall sign the said deed...*[392]

The question is whether this William Maybury, 'ironmonger of Shifnal' was the same person as the one who took over Upton Forge? On balance it seems most likely since the Maybury family and Hazledine were already well acquainted via Pitchford Forge (see Chapter 5). Maybury may have made this arrangement in order to secure the future of the forge, since in 1800 the Attingham Estate was expanding, and having taken a lease out on Duncot Farm (which they later bought),

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390 SC 18.4.1794
391 Staffs RO D695/3/49
392 SJ 28.10.1800 – I am grateful to Paul Luter for this reference

they were also actively considering purchasing Upton Forge.[393] On May 14th Lord Berwick of Attingham received an urgent letter from his attorney Robert Pemberton that Pemberton's assistant John Dodson had made calculations on the cost of a lease or purchase of the forge. Pemberton wrote that

> *The reimbursement of the principal part of the money is to arise from the increase in value to the lands of different properties adjoining by the forge being taken down... If Dodson is correct as to the deficiency, it does not strike me as being a large sum for the price of such a nuisance.*[394]

So the whole idea of the purchase was to demolish this noisy neighbour, which was a blot on their northern boundary, and so to increase the value of the adjoining properties.

But this proposed purchase fell through, and instead, John Dodson himself, in partnership with William Hazledine, took over the lease that John Wheeler and his partners had had for the forge since 1782.[395] Dodson's capital enabled the two men to pay off the old creditors and develop the business that had been 'ticking over' for the past six years. John Dodson of Cound (1767-1831) is variously described as a 'builder' and a 'gentleman'.[396] He designed and built the first iron bridge at Cound in 1795.[397] He was also effectively the administrator of the Attingham Estate, being the assistant to local attorney (solicitor) Robert Pemberton, who was much too busy

[393] SA 112/5/10/3-4, 7-8
[394] SA 112/14/70/75
[395] SA D3651/D/9/6/1-8
[396] SA 227/4; 112/5/43/7-8
[397] SA 227/4**;** Blackwall 1985, pp.48,50; Cossons and Trinder 2002, p.119

to be involved in day-to-day management.[398] Hazledine was evidently well respected by Dodson, having been used as the final referee in a building dispute that Dodson and another arbiter could not settle.[399] The precise date of the takeover is not stated in the documents, but a minute of the General Committee of the Shrewsbury Canal dated 8.10.1800 states that *'the Upton Forge Co shall be at liberty to cut through the towing path of the canal at Upton Wharf...'*, which suggests renewed activity at the forge at this time.[400] The partnership between Dodson and Hazledine was eventually dissolved in 1819, leaving Hazledine as the sole partner.[401]

So why was Hazledine interested in Upton Forge? Probably it was Upton's much better communications that encouraged him to give up the lease on Pitchford and move his wrought iron operations to Upton. As described in Chapter 6, he brought coal and pig iron from East Shropshire to Upton via the Shrewsbury Canal. Finished products could then be sent on to Shrewsbury by the canal, or else they could be sent to their final destination by river or road. By this time, the iron industry was being concentrated near the centres of raw material production, such as East Shropshire and the Black Country. By ensuring his supply of raw materials and minimising transport costs Hazledine was able to compete, even though his facilities were more spread out. The new centres of the iron industry also relied increasingly on steam power, which could be generated cheaply by the use of

[398] SA – summary of Attingham administrative history
[399] SA D3651/D/13/17
[400] TNA RAIL 868/1- Dodson had been on the General Committee of the canal since 1798, so the nominal payment of one penny a year that the Upton Forge Company had to make for this canal access probably reflects his 'insider' status
[401] SA D3651/D/9/6/1-8

substandard slack coal which was mined nearby.[402] On the other hand, Upton's power source, water, was free, and, because of the extensive improvements to the water supply, was reliable, except in times of flood. Being a millwright himself, presumably Hazledine was also more comfortable dealing with a power source that he understood well, rather than relying on the vagaries of early steam engines.[403]

It appears that Hazledine continued to work Upton Forge as he found it, using the three fineries, two chaferies and two puddling furnaces, and employing a combination of coke and charcoal technology depending on the quality of iron required. He himself was a frequent visitor to the site, as a Mr Caswell recalled many years later.[404] Caswell grew up down the road at Atcham, and what most struck him about Hazledine was that, when the famous ironmaster's carriage passed by, the young boy noticed *'his invariable courtesy in returning my salute when I doffed my cap.'* The writer contrasted this with *'those who considered themselves entitled to a 'bow' from their subordinates in rank or position [who] claimed it as a right, and the courtesy was seldom acknowledged.'* The young Caswell's abiding memory of the forge was, he wrote, *'the thump, thump of the*

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[402] Gale 1979, p.29

[403] Chaplin (1969), who was one of the first to draw attention to the industrial importance of the Tern Valley, wrote that 'Hazledine had a paper mill at Upton'. This is almost certainly incorrect. Chaplin probably got this idea from Lloyd (1937-8 & 1949-50) who quotes Shorter (1949-50) as having 'shown ... that there was a paper-mill [at Upton Magna] in the year 1816 conducted by William Hazledine, the celebrated ironfounder, and known as the Forge Mill'. What Shorter had in fact described was that in 1816 there was a paper Excise Number 350 which belonged to William Hazledine, the paper type being designated 'Forge'. Because the only forge that Hazledine was then known to be associated with was Upton, it was assumed that this paper-mill was at Upton. How Hazledine got into paper making is that in 1800 he answered an advert in a local newspaper to turn Longnor Forge into a paper-mill. He paid £500 to the owner Robert Corbett to fund the cost of conversion, and entered into a 25 year lease at £45 a year (SJ 7.5.1800; SA D3651/D/31/57; SC 25.2.1825). In all probability, therefore, the Hazledine paper Excise Number designated 'Forge' refers to paper made at Longnor Paper Mill (which was still often referred to as the Forge).

[404] SA 901/1

forge hammer [which] still reverberates to my memory.' If the hammer could be heard so clearly a mile or so away, what must it have been like to work at the forge day after day?

An example of the way Hazledine worked is recorded in two letters, handwritten by himself to Thomas Evans of Prescott, Baschurch, in May 1834.[405] Hazledine's assistants, Thomas Thomas and Nathaniel Evans, had evidently asked his advice about work they were doing to insert tie bars to strengthen the church tower. In his letters (one written on a Sunday) Hazledine advised inserting two extra bars. *'I shall go to the forge* [Upton] *early in the morning to have the iron drawn, and will endeavour to have the whole finished on Saturday,'* he wrote. Even at this stage (he was 71 by then) he clearly remained 'hands on'.

Wrought iron of the highest quality was required for Upton's most famous manufacture – the ironwork for the Menai (SH556714) and Conway (now Conwy) (SH785776) suspension bridges. The scale of this work has been described as 'unprecedented'.[406] The bridges were designed by Hazledine's old friend Thomas Telford, who had consulted suspension bridge pioneer Captain Samuel Brown (1776-1852),[407] and also done extensive tests to determine the tensile strength of the sort of wrought iron that would be used.[408] Telford initially planned to use cables formed from ½ inch (1.25cm) square bars welded together in segments. But before the ironwork contract was awarded to William Hazledine in July 1821, the

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405 SA P22/B/3/4,5
406 Paxton 1980, p.103
407 See Appendix 6
408 Paxton 1977; Day 2007

design was totally changed to an improved version of that of Brown, who used long eye-bar chains in single lines.[409] Telford's design consisted of

> *'Sixteen eye-bar chains, with each half of the deck being suspended at each side by two pairs of four vertically arranged chains. Each chain comprised five parallel flat-plate eye bars measuring 2.78 m [about 9 ft 1 in] between the centres of the eyes [the whole bar was about 2.9 m (9½ ft) in length], and having a cross section of 83mm [3¼ in] by 25 mm [1 in]. These were joined to the next group of eye bars by six short connecting plates, to which the hangers were attached. Single 75 mm [3 in] diameter pins [which were 406 mm (16 in) long] passed through all eleven piles[410] at each connection.'* [411]

This arrangement is illustrated in Figure 59, while Figure 60 shows the whole bridge (Conwy has been pictured because it still has its original (refurbished) wrought ironwork, which was replaced with steel at Menai[412]). Conwy has only one carriageway, whereas Menai has two, and Conwy's span is 100 m (328 ft), while that of Menai is 176m (579 ft).

Figure 59 – Conwy Bridge - showing two sets of six flat-plate eye-bars joined by six connecting plates

Figure 60 – Conwy Bridge today (the author)

[409] Paxton 1980, pp. 94,102, illustrations pp 100-101
[410] 'A set of wrought-iron bars placed together for welding ' (Chambers Dictionary)
[411] Day 2007, p.28 – items in square brackets are author's additions
[412] Maunsell 1946

Since the whole ironwork specification was changed just before Hazledine was awarded the contract, it begs the question as to how much input he had into the final specification. Day has written that

> *Telford recognised the horrendous task of completing as many as 50,000 hammer welds in the wrought-iron bars [the original specification] to achieve continuity, and erecting such intractable cables over such a great span.*[413]

In all probability his ironmaster friend would have left him in no doubt about the impracticality of the original design!

As it was, the revised specification presented Hazledine with probably his greatest challenge. For Menai alone the sixteen main chains (each 1710 ft (521 m) long) consisted of 14,960 eye-bars, around 16,000 connecting plates, and 6,000 screw-pins.[414] The chains needed a saddle at each end to allow them to pass over the masonry towers, and then had to be firmly anchored into rock. The saddles consisted of cast-iron rollers with brass bearings, designed to allow for expansion and contraction of the chains with changes in temperature. The chains were anchored by being attached to cast-iron plates, which were then screwed into the bedrock by means of wrought-iron bolts 9ft 6in (2.9 m) long (Figure 61).

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[413] Day 2007, p.28
[414] Paxton 1980

Figure 61 – main chain attachments at Menai (Provis 1828)

Work began at Upton soon after the contract was signed, but it quickly became clear that to make all the pieces to the required tolerances would require a completely novel approach. The first thing Telford did was to dispatch John Provis, the brother of resident engineer William, to Shrewsbury to supervise the testing of all the ironwork. To do this he (presumably with Hazledine) designed and built a 'proving machine', which took from January to June 1822 (Figure 62).[415] This was based at Hazledine's headquarters on Wyle Cop, to which all the ironwork was brought from Upton via the Shrewsbury Canal. After testing it was sent overland to Weston Wharf, then via the Ellesmere Canal to Chester, and finally by sea to Menai.[416] Not surprisingly, on arrival it was found that most of the anti-rust

[415] Provis 1828, p.33ff
[416] Ibid, p.35

treatment (baked linseed oil), had been knocked off by this journey. Once this machine was working, the first consignment of bars for the main chains was delivered to Menai by October 1822.[417] Floods in the winters of 1822-23 and 1823-24 also delayed the work, but another challenge that had to be overcome was the forming of the eyes in the eye-bars. Doing this under the hammer could result in irregular eyes with weaknesses where the metal had been worked, so it was decided to drill the eyes once the metal was cold using another specially designed machine.

Figure 62
Machine for proving the ironwork for Menai and Conwy Bridges (Provis 1828)

This work necessitated the installation of a new, more powerful steam engine, which, as well as punching the eyes of both main chain plates and links, was also able to turn the rollers for the saddles (they weighed 9 cwt (457 kg) each), and cut screw-pins. The introduction of these innovations took time, but the last links for

[417] Provis 1828

the two bridges finally left the forge in March 1825.[418] John Provis kept a meticulous record of all the tests he performed (Table 3). This is probably the first project for which the materials had been so extensively tested, and considering that the iron was forged using 'old' technology, the production of over 35,000 items with a rejection rate of less than 7% speaks volumes for the skill of all those involved.

Table 3 – Results of tests on ironwork for Menai and Conwy Bridges[419]

	No. tested	Rejected - visual imperfections	Cracked under test	Broke in two under test	No. sent to site	% rejected
4"x1" bars for chains in tunnels etc	5,032	60	0	0	4,972	1.2
Connectors for ditto	6,238	175	0	0	6,063	2.81
3¼"x1" main chain bars	10,476	249	100	47	10,080	3.78
Connectors for ditto	13,903	1438	225	90	12,150	12.61
Total	35,649	1922	325	137	33,265	6.69

Menai Bridge was opened on 30th January 1826. There was no official opening ceremony, just a decision that the Holyhead bound coach that night would cross the straits via the bridge rather than using the ferry. A contemporary described what happened.

[WA Provis] took charge of the mail [coach] across the bridge. It took up on its way to the bridge Mr Akers, the mail coach superintendant, Mr Hazledine, the

[418] ICE – Thomas Telford correspondence T/EG 125, 27.2.1825
[419] Provis 1828, Appendix 3, p.87

contractor for the ironwork, Mr J Provis, the superintendant for proving and examining it, Mr Rhodes, who had the charge of erecting the iron and timber work, Messrs W & J Wilson, sons of the contractor for the masonry, Mr Esplen, an overseer, and as many more as could either be crammed in, or find a place to hang by. Thus loaded, amidst the blaze of lamps, the cheers of those assembled, and the roaring of a heavy gale of wind, the gates were thrown open, and the mail passed triumphantly across![420]

As usual, William Hazledine had the happy knack of being in the right place at the right time! This contract also added considerably to his fortune, since he was paid £53,050 for Menai and £9,345 for Conwy, a total of £62,395 (over £3m in today's prices).[421]

The work for the Menai and Conwy Bridges was the largest project undertaken at Upton, but the forge remained busy up to the time of Hazledine's death in October 1840. Strangely, John Maybury, the clerk (or overseer) at Upton (and presumably William's Maybury's son), who had been *'upwards of 40 years the confidential servant of William Hazledine'*, died just a month before his master in September 1840.[422] When Hazledine himself died, Upton Forge died with him. None of his employees had the skill or breadth of knowledge to follow in his footsteps. Hazledine was a rare breed - one of the last of the ironmasters who had 'risen through the ranks', and Upton was by then probably antiquated, so the lease was surrendered, and the forge closed almost immediately after Hazledine died.

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420 Howell 1826, p.27
421 Trinder 1980, Appendix 2, pp.148-9
422 SC 2.10.1840

By the time of the 1843 field map (Figure 57) the leat and the forge pool had already been partly filled in and most of the forge buildings taken down. The Forgemaster's house became a small farm, whose employees lived in the cottages built for the forge workers. The River Tern was extensively dredged and banked up to reduce flooding in the latter years of the twentieth century, which has probably further obliterated any remains of the water supply.[423] After Upton Magna station closed it was demolished and some of the demolition rubble used to build up the land between the Forgemaster's House and the River Tern, possibly covering any forge buildings in that area.

However, a brief reconnaissance of the area identified much remaining iron-working slag (Figure 63), evidence of where the leat had been (Figure 64), and remains of other man-made watercourses (Figure 65).[424] As the site has been otherwise undisturbed since it was abandoned in 1840 it would seem to be an ideal candidate for a full archaeological assessment.

[423] Phil Roberts and Mrs L Sowerbutts (Upton Forge)

[424] I am grateful to Jeremy Milln and Tim Booth for help with this, and for helpful comments on this chapter

Figure 63
Upton Forge - ironworking slag
(the author, 2010)

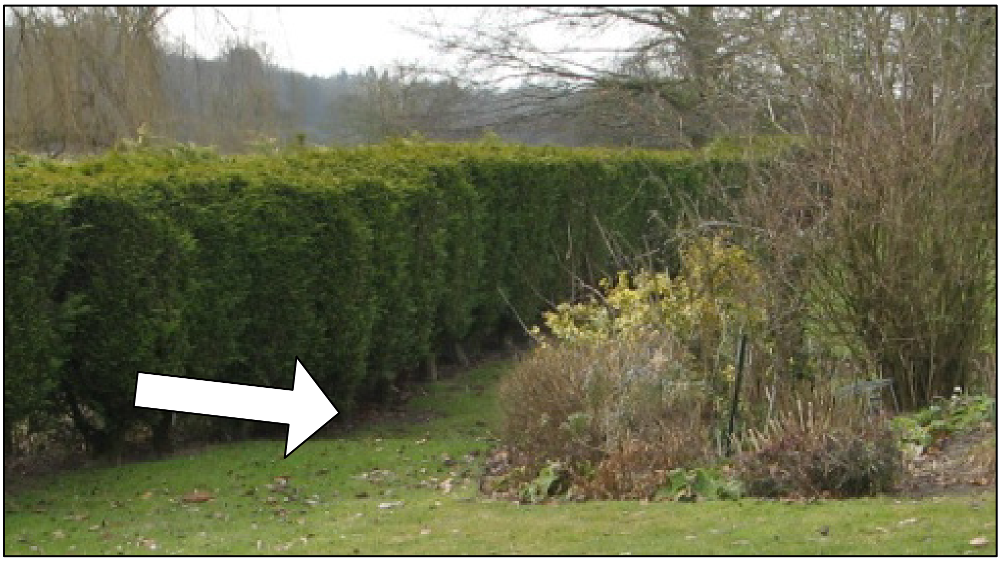

Figure 64
Upton Forge - Probable line of leat (arrowed)
(the author 2010)

Figure 65
Upton Forge - man-made watercourse (possible site of original mill pond)
(the author 2010)

9. BRIDGES

Hazledine's principal surviving legacy is the ironwork he produced for bridges and aqueducts. These were of three main types – cast-iron arch bridges and aqueducts, wrought-iron suspension bridges, and cast-iron swing bridges. In addition, he was also responsible for an unknown number of small traditional structures. Hazledine's wrought-iron suspension bridges are discussed in chapters 8 and 10, and his two major aqueducts (Chirk and Pontcysyllte) in chapter 7. This chapter deals with his other bridges. The details of all these structures are listed in Appendix 4.

Cast-iron arch bridges took a long time to become commonplace after the erection of the Iron Bridge at Coalbrookdale, which opened on January 1st 1781.[425] The reasons for this included cost, the difficulty of transporting iron components manufactured at a distance, and the well-publicised failure of bridges at Staines, Middlesex, and Yarm, Yorkshire in 1803 and 1806 respectively.[426] These failures were due to both design and construction faults. At this time there was a growing realisation that, as the strength of cast iron was established by tests such as those described in Chapter 6, bridges made of this material had to be well designed and the components made to the highest standards if they were not to fail. The combination of Thomas Telford as designer and William Hazledine as manufacturer fulfilled both these criteria.[427] The success of the Pontcysyllte Aqueduct seems to have reassured the two men that cast-iron arch bridges were safe, but it was a further six years after Pontcysyllte was opened in 1805 before they built their first

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[425] SC 20.1.1781
[426] Trinder 1979, Ruddock 1979, James 1987, Cossons and Trinder 2002
[427] James 1987, pp.179-180

iron bridge together. This was quite a modest affair at Meole Brace on the southern outskirts of Shrewsbury (SJ 491107) (Figure 66).

Figure 66
Meole Brace Bridge (Shropshire Archives)

The original documents have been lost, but it appears that Telford did the preliminary sketch, while his assistant Thomas Stanton did the detailed drawings.[428] Hazledine's estimate for the ironwork was £360, and John Simpson was employed to build the stone abutments for £1,825.[429] The ironwork consisted of four ribs, each cast in two halves, which were mirror images of each other. The ribs sprang from sloping stone abutments, and consisted of a curved lower member and a straight upper member. Between the two was another member of a lesser curvature to the lower one, pierced by holes for cross members to join the arches together. The three horizontals were joined by uprights shaped to be reminiscent of the voussoirs of a stone bridge or the sections of the Pontcysyllte Aqueduct. The

[428] Details of the Shropshire bridges mentioned are in Hill 1959, and Blackwall 1985. These are summarised and updated in Glover 2007. Unless otherwise stated, details are taken from these references.
[429] SA DP108

cast-iron roadway was bolted onto the upper members of the arches. This provided further stability for the bridge, which had a span of 55 feet (16.8m). Opened in 1811, apart from routine maintenance, Meole Brace Bridge survived till 1933, when it was demolished to make way for a modern concrete bridge.

The same team of Telford, Stanton, Hazledine and Simpson designed and built a similar bridge at Long Mill, Longdon-on-Tern (SJ 617155) in 1812. The span this time was 28 feet (8.5m), but the width was just 13ft (3.96m) because it led only to the mill (see Appendix 3). However, by 1847 this was found to be inadequate, and the bridge was widened 5ft (1.5m) on both sides, and an extra arch rib inserted. This rib was supplied by William Stuttle Junior, who had taken over the Coleham Foundry on Hazledine's death in 1840, so probably used the original pattern.[430] This bridge lasted till 1883, when it had to be replaced because the arch ribs and uprights were cracking.

Cantlop Bridge (SJ 517063) (Figure 67), which spans the Cound Brook on the road south from Shrewsbury to Pitchford, was built in 1813.[431] It was also built to Telford's design, and it is most likely that Hazledine and Simpson built it.[432] Like Meole, it has four arch ribs, but a shorter span of 31ft (9.5m), and is the only surviving bridge of this design still in its original location. As such it has its original railings, which are of a typical design that Hazledine used on many other bridges (Figure 67). Hairline cracks were noticed in Cantlop Bridge in 1974, so it is now bypassed.

[430] www.discovershropshire.org.uk – article on Long Mill bridges
[431] SA DP33
[432] Blackwall 1985, p.49; see also SJ 14.5.1812

Figure 67
Cantlop Bridge – notice the typical Hazledine handrail casting (the author)

The last of this group of Hazledine bridges was built on the main Shrewsbury to Bridgnorth road at Cound (SJ 558057) in 1818. This replaced the previous bridge at the same site built by John Dodson (see Chapter 8 and Appendix 6), which was too short to withstand flooding. William Hazledine was contracted to produce the ironwork for £494, the stonework being erected by local builder John Carline (see Appendix 6), since by this time John Simpson had died.[433] The four ribs of 55ft (16.8m) were exactly the same dimensions as Meole Brace. This bridge survived until 1967, when it was replaced by one designed to carry modern traffic. The ribs and railings, however, were preserved, and two ribs are now incorporated into a pedestrian bridge over Hall Park Way in Telford Town Centre in 1988 (Figure 68).[434]

[433] SA 227/5
[434] Dates from Blackwall 1985, p48 and plaque on footbridge. A bridge of exactly the same design was erected at Stokesay (SO 438818) in 1823, but this time the ironwork contract went to the Coalbrookdale Co (SA PH/S/30/8). When the bridge was dismantled in 1965 the intact ribs were given back to Coalbrookdale, one of which is on display at the Museum of Iron near the Darby furnace

Figure 68
Outer ribs of Cound Bridge incorporated into Hall Park Way pedestrian bridge, Telford. Notice typical Hazledine railing design (the author)

Hazledine's obituary stated that he had been responsible for *'several small iron bridges in this county, and many others all over the kingdom,'*[435] which suggests that there may be other as yet unrecognised examples of his work. One such is the Dolforgan Estate Bridge in Kerry, Powys (SO 144901), restored in 2002/3.[436] This bridge was erected by 1818, and incorporates the trademark Hazledine railings, though the four arch ribs (cast in two halves) incorporate different designs from those in Shropshire (perhaps a reflection on their small size and the lesser strength needed for an estate bridge) (Figures 69 & 70).

Figures 69 (left) and 70 (above)
Dolforgan Bridge, Kerry.
Notice typical Hazledine railing (left), and elegantly simple rib design. The shortness of the ribs (above) allows them to be only joined together at their abutment fixings (the author).

[435] SC 30.10.1840
[436] http://www.bbc.co.uk/wales/mid/sites/kerry/pages/dolforganhall_bridge.shtml

Another possible Hazledine bridge in Shropshire is Boreton (SJ 516068), near Cantlop. This bears the date 1826, and hence is contemporary with Hazledine, but the design is quite different to the other bridges detailed above, and the workmanship appears to the author to be inferior. Further afield, the Ha'penny (or Liffey) Bridge in Dublin (Figure 71) bears a striking resemblance to the Shropshire bridges already described. This pedestrian bridge was opened in May 1816. It was reportedly designed and cast by John Windsor one of the foremen of the Coalbrookdale Company.[437] On the other hand, it hard to believe that a bridge that looks almost exactly the same (even down to the handrails) as the other Telford/Hazledine ones of the same genre had no input from them.[438] One source suggests that Chepstow Bridge was cast by William Hazledine, but does not provide documentary evidence, and it is generally believed that this was erected by JU Rastrick who took over William Hazledine's brother John's foundry at Bridgnorth after the latter's death in 1810.[439]

Figure 71
Ha'penny Bridge Dublin – note the same arch rib design as Telford's Shropshire bridges, and same railing design as other Hazledine bridges
(Google Images)

[437] SJ 12.6.1816
[438] De Courcy, 1991
[439] http://www.transportheritage.com/find-heritage-locations.html?sobi2Task=sobi2Details&sobi2Id=663

At the same period as these small cast-iron Shropshire bridges Telford was also designing much more ambitious structures in the same material, beginning in Scottish locations where the nature of the terrain made stone impractical. The first of these was at Bonar Ferry (NH 609917), and spanned the Kyle of Sutherland north of Inverness.[440] This bridge has been described as '*epoch-making*'[441], and the poet Robert Southey wrote that,

> *I could see no bridge. At last I came in sight of something like a spider's web in the air. If this be it, thought I, it will never do! But, presently, I came upon it; and oh! it is the finest thing that ever was made by God or man!*[442] (Figure 72)

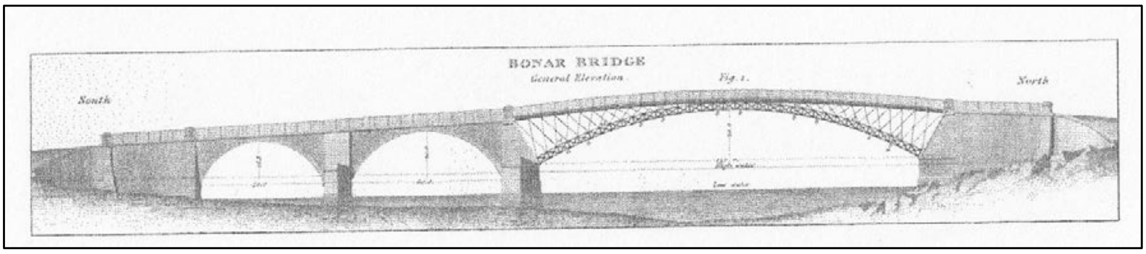

Figure 72
Bonar Bridge (Telford's Atlas)

What had struck Southey was the design of the spandrel bracings to form lozenges, which made the bridge look like a spider's web from a distance. But this was just part of Telford's revolutionary design to produce a strong lightweight arch of 150 ft (45.7m).[443] For this to succeed he needed the best contractors, so he naturally turned to his friends John Simpson, for the approach roads and abutments, and William Hazledine, for the ironwork. The two men reluctantly agreed with Telford

[440] Paxton and Shipway 2007, pp.211-13; Paxton 2007
[441] Paxton and Shipway 2007, p.212
[442] http://www.scotsites.co.uk/ebooks/lifeoftelfordchapter14.htm
[443] Paxton 2007, p.16

on a fixed price contract, of which Hazledine was to get £3,100 15s for the ironwork.[444] Telford wrote in July 1811 that Simpson and his partner John Cargill *'are miserable about undertaking Bonar Bridge at a closed sum, and to undertake to uphold [keep to] it.'* Hazledine was likewise *'miserable'* and would gladly have relinquished the project.[445] Their misgivings were understandable. In 1811 the country was exhausted after nearly 20 years of war with France, with many working men away fighting.[446] In addition, the north of Scotland was extremely remote and inaccessible, and all the bridge castings, which were to be made at the Plas Kynaston foundry, had to be sent by canal to Chester and then undertake the long and dangerous sea voyage round the north of Scotland. Finally, such a bridge had never been made before – to expect Hazledine's men to erect the first in such a difficult location must have seemed a very risky undertaking. In the end the main problem with the bridge was that Telford hadn't surveyed the foundations adequately and had to hastily redesign it with two masonry arches in addition to the iron arch (Figure 72).[447] All this extra work meant that Telford had to give way on the financial details and Hazledine was eventually paid £3947.[448]

As planned, the ironwork was cast at Plas Kynaston, until the supervision of William Stuttle. In early June the bridge was erected in front of the foundry to ensure that it all fitted into place, and there it became *'a new object of attraction and wonder'* according to the local paper, which went on to describe it as *'an*

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[444] SA D3651/D/5/562
[445] Gibb 1935, p.156
[446] For example, John Cargill's brother was held as a POW for eight years up to May 1814 (Matthew Davidson to John Davidson 24.5.1814, IGMT 1981.3588)
[447] Gibb 1935, p.156
[448] Paxton and Shipway 2007, p.212

admirable union of strength with neatness and elegance.'[449] At the end of the month it began its long journey north, followed soon after by Stuttle and two of his colleagues who were to erect the bridge. By mid-November they had finished the ironwork, in *'a masterly manner'*, according to Matthew Davidson.[450] Bonar Bridge survived until it was washed away in a flood in 1892. It became the template for others, a number of which are still standing.[451]

The first of these was Craigellachie Bridge (NJ 285452), which spans the River Spey 19km above Fochabers.[452] The arch of 150ft (45.7m) is identical in size to Bonar and of the same construction, and like Bonar it was cast at Plas Kynaston, before making the even longer voyage round the north of Scotland to Speymouth, and finished its journey by horse and cart. Again William Stuttle and assistants did the erection, which took just two months, August and September 1814. But first they had to check and repair any damaged items in a smith's shop they built nearby, which still existed in the late 1960s.[453] Among the items they put up were two plaques (Figures 73 & 74). The bridge remained in full use until 1963, when it had to be dismantled above arch level due to some of the components working loose. As much of the ironwork as possible was retained, and the rest replaced with identical parts in steel.[454] This provided an opportunity to understand the bridge's construction, the complexity of just part of which is demonstrated in Figure 75.

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[449] SC 5.6.1812
[450] Matthew Davidson to Thomas Davidson 14.11.1812, IGMT 1981.3588 – curiously Davidson calls Stuttle 'Stuteville'
[451] Paxton and Shipway 2007, p.212
[452] Paxton and Shipway 2007, pp. 130-132; Paxton 2007, pp.16-17
[453] Lowson 1967, p.25
[454] Lowson 1967a, 1967b

Figure 73
Craigellachie Bridge - Plaque on handrail stringer (Lowson 1967a)

Figure 74
Craigellachie Bridge - Plaque on castellated abutment
(Google images)

A metallurgical analysis of the castings was done, the results of which are detailed in Table 4. The table also shows average metallurgical values of the ironwork at the Ditherington Flax Mill (p.85). Even making allowances for the small number of samples and possibility of changes in analytical methods between 1963 and 2006, the results show an increase in purity, with less sulphur and phosphorus, and an increase in the beneficial manganese. In 1963 it was stated that the metal bore some of the characteristics of 'primitive steel', but it was cast iron of the highest quality.[455] In summary, Lowson, the engineer in charge of the reconstruction project, stated that, *'it did not seem possible that this* [design] *could have worked at all, but it did!'*[456]

Table 4 – Comparison of the metallurgical analysis of beams at Ditherington Flax Mill (1797) and Craigellachie Bridge (1814)[457]		
Element	Ditherington Flax Mill Beams (average) (%)	Craigellachie Bridge (%)
Total carbon	3.35	3.61
Silicon	0.91	0.98
Manganese	0.40	0.72
Sulphur	0.19	0.05
Phosphorus	1.02	0.62

[455] Lowson 1967b, p.289
[456] Lowson 1967b, p.288
[457] Alan Baxter & Associates 2006, Appendix H; Lowson 1967a, p.26

Figure 75
Detail of joints used on the Craigellachie Bridge. It is assumed that this level of design was done by William Hazledine and/or William Stuttle (RCAHMS)[458]

[458] http://canmore.rcahms.gov.uk/en/site/16336/details/craigellachie+telford+bridge/

The next bridge of this type designed by Telford and built by Hazledine is the 'Waterloo' Bridge at Bettws-y-Coed (SH799557), erected as part of the remodelling of the Holyhead Road.[459] The bridge bears the date 1815, but was not erected until late 1816.[460] Like Bonar and Craigellachie, it was cast at Plas Kynaston; it then went by canal to Chester, by sea as far up the Conwy River as possible, and finally by horse and cart. With a span of 105ft (46m), the main feature of the bridge is the magnificent castings (doubling as spandrel bracers) of the emblems of the four countries of the Union - the leek, thistle, rose and shamrock, which surmount the words, *'this arch was constructed in the same year the battle of Waterloo was fought'* (Figure 76). On the opposite side of the bridge are two plaques, one to Telford, the other to Hazledine and Stuttle (Figure 77). Hazledine was paid £2,577 (around £108,000 in today's prices) for this contract.[461]

Figure 76
Waterloo Bridge, Bettws-y-Coed – casting on downstream arch (the author)

Figure 77
Plaque on upstream handrail stringer (the author)

[459] Quatermain et al 2003, pp.79-81
[460] SJ 7.8.1816 records that the parts for the bridge were shipped the previous week
[461] Quatermain et al 2003, Appendix 2, p.148

The River Esk Bridge (locally known as the Metal Bridge) (NY 354649) is the least documented of this group. It was erected in 1820 as part of Telford's work on the Carlisle to Glasgow main road (now the M6/A74) just south of the Scottish border.[462] It had three cast-iron spans; the southernmost span measured 150ft (46m), like Bonar and Craigellachie, while the other two were 105ft (32m), like Waterloo. Evidently Telford used these dimensions as a way of saving money, knowing the patterns were already made. Once more the casting was done at Plas Kynaston. In 1911 the bridge was found to be severely corroded, and replaced with a modern ferro-concrete one. Considering that at this point the Esk is as broad as the Thames in London, and has a tidal range of over 16ft (5m) this was a considerable engineering and constructional achievement.

The next bridge of this type that the Hazledine team erected was over the River Dee on the Duke of Westminster's estate at Eaton Hall, near Chester (SJ 418601) in 1824.[463] The bridge has an arch of 150ft (46m), which is the same as Bonar and Craigellachie, and also has four ribs cast in seven sections.[464] The ironfounders were able to indulge in fancy spandrel lattice decorations (Figure 78). Unlike the other bridges of this type, there is no evidence that Thomas Telford was involved in the design. Plaques on the side of the bridge mention William Crosley (surveyor), William Stuttle (resident engineer), William Stuttle Junior (founder) and William Hazledine (contractor).[465] William Crosley was a well-respected

[462] http://www.engineering-timelines.com/scripts/engineeringItem.asp?id=883
[463] Chester and Cheshire archives, Eaton Estate Account Book, EV387, 1824
[464] http://www.engineering-timelines.com/scripts/engineeringItem.asp?id=785
[465] Laurie 1985, p128 states that it was built by John Hazledine, which is contradicted by the plaque and accounts

engineer,[466] whom Hazledine presumably used to do the survey, while he supplied the bridge 'off the shelf', as it were. It was also cast at Plas Kynaston, and then sent the short canal journey to Chester. Being an estate bridge meant that it has not had to deal with heavy traffic, and so it remains as originally built.

Figure 78
Eaton Hall Bridge – detail of decorative spandrel bracings. Notice trademark 'Hazledine' railings (the author)

The last two bridges of this type for which Hazledine did the ironwork are both over the River Severn. They are Mythe, which now carries the A438 route out of Tewkesbury, Gloucestershire (SO 889337), and Holt Fleet, which carries the A4133 road near Ombersley, Worcs (SO 824634).[467] The former was opened in 1826, the latter in 1828, and both are still in use, albeit after strengthening. It has been suggested that these bridges were cast at Coleham,[468] but since we know that

[466] http://www.engineering-timelines.com/scripts/results.asp?engineer=290
[467] Paxton 2007, p.18; Sievewright 1986, pp.136-8; Cragg 2010, p.144
[468] Cossons and Trinder 2002, p.123

Laira Bridge (see below) was cast at Calcutt's,[469] they may just as well have been cast there. Either way, transport was easy down the Severn. Holt Fleet is a standard Telford/Hazledine design and construction, with the usual 150ft (46m) arch with five ribs (Figure 79).

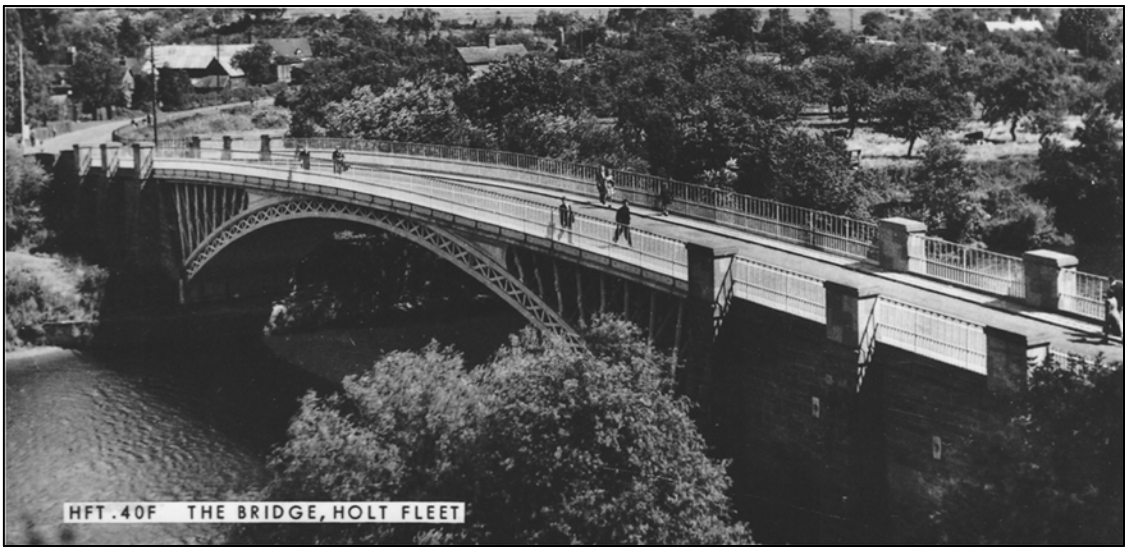


Figure 79
Holt Fleet Bridge (undated postcard).

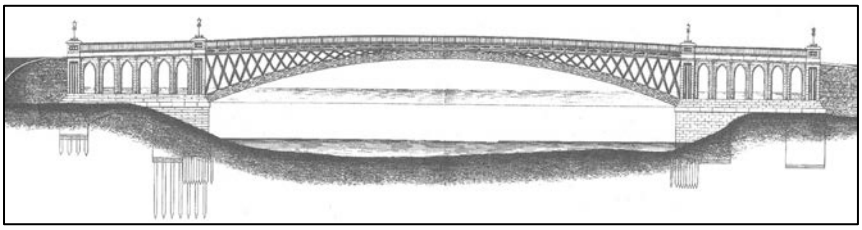
Telford reluctantly became involved at Mythe in 1824 after a disagreement between the previous architect and the Trustees.[470] Part of the 'deal' with him coming on board was that Hazledine should do the ironwork, as he wrote,

> *As Mr Hazledine has at his works some of the apparatus used in the three [he seems to have meant 'four', as he had written four earlier in the report] similar bridges he has constructed for me, and his works being adapted and his workmen accustomed to the management of all the parts, he will execute the*

[469] Perkins 1979
[470] Mackenzie 1838

proposed plan of one arch of 170ft [51.8m] span for the same sum as his former proposal contained, that is to say £4,500.[471]

In addition to being 20ft longer than the others he had designed, this bridge was also seven feet wider to allow for toll-paying pedestrians. To accommodate this, there are six arch ribs, rather than five, and to further strengthen the structure the spandrel lozenges are vertically aligned (Figure 80). Telford also took the opportunity to redesign the railings (Figure 81).



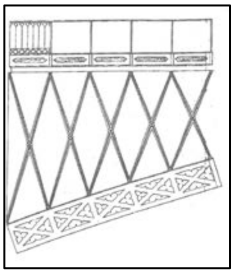


Figure 80 (above), Mythe Bridge, general view. Figure 81 (right), detail of arch rib, spandrel bracing and railings. The four columns and capitals at each end of the masonary flood arches were also of cast iron (Mackenzie 1838)

The two major cast-iron arch bridges of a different pattern for which Hazledine provided the ironwork were both opened in 1827. The first was the Laira (or Lary) Bridge (TA 044882), over the Estuary of the River Plym, near Plymouth.[472] The original plan was for a suspension bridge, for which Hazledine had obtained the ironwork contract, but that was abandoned in favour of a cast-iron bridge with five arches, each having five ribs (Figure 82). The central arch had a span of 100ft (30.5m), while that of the adjoining arches was 95ft (30m) and that of the outer two

[471] Mackenzie 1838, p.5
[472] Rendel 1836

81ft (24.7m). The bridge was designed by up and coming architect James Rendel (1799–1856), a protégé of Telford, who travelled to Shrewsbury in August 1824 to clinch the ironwork contract for the newly designed bridge.[473]

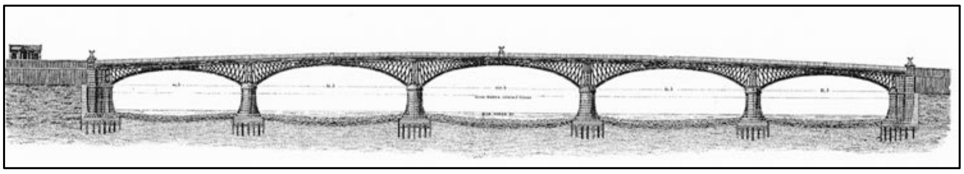


Figure 82 Laira Bridge (Rendel 1836)

In March 1825 the patterns were ready and Hazledine made the long journey to Plymouth to make final arrangements before casting began at Calcutts. The building work was subject to delay from many directions – such as antagonistic nearby landowners, a disgruntled contractor, and problems with foundations. All these delays were probably just as well, as Hazledine was struggling to provide the ironwork on time. His works were very busy with the casting the parts for both Mythe and Cleveland Bridges (see below), and over the summer of 1826 the water level in the River Severn was so low that it was impossible to ship anything. But in addition, Hazledine himself was involved in a serious accident early on Monday September 18th 1826 when a runaway cart collided with his gig on Wyle Cop, Shrewsbury.[474] Both he and his young granddaughter were thrown out of the gig. She was unharmed, but he had a compound fracture of his arm and a dislocated elbow. The dislocation had to be reduced and the arm manipulated without anaesthetic.[475] It is said that the shock of this accident precipitated the sudden

[473] Details of the building of the bridge are from Rendel 1836 and Welch 1966, supplemented by material from Perkins 1979, a copy of which is in SA C24.1 v.f.
[474] SC 18.9.1826; SC 30.10.1840 states it was the Union Coach that collided with the gig, which is incorrect
[475] SC 30.10.1840; Probably the only man brave enough to perform this manoeuvre at that time was William James Clement (1804-70), pioneering surgeon, and a radical politician, like Hazledine

death of his wife Eleanor just three weeks later, on 4th October.[476] Astonishingly, Hazledine had only about six weeks off work, and he was soon able to oversee the shipping of the ironwork down the Severn to Bristol, from whence it sailed round Land's End to Plymouth. Having more or less fulfilled the agreement that he would supply the ironwork by the end of 1826, Hazledine hoped that Lord Morley, who was financing the bridge, would allow his men to wait until the spring for the work of erection to start. Lord Morley, however, would have none of it, as he was in seriously straitened financial circumstances, so Hazledine had no option but to send William Stuttle to supervise such a foolhardy venture. Some days the wind was so strong that it was impossible for them to work, and at other times frost had the same effect. Perhaps inevitably, Stuttle, worn out by years of overwork and far from young, succumbed to pneumonia from which he didn't recover, dying on February 23rd 1827. Hazledine was devastated, but had no option but to substitute Stuttle's son, also William, for his father. Stuttle junior proved an able and energetic replacement, and the ironwork erection proceeded rapidly enough for the bridge to be officially opened on July 14th 1827. Perhaps Hazledine wondered if the £13,761 he received for the ironwork was worth it. This bridge lasted until 1962 before it was replaced – a testimony to excellent design and workmanship.

Hazledine's last major cast-iron arch bridge contract was that for the Cleveland Bridge, Bath (SO 753657), designed by architect Henry Goodridge.[477] It is built in neo-classical style with four symmetrical 'tollhouses' (only one was actually

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[476] SC 6.10.1826

[477] He did, however, supply the ironwork for the Nantwich (1828) and Stretton Aqueducts (1832) for the Birmingham and Liverpool Junction Canal (Quenby 1992, pp. 76, 82)

used for the purpose). The span is 110ft (33.9m), with seven ribs, each made from five segments, cast at Coleham.[478] At 36ft (11.1m) this is the widest Hazledine bridge (Figure 83).[479] It appears that Hazledine built the whole bridge, not just supplying the ironwork. A newspaper report recording the finding of Roman coins during the excavations for one of the abutments of the bridge states that the workmen were employed by Hazledine, and a plaque on the bridge, records Hazledine as the contractor, not just having supplied the ironwork (Figure 84).[480] The bridge was opened in October 1827,[481] and is still in daily use. Because it carries the heaviest of traffic, the bridge has had to be strengthened twice in the last 80 years. Hazledine's original ironwork has been tastefully retained, but now carries almost no weight.[482]

Figure 83
Cleveland Bridge in 1830
(FP Hay).

Figure 84
Cleveland Bridge - plaque recording
Hazledine as the contractor
(the author)

[478] SC 5.10.1827
[479] Cossons and Trinder 2002, p.86
[480] SC 4.8.1826
[481] SC 5.10.1827
[482] Dodds et al 1995

Hazledine's foundries also cast a number of swing (more correctly 'turn') bridges. These were favoured for little-used routes over relatively narrow channels, and so allowed the free passage of boats. The only example still in use is Moy Swing Bridge on the Caledonian Canal (NN 162826), which was originally one of several on the canal, all of which were cast at Plas Kynaston.[483] Moy Bridge (Figure 85) was erected in 1820, and has a span of 40ft (12.2m) and is 10ft (3.05m) wide. It has two counter-balanced arms turned by hand, which pivot on horizontal bearings. The arms meet at the middle, which means that the lock keeper has to row to the other side to close the bridge for road traffic. Hazledine also supplied swing bridges for Princes and Georges Docks in Liverpool in 1820,[484] and the Shadwell entrance of the Eastern Dock in London in 1830-31.[485] These bridges have been demolished. It is possible that a study of the records of other docks may reveal more such Hazledine bridges.

Figure 85
Moy swing (turn) bridge – open and closed for road traffic (Google Images)

[483] Paxton and Shipway 2007, p.32
[484] Taylor et al 2009 (this reference supplies useful information on the plans and fabrication of such bridges); Ritchie-Noakes 1984, p.164
[485] Skempton 1981, p.88

Figure 86
Iron bridge over River Arrow at Kington, c1970 (this is now rebuilt)
(Rattenbury and Cook, 1996, p.95)

Figure 87
Reconstruction of typical masonry bridge
(Ibid. p.88)

The final group of Hazledine bridges are small ones, either built of stone, or using simple iron girders. The best documented of these were for the Kington Tramroad.[486] This was part of a tramroad system that linked the border areas of Wales and Herefordshire to the Brecknock and Abergavenny Canal at Brecon. The contract for the 12-mile section from Burlingjobb to Kington was won by Hazledine in partnership with local surveyor Morris Sayce. Hazledine obviously provided the iron rails, and he also made some rather crude iron bridges, such as one over the River Arrow (Figure 86). There is no record of who designed the stone bridges – it may well have been Hazledine also (Figure 87).

Another project for which Hazledine was responsible was the construction of a towpath along the River Severn from Coalbrookdale to Shrewsbury. The scheme was agreed in February 1809, and the £5000 that Hazledine reckoned it would cost was raised by subscription, to which he

[486] Hadfield 1960, pp.182-3; Sinclair and Fenn 1995, pp. 116-118; Rattenbury and Cook, 1996, pp.84-95;

contributed £500.[487] Hazledine was appointed surveyor, which involved designing and building gates, bridges, culverts and a house for the collector of tolls at Underdale.[488] Among the bridges were two over the Cound and Leighton Brooks, both quite substantial rivers where they join the Severn. The towpath was opened by early December 1809,[489] a remarkable achievement considering that an Act of Parliament had to be obtained, as well as doing the construction. The path has long since fallen into disuse, but it is still clearly visible in places; the bridges no longer survive.

[487] SC 24.2.1809; SA 7112 (sundries) 17.2.1809; Trinder 2005, p.64; Hadfield 1969, p.125 (Hadfield confuses William Hazledine with his brother John from Bridgnorth)
[488] SA 7112, 4.7.1809, 25.9.1809
[489] SC 15.12.1809

10. MARLOW BRIDGE

After a working life of nearly forty years, by the 1820s William Hazledine was more than just a supplier of ironwork for others. Though not an engineer himself, his vast practical experience, allied with his no-nonsense personality, had the potential to bring him into conflict with members of the newly-emerging profession of civil engineering. The building of Marlow Bridge (SU 851860) is a good example of that.

In 1825 the old timber bridge that united Marlow in Buckinghamshire on the north bank of the River Thames with Berkshire on the south side, was close to collapse. In response to this, the magistrates of the two counties set up a joint committee to take responsibility for rebuilding the bridge (Figure 88).[490] After much discussion, in 1828 the committee decided to opt for an iron bridge, rather than using the traditional materials of wood or stone.

Figure 88 - Plan for the new Marlow Bridge,
(Centre for Buckinghamshire Studies, Q/AB/43/758)

[490] http://www.marlowtown.co.uk/bridge.html

The chosen designer and engineer of the bridge was John Millington (1779-1868).[491] Millington, who owned a foundry in Hammersmith, was perhaps a surprising choice, since he had been dismissed as engineer for the West Middlesex Waterworks in 1810 for incompetence.[492] It appears that Millington produced designs for both a suspension bridge and an iron arch, though the original drawings have not survived. The suspension bridge design was like Telford's design at Menai and Conwy, with chains formed from links of wrought iron bolted together and slung over cast-iron towers erected on either shore of the river, with the ends of the chains fixed securely deep into the banks. Eventually in the spring of 1829 the committee decided to opt for the suspension bridge, though not before tenders had been invited for both the suspension and iron arch designs. Amongst the tenders received for the ironwork was one from William Hazledine, who for the suspension bridge offered to supply the cast iron at £11 a ton and the wrought iron for £21 a ton, with erection costing £450. Alternatively, he would supply a cast-iron arch of 200 foot span and 20 feet width for a total of £6,500.[493] After some negotiation, the committee agreed on 24th April 1829 that Hazledine would supply all the ironwork for the suspension bridge for £3650.[494]

Contracts were signed, and after receiving the detailed plans, Hazledine's firm started work in September 1829. The wrought iron was produced at Upton

[491] Brown and Hunt 1994
[492] Smith D 1991, p.182
[493] Centre for Buckinghamshire Studies Q/AB/43/772a – 20.4.1828; all further quotations from the same collection are abbreviated CBS/last figure - date
[494] CBS /778 (no date)

Forge, and the cast iron was made at Coleham (Figure 89).[495] Then in October Millington suddenly resigned to take up a post in Mexico, though whether he 'jumped' before he was 'pushed' is hard to gauge, since it appears that the committee were beginning to doubt his competence. William Tierney Clark (1783-1852) was appointed in his place, though the committee was unhappy that he would not be resident to supervise the work.[496] Clark (Figure 90), though 20 years younger than Hazledine, had a similar background.[497] After training as a millwright in the Bristol area, he moved to Coalbrookdale, where he had a thorough grounding in the practicalities of the iron trade. No doubt he was aware of William Hazledine from his time there, though it is not known if they were personally acquainted. The great engineer John Rennie offered the young man a situation at his ironworks in London and during the next few years the two men became close. In 1811 Rennie recommended his protégé for the post of engineer at the West Middlesex Waterworks, which he joined after the sacking of John Millington. Under his supervision the works were transformed into one of the most important in London, and such was the esteem in which he was held, that his employers allowed him to take on consulting work as well.

[495] CBS /141 – 8.9.1829
[496] CBS /162, 168, 181 – 14.10.1829, 26.10.1829, 9.11.1829
[497] Anon 1853

Figure 89
Coleham Foundry 1891 drawn from upstream.
Greyfriars Bridge, opened in 1881, was not there in Hazledine's day
(Shrewsbury Museums Service)

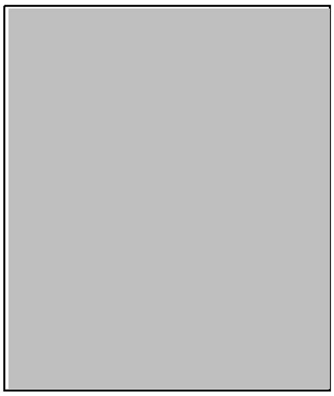

Figure 90
William Tierney Clark
(Google Images)

Clark's first excursion into suspension bridge design and execution was the bridge over the Thames at Hammersmith, which was built between 1824 and 1827. The ironwork for this bridge was supplied by the foundry of Captain Samuel Brown,[498] and it was presumably as a result of the success of this venture that Clark was employed at Marlow. Immediately after he was appointed in November 1829 he made modifications to the design of the bridge, though as the original plans have not survived it is difficult to know how extensive these alterations were. One thing he certainly did was to replace the cast-iron towers with masonry ones.[499] These alterations were agreed by the committee later in November, and the following month Hazledine travelled to Hammersmith to see Clark, and the two men agreed on the necessary alterations to the ironwork.[500] The final design for the suspension system

[498] Hailstone 1987, pp.20-21, Appendix 5
[499] Anonymous Dissertation on Marlow Bridge, p.57, undated, CBS L486:62. This document is not very reliable, but appears accurate on this point.
[500] CBS /795 – 9.10.1830

...comprised four wrought-iron eye-bar chains arranged in vertical pairs on either side of the carriageway, each chain consisting of four eye-bar links...arranged horizontally and joined by sets of five connector plates and wrought-iron pins. Wrought-iron suspender rods attached alternately to the upper and lower chains carried the deck bearers...[501]

The specification detailed 3526 separate pieces of wrought iron of 12 types, and 452 pieces of cast iron of seven types.[502] Presumably boring machines designed for the Menai and Conwy Bridges (Figure 62) could be reused to drill the holes for the connecting links.

Detailed drawings took a while to produce, but by March 1830 Clark was able to report to the committee that he expected to meet Hazledine in Hammersmith that week for the ironfounder to look over the plans and inspect the proof patterns.[503] No record of this meeting survives, but it appears that the two men disagreed strongly about the plans. As a result Hazledine refused to sign the amended agreement necessitated by the changes in the design, for Clark's next letter to the committee secretary on 8th April asked, *'Have you received Mr Hazledine's agreement, and is it signed? If not, it should be, for I think he would have no objection to give us some trouble.'*[504] So what was the problem? Hazledine's objection to the design was related to the links of the main chains. His problems were twofold. First the bars were supposed to be of circular cross section, a design which had already been rejected at Menai as almost impossible to

[501] Wadsworth and Waterhouse 1967, pp.297-8
[502] CBS /798 – 13.4.1831
[503] CBS /203 – 9.3.1830
[504] CBS /206 – 8.4.1830

forge. The second problem was that Hazledine felt that the eye bars would be too thin to support the structure. Hazledine's objections were well-founded, since a disaster that occurred to a new suspension bridge at Montrose in Scotland the previous year was fresh in the memory of bridge engineers and contractors. This bridge, engineered by Captain Brown, was of similar design to Marlow, with chains consisting of just four sets of iron bars (Menai Bridge had five bars in a set). Soon after Montrose Bridge was opened, a large crowd gathered upon it to watch a boat race. As the boats went under the bridge, the crowd surged to the other side to follow them, and the oscillations so produced caused one of the upper chains to break, whereupon the bridge partly collapsed and a number of spectators were killed.[505]

Clark, though, was unmoved by Hazledine's arguments – presumably he felt that his position as engineer and his experience at Hammersmith gave him the last word. Hazledine, though, was a stubborn man. He could point to his experience in producing the ironwork for the Conway and Menai suspension bridges. Above all, he was concerned for the safety of those who would use the bridge. So a stalemate ensued. Initially Hazledine played for time, asking for more detailed plans, which were duly delivered in July 1830.[506] The following month the masons had finished work on the towers, and so the ironwork was urgently needed.[507] By September Hazledine reported that all the ironwork was ready, but Clark was unwilling to

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[505] Pasley 1840; Rendel 1841; Seaward, Rendel et al. 1841; Mawson 2009; with hindsight, engineers realised that the main problem was that the decking was not stiff or heavy enough to withstand oscillations such as those produced by strong winds. Clark had made Hammersmith Bridge stronger in this way, but it is not clear if this was accident or design.
[506] CBS /232 – 26.7.1830
[507] CBS /240 – 29.8.1830

accept it until Hazledine signed the contract. Hazledine wrote via his solicitors that *'of course he was desirous of finishing the bridge, and that if Mr Clark will send a person to inspect* [the ironwork that] *is now here...* [he would] *agree upon the contract.'*[508] In other words, Hazledine was saying to Clark, "if this bridge fails, the fault is yours, not mine." Clark was incensed, writing to the committee that

> *...you will not sanction any further alteration in the agreement with Hazledine... He has treated us very unhandsome in every stage of this business as such to deserve the least favour whatsoever...*[509]

At the same time Clark was making tentative enquiries about an alternative supplier for the ironwork.

Hazledine could see that his only chance of getting his way was to discuss the matter directly with the committee, so he and his solicitor travelled to Buckinghamshire on October 6th 1830 for a face to face meeting. Clark had hoped to be there, but was delayed at one of his other projects, but it appears that the meeting between the committee and the Shrewsbury men went well. No doubt Hazledine used his considerable experience and persuasive powers to bring the magistrates round to his view.[510] Though unwilling to go against Clark's wishes and change the contract, the committee persuaded Clark to send his assistant Thomas Young to test the ironwork in Shrewsbury. Young began his work in late November. Initially his reports were encouraging, but early in the New Year he was unhappy

[508] CBS /247 – 17.9.1830
[509] CBS /250 – 22.9.1830
[510] CBS /255,279 – 9.10.1830, 8.4.1831

with progress and asked Clark to come to Shrewsbury to check things for himself.[511] Clark was so busy with other things that it took him till late March to make the trip, and receive Young's report. The gist of the matter was that, whereas virtually all the cast-iron parts were ready, Hazledine had obviously instructed his workmen not to produce any links or connecting pins for the main chains of the size that Clark wanted. Not surprisingly, Clark's report to the committee was very negative, and it wasn't long before Hazledine received a letter threatening legal action.[512]

Hazledine's reply contradicted Clark's report in many respects. Clark said he spent three days in Shrewsbury, Hazledine replied that Clark was in the town for just an afternoon. Clark said that a bar he tested failed, whereas Hazledine replied that it more than passed the test. Hazledine maintained that the ironwork was much further on than Clark's report suggested. Hazledine also accused Clark of making *'ridiculous demands'*, of delay in sending Young, and also of being unable to make up his mind what he wanted. Evidently, since Hazledine's meeting with the committee, he and Clark had had a correspondence about the strength of the bridge. Hazledine had been so concerned that he had arranged to meet Clark at the latter's home in Hammersmith in February, but had waited two days and Clark had failed to show up. The nub of Hazledine's argument was that ironwork for the current design was dangerously inadequate. As evidence for this he listed not only the Montrose Bridge, but also bridges at Morpeth, Middleham (Yorkshire), Cambridge and Manchester that had *'all fallen down within about 8 months'*.[513]

[511] CBS /264,265,266 – 23.11.1830, 9.12.1830, 1.1.1831
[512] CBS /798 – 13.4.1831
[513] CBS /283 – 23.4.1831

In response to this criticism Clark dithered and continued to lay the blame on Hazledine.[514] Hazledine wanted an assurance than in the event of disaster it would be Clark, not himself, who would be held responsible.[515] As the stalemate dragged on over the summer the committee became increasingly irritated. One member, Sir George Nugent, even threatened to resign, writing that,

> *I more than suspect that our architect has so many irons in the fire of greater advantage to him than our bridge, he will not be made to attend to our concern without a most serious remonstrance from the committee.*[516]

Perhaps as a result, Clark began to give way, first allowing the bars of circular cross section to be replaced with rectangular ones. Even in this letter he criticises Hazledine, who, he says, *'very ingeniously wishes to transfer his own want of attention to the want of strength in the original dimensions.'*[517]

Young was again despatched to Shrewsbury to check on progress. In the end Hazledine took matters in his own hands, deciding by the end of July to make the bars to his own measurements.[518] Clark's reply was, in effect, "if you insist on doing that, you must sign a new contract which expressly states that you now carry the legal responsibility." Hazledine, via his solicitors, refused.[519] Clark was furious, writing to the committee,

[514] CBS /286, 287, 289-291, 294, 296-297 – 3.5.1831, 4.5.1831, 6.6.1831, 8.6.1831, 10.6.1831, 22.6.1831, 27.6.1831
[515] CBS /287 – 4.5.1831
[516] CBS /295 – 24.6.1831
[517] CBS /296 – 27.6.1831
[518] CBS /297b, 308b, 301, 304 – 22.6.1831, 30.7.1831, 26.7.1831, 11.8.1831
[519] CBS /306, 307, 308a – 23.8.1831, 26.8.1831, 30.8.1831

the sooner the contract [with Hazledine] is put an end to the better... Any further correspondence with Hazledine will be as bad as a chancery suit.[520]

True to his word, Clark travelled to Staffordshire in early October 1831 and made a provisional agreement with the Gospel Oak Ironworks in Brierley Hill to complete the ironwork in the event of Hazledine failing to do so. Perhaps he hoped that this would put pressure of Hazledine, though he recognised that the logistics of two different suppliers working on the same job were probably insurmountable. Clark then travelled on to Shrewsbury for what the two men probably expected to be a very frosty meeting. In the event it appears that both sides were willing to accept a compromise. Clark was pleasantly surprised to see how far advanced the production of the ironwork was, much of which was ready to be loaded on barges for delivery. Hazledine also promised that machinery to erect the work would go with it, followed soon after by his foreman (probably William Stuttle Junior). For his part, Clark was willing to strike a pen through the clause in the new contract that made Hazledine responsible for any failure in the ironwork due to the alterations he had made.[521]

From this point things moved quickly. Clark's hope that the ironwork would be finished and delivered by January 1st 1832 was always going to be unrealistic, but both Young, who had remained in Shrewsbury, and Hazledine were able to report that much of the iron had already been shipped by the end of 1831.[522] It went initially to Gloucester on the River Severn; from there it was probably sent via the

[520] CBS /308a, 309 – 30.8.1831, 8.9.1831
[521] CBS /801 – 17.10.1831
[522] CBS /327, 329 – 28.12.1831, 14&2.1.1832

Kennet and Avon Canal to the Thames. Young left Shrewsbury late in January, reporting that the last load of iron had been sent off, accompanied by a man who would ensure that there was no delay during the shipping. At the same time, Hazledine's men left Shrewsbury for Marlow to begin the erection of the ironwork on the last Monday in January.[523] The fabrication and erection of the bridge seems to have proceeded smoothly over the following months, and by May 1832 the bridge was nearly finished. A nearby resident wrote,

> *Our new bridge is now nearly completed, and a very pretty thing it is. It is very ingeniously and carefully constructed, and will be a great ornament to the neighbourhood.*[524]

The bridge was finally opened on 23rd September 1832, without any ceremony, perhaps a reflection of the discord and delay that had dogged the project. The local newspaper, however, was delighted, reporting that,

> *This beautiful and convenient bridge is at length completed and opened to the public. Its execution is of the best kind and reflects the highest credit on the architect* (Figure 91).[525]

The public were happy, but it seems that both the architect and the contractors were less so, as the magistrates of the two counties weren't keen to part with their money. Hazledine sent his first account at the end of January 1832, his bill for £3,200 14s 1½d being exactly the contract price.[526] Despite being immediately approved by Clark, no payment was made. Hazledine wasn't coy about

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[523] CBS /331 – 27.1.1832
[524] CBS /345 – 10.7.1832
[525] Bucks Herald, 22.9.1832, p.3
[526] CBS /892a - undated

requesting what he was due, as he regularly reminded the magistrates![527] Eventually he received £1000 on 18.10.1832, but by then his final payment of £1277 was also due. Over the ensuing months he exerted all the pressure he could to get them to pay. He wrote on 15th November 1832,

Figure 91
Marlow Bridge today (the author)

> *I am much in want of the money...having made engagements in the full expectation of receiving it.*[528]

He complained on 8th February 1833,

> *Most assuredly I am not well used by delaying the payments, particularly considering the trouble and expense I was put to in doing a deal of the work twice over.*[529]

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[527] CBS /332, 339, 344, 346, 347, 351, 362 – 30.1.1832, 4.4.1832, 9.7.1832, 30.7.1832,6.8.1832, 22.9.1832, 16.10.1832
[528] CBS /369 – 15.11.1832
[529] CBS /385 – 8.2.1833

By July he started to add interest to the bill, and in September he threatened to come in person to collect it, but in the end it was settled on October 31st, but without the interest![530] The problem of late payment seems to have been partly due to the County having problems with their treasurer, whom they had had to sue, an action that cost them thousands of pounds.[531] Hazledine's case was not exceptional, as all the contractors complained bitterly about the slowness in being paid. Their problems were nothing, however, compared to Clark's. Though not as persistent as Hazledine, he was not slow to demand his money. The County wrote him a cheque in June 1835 for the balance of his account, but unfortunately it bounced, as the bank had gone bust in the meantime! As he had still not received his full payment by the following year he sued the County, and his bill was not finally paid until April 1838![532]

The modern plaque on the bridge (Figure 92) gives Clark all the credit for the design and erection of the bridge. But from what the archives tell us, perhaps the plaque should read, 'Original design by John Millington, alterations by William Tierney Clark, made safe by William Hazledine, and erected by Thomas Young and William Stuttle Junior'. All but Clark, though, have been written out of the official story, though it appears that Hazledine's role became a legend within the trade.

[530] CBS /412, 419, 424, 426 – 24.7.1833, 24.8.1833, 20.9.1833, 31.10.1833
[531] CBS /386 – 11.2.1833
[532] CBS /438, 439b, 457, 463 – 12.6.1835, 10.6.1835, 23.8.1836, 16.4.1838

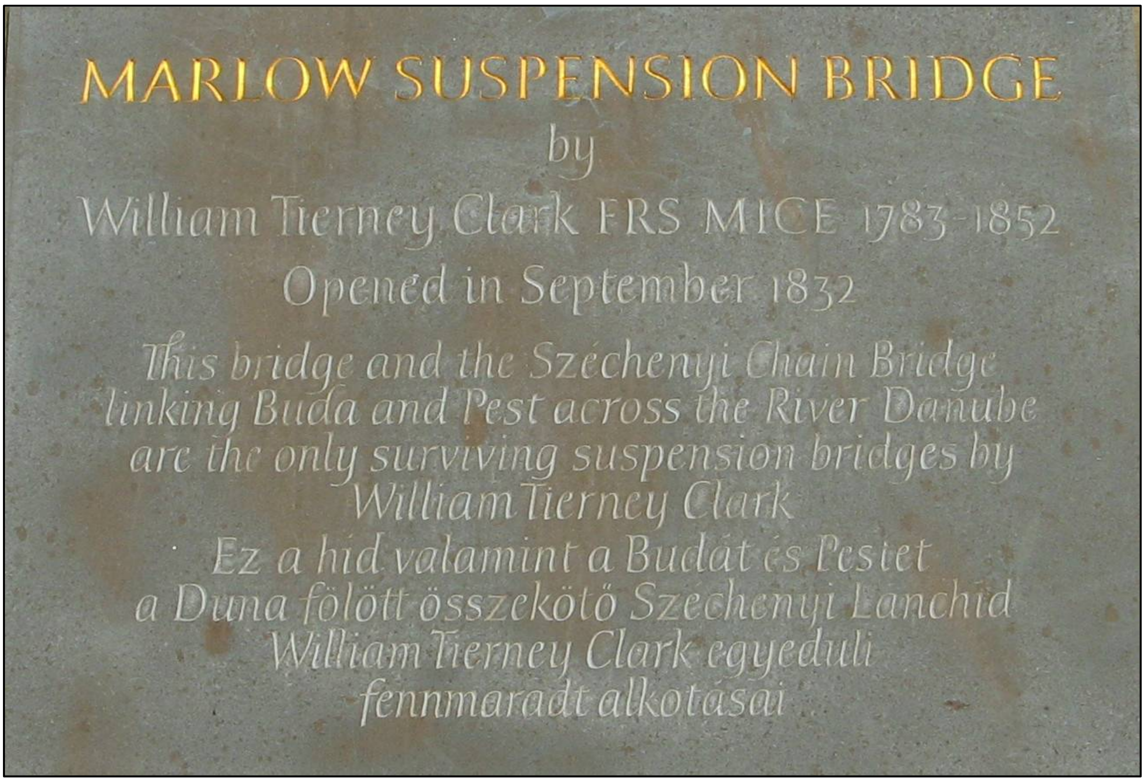

Figure 92
Marlow Bridge Plaque (the author)

In 1884 Clark's Hammersmith Bridge was replaced. At that time, the *Builders' Weekly Reporter* carried an article that has confused later historians.[533] The reporter wrote that Clark and Hazledine had had an argument over the ironwork for the Hammersmith Bridge, but since there is no evidence Hazledine was ever involved with Hammersmith,[534] this must refer to the building of Marlow Bridge. The reporter wrote,

> *The contract for its erection was undertaken by the late Mr William Hazledine of Shrewsbury, the builder of other suspension bridges... After he signed the contract, Mr Hazledine did not at once proceed with his work, and legal proceedings were threatened. But that gentleman, having carefully perused the*

[533] A copy of the article is in SA 901/1; it is undated
[534] Anne Wheeldon, Hammersmith and Fulham Archives, via email 5.2.2010

specification, found that the enormous weight of iron specified for in some parts of the structure would prove its own destruction, and declared that if the bridge were built according to the engineer's design it would fall as soon as completed. This proved a serious stumbling-block, but Mr Hazledine - who was a thoroughly practical man, though not an engineer in the ordinary sense of the word – stipulated he would build a bridge according to the engineer's plan, but not in accordance with the specification, which he would guarantee to stand for more than 20 years.

In the event, the original Marlow Bridge lasted not just 20 but nearly 130 years without major maintenance. By the 1960s, however, the anchorages were giving serious cause for concern, and it was felt the bridge needed replacement. An initial plan to demolish it and build a modern replacement produced a storm of protest in the town, and it was decided to dismantle the bridge and rebuild it to exactly the same design, but using steel instead of wrought iron. When the wrought iron came to be dismantled, much of it was still safe and serviceable, a tribute to the original workmanship. When the chains came to be replaced,

...it was found advantageous to write a program for processing on an electronic computer [a novelty in 1966!] *the calculation of the lengths of the eye-bar chain links, the geometry of the connector plates carrying the suspenders being somewhat complex.*[535]

Hazledine didn't have such luxuries as computers in the 1820s – just experience and practical knowhow!

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[535] Wadsworth and Waterhouse 1967, p.301

There is one more footnote to this story. The occasion when Hazledine visited Clark at Hammersmith and failed to find him in, was probably when he sat for the famous sculptor Sir Francis Chantrey at Twickenham.[536] There he had his portrait drawn, both from the front and in profile, and it was from these pictures that Chantrey sculpted the bust that is now in St Chad's Church, Shrewsbury (Figures 93 and 94). One might well wonder how a rural ironmaster like Hazledine came to be sculpted by the foremost sculptor of his generation, who was a favourite of the royal family. It appears that it was through Lord Liverpool of Pitchford Hall that Chantrey met Hazledine. Quite why Hazledine commissioned the statue of himself at that time in his life is impossible to say, but Chantrey was evidently pleased with the result, though not with the dark corner of the Church where it sits.[537] When he visited Shrewsbury after Hazledine's death he remarked that, *'in his studio the bust of Mr Hazledine was used to be looked upon by him with pleasure, as the best effort of his chisel.'*[538]

[536] CBS /283 – 23.4.1831; Chantrey dated the portrait '28th to 31st Feb 1831' – presumably he meant January!
[537] SC 15.1.1841
[538] Pidgeon 1851, p.60

Figure 93
Pencil drawings of William Hazledine by Sir Francis Chantrey, 1831
(National Portrait Gallery)

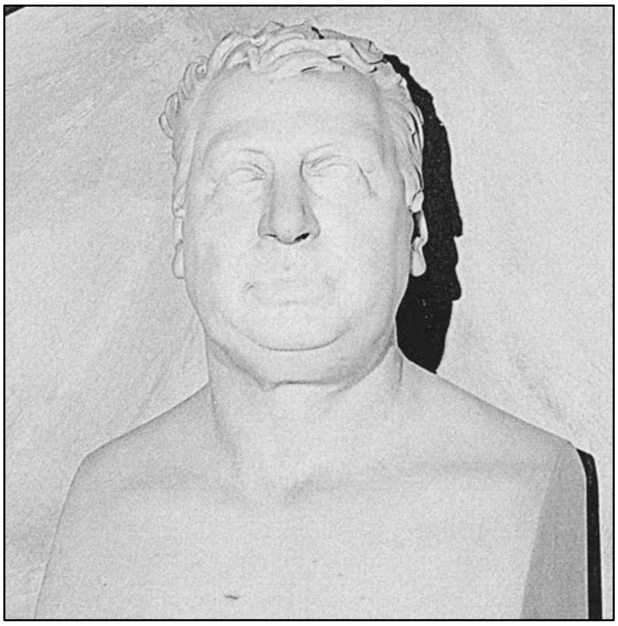

Figure 94
Bust of William Hazledine by Sir Francis Chantrey in
St Chad's Church, Shrewsbury
(John Swannick)

11. IN CONCLUSION

Marlow was Hazledine's last major bridge contract, but he remained as energetic as ever right up to his death on Sunday October 25th 1840.[539] One of his major concerns during his last years was the Birmingham and Liverpool Junction Canal, Telford's last canal work, in which Hazledine was a major shareholder and also a member of both the management committee and sub-committees.[540] A number of these meetings in early 1833 took place in Telford's house in London, since he was too ill to travel, and his death in September 1834 preceded the much-delayed opening of the canal. As well as being on the committee, Hazledine was also the contractor for a number of works associated with the canal, such as the Nantwich (SJ 641526) and Stretton (SJ 871107) aqueducts (Figure 95), the wharf at Market Drayton, and the provision of cranes and warehouses.[541]

Figure 95
Stretton Aqueduct – plaque to Thomas Telford (the author)[542]

[539] The obituary in SC 30.10.1840 gives the date of death as Sunday 26th, but this must be a mistake as Sunday was the 25th. The inscription beneath his bust in St Chad's Church gives his date of death as 25th October.
[540] TNA, RAIL 808/1
[541] Quenby 1992, pp.76-83; SA 327/2/4/2/78; SA 901/1; RAIL 808/4, 2nd October 1839
[542] The aqueduct is credited to 'Thomas Telford FRSL&E Engineer 1832', but careful examination reveals that under Telford's name is the inscription 'William Hazledine, contractor', which has been partly obliterated and painted over. There was evidently animosity between Hazledine and Telford's assistants (Pattison 2009).

During the 1830s Hazledine was making good profits, much of which he invested in property. Some of this property he bought (such as Swan Hill House), and some he built himself (such as Old Mount Pleasant).[543] He specialised in buying anything at a knockdown price that looked a good investment, such as Coleham Brewery, sold in 1830 to Hazledine for *'a mere bagatelle'*, according to Charles Hulbert.[544]

The 1830s were also a period when Hazledine spent much time on political activities. This was a period of great agitation for both parliamentary and local government reform, and Hazledine was one of the leaders of this movement in Shrewsbury. It appears that he had supported reform since the time of William Pitt, when the reform process had been abruptly terminated in 1793 by the fear of revolution.[545] By 1814 Hazledine was chairing a public meeting to support the adoption of Benjamin Benyon as the Whig candidate. This meeting passed a resolution *'that the freedom of election is a right, the inviolable exercise of which is guaranteed in the Great Charters of English Liberty.'*[546] So it was natural that Hazledine should be one of the most vociferous of the local supporters of the Reform Society.[547] And he was also prominent amongst those who celebrated the passing of the 'Great' Reform Bill in June 1832. At the Shrewsbury Reform Festival of that year it is recorded that

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[543] SA 4457/9; Sale catalogue October 29th 1841 - SA 901/1

[544] SA 4762/3/6-7; Hulbert 1837, p.308, footnote; Hulbert went on, 'Mr Hazledine is also proprietor of a great portion of Coleham; many houses of consequence, and other premises in this town; his property in various parts of the county, and out of it, is beyond my description; and shares in public companies, etc almost immense'

[545] Speaking at a meeting in 1831 (SJ 23.3.1831), Hazledine commented that in regard to 'the means brought forward 38 years ago [i.e. 1793] ...in those days people were afraid of opening their mouths lest some of the great men of the land should jump down their throats'

[546] SC 6.5.1814; Benyon was not elected, but later went on to represent Stafford from 1818-26

[547] SJ 23.3.1831

...after parading the streets and suburbs, the procession halted in front of the Town Hall, where Mr Hazledine addressed a few words from his carriage to the immense crowd around him...[548]

Once parliamentary reform had been obtained, the reformers turned their attention to local government, calling for *'a speedy reform to all rotten corporations'.*[549] Such language reflected a poem written 50 years before by William Cowper,

Hence chartered boroughs are such public plagues;
And burghers, men immaculate perhaps
In all their private functions, once combin'd,
Become a loathsome body, only fit
For dissolution – hurtful to the main.[550]

Needless to say, the Municipal Corporations Act, which would sweep away the old Corporations and replace them with councils elected on a wider franchise, was bitterly opposed by the Tory majority.[551] On the other hand, when the Act was struggling to get through the House of Lords, over 500 Freemen and other inhabitants of the town earnestly petitioned Parliament to pass the measure.[552] The Act received the royal assent in September 1835, and the urgent process of registering all those entitled to vote was started. The first election of town councillors was fixed for Boxing Day 1835, so that the new Council would be able to start on January 1st 1836. William Hazledine stood as a Liberal candidate for Castle

[548] SC 26.10.1832
[549] William James Clement, SC 6.2.1835
[550] *The Task,* Book 4
[551] SC 25.6.1835
[552] SC 6.9.1835

Ward (Within), but failed by four votes to be elected, although overall the Liberals triumphed by a majority of four.[553] The *Shrewsbury Chronicle* reported that,

> *The Liberals were triumphant wherever there was a numerous constituency and the Tories only where a contracted number gave them ready means of intimidation. The Liberals have chiefly very large majorities; the Tories crept in, in three cases, by one vote.*

In this sort of poisonous atmosphere, the Liberals were in no mood for compromise with regard to the position of mayor. Robert Burton of Longner Hall (Figure 96), the Tory incumbent, who was only part way through his period of office, was ousted.[554] The Liberals appointed all ten aldermen from among their ranks, among which was William Hazledine, who was invited to become Mayor after the elder William Clement had declined. Despite these inauspicious beginnings, it is recorded that Hazledine *'passed through his mayoral year with marked honour'*.[555] He presented a red mayoral robe trimmed with ermine to the new council, which he first used himself (Figure 97).

[553] SC 1.1.1836 – further details from this source
[554] Robert Burton was later elected as Mayor in 1843 for a full term
[555] *Byegones,* Jan 6th 1875, p.173, SA C05

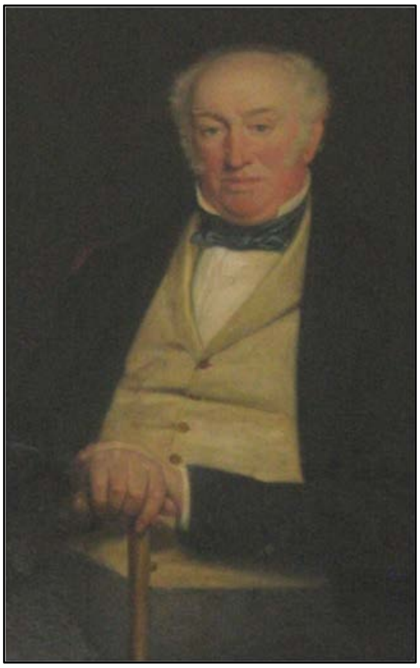

Figure 96
Robert Burton (1796-1860)
(the author, courtesy of the Burton family of Longner Hall)

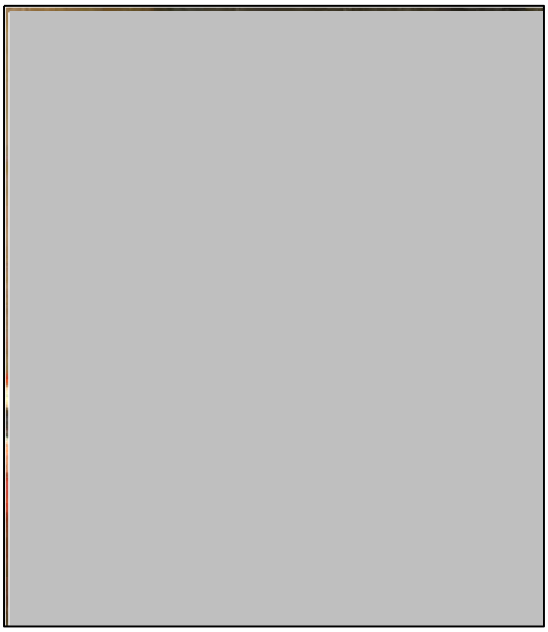

Figure 97
William Hazledine as Mayor of Shrewsbury, 1836,
By Thomas Weaver
(Shrewsbury Museums Service)

Such activities did not keep Hazledine from his work for long, or from looking forward. One of his last public appearances a short while before his death was at the committee of the Shrewsbury Railway Company, *'where he expressed a hearty wish that his life might be spared to see this great project carried into execution.'*[556] Perhaps his best epitaph is the following.

> *A very short time before he was confined to bed by his last illness, a nobleman, equally distinguished by his literary and legal talents...arrived in the town at a little before seven in the morning, and inquired at the Lion [Hotel] if Mr Hazledine was likely to be up? "Oh, yes," was the reply. "He passed here an*

[556] SC 6.11.1840

hour and a half ago, on his way to the foundry." "I regret that," said his lordship, "for I wanted a few minutes' conversation with him, which I cannot now have. But tell him from me, that Lord ----- [the newspaper did not divulge his name] *inquired after him. My belief is," added his lordship, "that William Hazledine is the first [foremost] practical man in Europe."*[557]

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The possibilities of further work arising from this thesis are many. The first is that, although much information on the life and work of William Hazledine has been uncovered, there is almost certainly more scattered in various archives that may significantly add to the story, both of his life and the technology of the period in which he lived.[558] As well as archival material, there are probably also structures such as mills and minor bridges that can be linked with Hazledine.

The discovery of the notebooks belonging to William Hazledine's father offers scope for further research. These provide details of his money lending activities and shop accounts, as well as family information and some of the details of his millwrighting work. In general, the records for the village and area of Shawbury are exceptionally well preserved, which would allow such a study to be contextualised. These records comprise parish registers (where a succession of incumbents recorded far more detail than is usual), poor law assessments and disbursements, and estate records for both the Sundorne estate and the Charlton Estate at Apley Castle. Many of the individuals recorded appear in different

[557] SC 30.10.1840

[558] Perhaps the first step would be to correct some of the material that is in the public domain, for example the article in the *Dictionary of National Biography,* misspells his name, has a wrong birthplace, and wrong date of death

sources, including the Hazledine notebooks, so could be followed in the context of the wider economy and social changes.

The history of mills in general, and millwrighting in particular, is rather sparse, a situation which applies also in Shropshire, especially to the north and west of the county, where Hazledine did much of his work.[559] Trinder[560] provides the most comprehensive list of mill sites in the county, but this is incomplete, and contains little information on the history, and none on the construction, of the mills. Shropshire windmills are detailed in both a booklet and on the web, but these lists are incomplete and contain no information on their construction.[561] Some of the watermills in the south of the county have been described, as have some on the Rivers Worfe and Meese in the east of the county.[562] There are also some handwritten notes in the Archives,[563] and a number of articles or technical reports on individual mills, often not in the public domain.[564] The field is thus wide open for further historical study and analysis of surviving structures. The difficulties involved in trying to reconstruct a history of millwrighting in the county are formidable, however. Millwrights in the past were practical men, most of whom wrote little down, their expertise being passed on by apprenticeship. Archaeological and

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559 'There is as yet no book on the history millwrighting in England; a great deal has been published on windmills, and, to a lesser extent, watermills, although the best studies are rather general...or specific to certain counties or regions' (Martin Watts, personal communication, 4.2.2007). The best available general histories are by Watts (Watts 2000, 2002, 2008)

560 Trinder 1996, p.9ff and p.229ff

561 Seaby and Smith 1984; http://www.windmillworld.com/uk/shropshire.htm - lists surviving mills; http://en.wikipedia.org/wiki/List_of_windmills_in_Shropshire - details both surviving and demolished mills, though is incomplete (for example Uffington and Sheinwood are not mentioned)

562 Tucker 1991, Booth, 2011, Robinson 1980, Robinson 1988

563 Judd 1953

564 See, for example, Andreae 1990; Boucher 1963; Frost 2003; Wharton 1976a-d; there is also information in the HER collection

structural assessment of the mills that remain is complicated by the fact that many have been converted to domestic use; if machinery remains it may be 'sanitised' or out of its original context. Since mills were dynamic structures, much of the machinery will have been replaced as it wore out, so reconstructing how it may have looked and worked at a given period in the past is almost impossible. The best assessment will be done by those who have a practical understanding of a subject which is bewildering to the non-specialist, but up to now most of these practical people have been too occupied with restoration work on individual mills to look at the bigger picture.

This study may provide some help in this challenging subject. Firstly, the work on Upton Forge (Chapter 8) demonstrates that it is possible, given favourable archival resources, to reconstruct the history of some sites. The conclusion drawn at the end of that chapter is that Upton could be assessed much more fully, and there must be a number of other mill sites that would lend themselves to this. Even if professional archaeologists cannot do this work, the Sheinton Heritage Group, which has studied Shinewood in the context of the area, has demonstrated what could be possible for enthusiastic amateurs to do with professional oversight.[565]

William Hazledine's story could also provide a window into the practice of millwrighting in the area at that time. Hazledine's practice was faithfully recorded by his friend Telford, but this material has never been fully put in the public

[565] Rayner 2006

domain.[566] Having this report available for discussion would provide a unique window into the mind and practice of a late eighteenth century practical millwright. Collaboration between a mill specialist and a historian would provide the best way of integrating the technology with agricultural and economic conditions at the time. Hawkstone windmill would provide a particularly interesting project for further research involving both industrial archaeology and milling history and practice. Hawkstone is the only surviving Hazledine windmill with some intact machinery; it is also thought to be the only surviving example of an English wind-powered oil mill, which makes it of especial importance.[567]

This research has also highlighted the lack of studies into the methods of casting, fabricating and erecting large cast-iron structures such as those produced by Hazledine.[568] Studies at Ditherington Flax Mill, Pontcysyllte, Craigellachie and the Iron Bridge[569] have begun to open a window into this field, but much more could be learned, especially with collaboration between historians, industrial archaeologists, engineers and archaeometallugists.

During the historical period of this study, the profession of civil engineering was born, and the development of the management of large projects has been noted. This has already been the subject of a good deal of research, especially in

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[566] Telford 1798; Burne (Telford and Burne 1936) only reproduced part of Telford's handwritten manuscript, and the illustrations are very poor, given the reproductive technology available at the time

[567] Gregory 2005, p.25

[568] For example, Hayman 2005 devotes 9 pages out of 150 to the whole subject of cast iron ; Gale 1979 does not mention the subject at all

[569] Baxter 2006;
www.rcahmw.gov.uk/HI/ENG/Heritage+of+Wales/World+Heritage+Wales/Pontcysyllte+Aqueduct+%26+Canal; Lowson 1967a,b; De Haan 2004

relation to Telford's life and work.[570] However, Hazledine's work would provide an opportunity to examine this further from the point of view of the contractor. Space did not allow the discussion of works such as the Custom House in Dublin, which is an excellent example of this.[571] The conflict between engineer and contractor has been documented in the story of Marlow Bridge. Was this unique to Hazledine, with his enormous experience and forceful character, or did it happen often in this period when civil engineering was becoming a profession?

A final unrelated area that is suggested by the career of William Hazledine is the impact of the Municipal Corporations Act on a town such as Shrewsbury. It has been demonstrated that the earlier parliamentary Reform Bill resulted in a rise of partisanship in the town.[572] A similar quantitative and qualitative study could be done in regard to local politics and politicians, some of whom were profoundly affected by the controversy surrounding the passing of the Act.[573]

That so much still remains to be learned about Hazledine and his age is a tribute to his importance as an individual and as an innovator, even at that time of great innovation. The study has reconstructed much of Hazledine's life and work, and perhaps the most pressing need now is for others to re-examine Hazledine's contemporaries and their work in the light of this study, so as to arrive at a closer assessment of his significance to the broader profession.

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[570] Day, T 1998; Barnes 2007
[571] ICE, Thomas Telford correspondence, T/EG; Cox 2009
[572] Phillips and Wetherell 1991
[573] For example William James Clement, a brilliant young surgeon who led the reform party, had his application for a post at the Salop Infirmary repeatedly blocked by the predominantly Tory hospital trustees (see SC 25.9.1835 and 2.9.1870)

APPENDIX 1

WILLIAM HAZLEDINE TIMELINE

Year	National/International Events	Industrialisation	William Hazledine
1763	Treaty of Paris	Watt starts work on steam engine	Born Shawbury, April 6th
1764			
1765		Watt invents steam engine with separate condenser	
1766	Pitt (Earl of Chatham) Prime Minister		
1767		Wright paints 'Experiment on a bird in an air pump'	Family moves to Moreton Forge
1768		Arkwright invents water-powered spinning machine	
1769		Watt patents steam engine	
1770	Increasing tension in America Cook discovers Australia		
1771			
1772		James Brindley (canal pioneer) dies	
1773	Boston 'tea party'		
1774	American declaration of independence	John Wilkinson patents cannon boring machine Joseph Priestley discovers oxygen	
1775	American war of independence starts	Boulton and Watt go into partnership	
1776			
1777	Britain loses battles in America		
1778	France and Holland join America Chatham dies (May 11th)		Begins apprenticeship to uncle, May 11th

1779	Spain joins the war	Samuel Crompton invents spinning mule	
1780	Spain defeated at Cape St Vincent Gordon riots		Does work at Upton Forge
1781	Cornwallis surrenders in America	Rapid growth of cotton industry The Iron Bridge opened (Jan 1st)	Does work in South Wales
1782	Preliminary end of American war	Watt invents double-acting rotary steam engine; Josiah Wedgwood installs first steam engine in a factory	
1783	Treaty of Versailles – American independence William Pitt becomes Prime Minister	Henry Cort's first patent for producing wrought iron by 'puddling' Arkwright installs first steam engine in cotton mill	
1784			
1785	First bill for parliamentary reform rejected	Edmund Cartwright invents power loom	Ends apprenticeship, sets up as millwright in Wyle Cop, Shrewsbury
1786		Economic boom with rapid industrialisation	
1787		John Wilkinson launches first iron boat	Thomas Telford moves to Shrewsbury ?Iron foundry with Robert Webster
1788	George III's first bout of insanity	Andrew Meikle invents threshing machine	Takes over whitesmith business in Wyle Cop
1789	Outbreak of French Revolution	Abraham Darby III dies	Leases Pitchford Forge Builds first water mill in Staffordshire
1790		Crompton's mule harnessed to water power First steam rolling mill	John Simpson moves to Shrewsbury Water mill in Nantwich Marries Eleanor Brayne (Jan) – daughter Mary born (Dec)

1791	Birmingham riots against French Revolution	India rubber cloth patented	
1792	Tom Paine's *Rights of Man* published	Coal gas first used for lighting John Smeaton (pioneer engineer) dies	Land drainage work in Wales First recorded windmill design Ironwork for St Chad's church
1793	War begins with France Economic depression		Begins work on Coleham Foundry Son John born
1794	Habeas Corpus Act suspended Howe defeats French fleet	John Wilkinson patents cupola for making cast iron	Broadstone water mill; Fitz bone mill Daughter Elizabeth born
1795	Speenhamland poor relief system starts Hunger and high prices	Joseph Bramah invents hydraulic press	(Approx) Hawkstone windmill
1796	Spain enters the war against Britain Jenner proves vaccination works	Telford's Longdon-on-Tern Aqueduct Telford's Buildwas Bridge	First mine lease at Plas Kynaston Longnor water mill; Kingsland windmill
1797	French landing and defeat in Wales Spanish fleet defeated at Cape St Vincent	Shrewsbury Canal opens	Vyrnwy Aqueduct (with Simpson) Ditherington Flax Mill Daughter Ann born
1798	Irish rebellion Nelson wins Battle of the Nile	Boulton-Watt rotary engine applied to spinning mule	Welsh lime works extended Telford's *On Mills*
1799	Income tax introduced	Royal Institution founded	Leases Plas Kynaston estate Daughter Eleanor born (dies 1800)
1800	Poor harvests, high prices Malta captured	Richard Trevithick invents high pressure steam engine Henry Maudslay invents precision screw-cutting lathe	Leases Upton Forge Leases Longnor Forge and converts it to paper mill
1801	Pitt resigns Another bad harvest First census Union of Britain and Ireland	Richard Trevithick's steam carriage	Chirk Aqueduct Toft Windmill, Trentham Daughter Fanny born

1802	Peace of Amiens – some economic recovery First radical MPs elected	Telford begins road building in Scotland and work on Caledonian Canal	Buys Abbey Foregate property Buys and sells Billingsley mines
1803	French war restarts – invasion threat Mass volunteer movement	John Dalton introduces atomic theory First wholly metal power loom William Reynolds (ironmaster) dies	Queenbatch watermill Plas Kynaston foundry
1804	Pitt again Prime Minister Spain declares war	Trevithick's first steam locomotive to haul a load	Coleham Foundry damaged by fire Welshpool Town Hall (with Simpson) Buys Jones' Mansion (Wyle Cop)
1805	Victory at Trafalgar, defeat at Austerlitz		Pontcysyllte Aqueduct
1806	Deaths of Pitt and Fox 'Continental' system causes economic hardship	Gaslight installed in Lancashire cotton mill	Shinewood water and windmills
1807	Tories back in power Slave trade abolished in British Empire	Geological Society of London founded	
1808	Peninsular War begins Manchester weavers' strike	John 'Iron-Mad' Wilkinson dies	
1809	Defeat at Corunna, but Wellington wins victories	Humphry Davy invents arc lamp Charles Darwin born	Engineer for Severn Towpath Caynton Mill partnership dissolved
1810	Wellington wins victories in Spain		Relinquishes Pitchford Forge John Hazledine (brother) dies Pontysgawrhyd Mill
1811	Prince Regent takes over permanently Severe financial crisis; Luddite riots		Meole Brace Bridge
1812	Prime Minister Percival assassinated – Liverpool takes over Severe food shortages and riots Napoleon defeated at Moscow		Long Mill Bridge Bonar Bridge Platt watermill

1813	Wellington invades France Napoleon defeated at Leipzig	Polarisation of light first described	Cantlop Bridge
1814	Napoleon abdicates Exceptional cold due to volcanic ash	Stephenson builds first steam locomotive	Craigellachie Bridge Hogstow watermill
1815	Congress of Vienna Napoleon defeated at Waterloo Introduction of Corn Laws	Davy's miners' safety lamp invented	John Simpson dies
1816	Economic depression and unemployment; Spa Fields riots – call for Parliamentary reform		Waterloo Bridge (Bettws-y-Coed) Long Mill (watermill)
1817	Widespread unrest, suspension of Habeas Corpus Attempt to assassinate Prince Regent Princess Charlotte dies		Leases Calcutts ironworks
1818	Habeas Corpus restored	Institution of Civil Engineers formed First iron ship built on the Clyde	Cound Bridge Dolforgan Bridge, Kerry
1819	'Peterloo' massacre Large tax rises First factory act	Steamship 'Savannah' crosses the Atlantic	Work begins on Menai Bridge
1820	Death of George III, George IV crowned Cato Street conspiracy – hopes of moderate reform dashed	First iron steamship launched Samuel Brown's suspension bridge at Berwick-on-Tweed	Kington Tramway Esk Bridge, near Carlisle Moy turn (swing) bridge
1821	Agricultural distress	John Rennie (engineer) dies	Daughter Fanny dies
1822	Agricultural distress worsens Castlereagh (Foreign Secretary) commits suicide		Work starts on links for Menai and Conwy Bridges Dublin Custom House roof

1823	Prison and criminal reform (Peel) First Mechanics' Institute	Chlorine liquefied (Faraday); first calculator (Babbage); waterproof fabric (Macintosh)	Severe floods at Upton Forge Gives up lease on Plas Kynaston foundry Daughter Elizabeth Austin dies
1824	Loosening of anti-trade union laws Economy overheats	Portland cement patented	More floods at Upton Forge Eaton Hall Bridge
1825	Commercial and financial crises – Rothschild saves Bank of England	Stockton to Darlington railway opens Faraday isolates benzene and invents electromagnet	Links for Menai and Conwy finished Helps finance lowering of Castle St Gives up Longnor Paper Mill
1826	Many bankruptcies Weavers' riots	Royal Zoological Society founded	Menai and Conwy Bridges opened Has serious accident Wife Eleanor dies Mythe Bridge (Tewkesbury)
1827	Lord Liverpool resigns	First friction matches	Laira Bridge (Plymouth) William Stuttle (foreman) dies Cleveland Bridge (Bath)
1828	Wellington Prime Minister Corn Laws loosened Dissenters obtain civil liberties		Holt Fleet Bridge (Ombersley) Buys the Armoury, Shrewsbury
1829	Catholic emancipation debates Metropolitan Police Act		
1830	George IV dies, William IV succeeds Agitation for parliamentary reform Wellington replaced by Grey (Whig)	Opening of Liverpool to Manchester railway – government minister William Huskisson killed	Buys Coleham Brewery Fence for new Salop Infirmary Nantwich Aqueduct
1831	Rural ('Swing') riots Riots over first rejection of Reform Bill	Darwin begins *Beagle* voyage Faraday refines electro-magnetic induction	Shadwell Dock entrance swing bridge Gives up lease on Calcutts ironworks

1832	Reform Bill passed Major cholera epidemic		Marlow Bridge opens Meets Princess Victoria Elected Freeman of Shrewsbury
1833	Abolition of slavery in the Empire Factory inspections begin	Brunel begins Great Western Railway Richard Trevithick dies	Remarriage to Elizabeth Jane Dixon Stretton Aqueduct
1834	Poor Law amendment act Tolpuddle Martyrs Houses of Parliament damaged by fire	Thomas Telford dies (September 2nd)	
1835	Municipal Corporations Act	Institute of British Architects founded	Shrewsbury Corporation abolished – bitter election battle for new council
1836	Chartist movement starts	Screw propeller invented	Becomes Lord Mayor, Tory ousted
1837	William IV dies, Victoria succeeds Registration of births, marriages and deaths begins Severe commercial and financial crisis	Electric telegraph invented Euston Station opens British Museum opens	Buys properties in Swan Hill, Shrewsbury
1838	Chartist agitation Anti-Corn Law League	Regular steamship services to America begins	Helps to found Shrewsbury Racecourse and Dogpole House museum
1839	County Police Act Chartist riots	Photography and bicycle invented	
1840	Marriage of Victoria and Albert Penny Post	Incandescent light invented	Dies, October 25th, buried October 31st
1841	Peel replaces Melbourne as Prime Minister	British Pharmaceutical Society founded	Sale of Dogpole House and contents Attempted sale of Coleham Foundry

APPENDIX 2

GLOSSARY OF TECHNICAL TERMS RELEVANT TO THIS THESIS[574]

Bridge parts[575] –

Abutment – the supports on the bank at the side of a bridge, built to resist the thrust of the structure

Bascule – a 'see-saw' type bridge with a counterweight on one end of a hinged deck (e.g. London's Tower Bridge)

Centring – a temporary timber frame used to support an arch under construction

Hanger – a vertical suspension rod connecting the deck to a main chain in a suspension bridge

Soffit – the underside of an arch

Spandrel – the face of the bridge between the arch and parapet

Voussoir – a wedge-shaped stone forming part of an arch

Cam - a projection on a wheel or shaft to transmit movement to another part of the machinery

Fulling - scouring or beating cloth in the finishing process

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[574] Jones 2006 has been used extensively for this section
[575] See Yorke 2008, pp.156-7

Helve - A heavy hammer (usually with a cast iron head by Hazledine's time) pivoted at one end, lifted by a cam and allowed to fall by gravity (see Figure 6). (Hazledine seems to have used a 'belly helve', in which the cam operates at about the mid-point of the hammer.)

Iron – metallurgy

Iron is obtained by heating iron ore (which most commonly occurs as various iron oxides) with charcoal or coke and limestone.[576] The basic chemical equation for this process is $Fe_3O_4 + 2CO + 2H_2 \rightarrow 3Fe + 2\ CO_2 + 2H_2O$, the carbon monoxide (CO) and hydrogen (H_2) being produced by the interaction of the charcoal or coke and the air blast at high temperatures. The charcoal or coke is the source of carbon (for the carbon monoxide) and hydrocarbons (for the hydrogen). The limestone combines with some of the impurities (mostly silica) in the ore to produce slag. The *pig iron* that results from this process contains about 4% carbon, as well as other elements such as phosphorus, sulphur, silicon and manganese, depending on the source of the iron and coke. Traditionally, most of this pig iron was converted to *bar (now known as wrought) iron* by reheating and hammering. The carbon content of wrought iron is very low (less than 0.1%), and hammering transforms the silica into fibrous inclusions, which gives wrought iron a 'grain' resembling wood. It has a much higher melting point than cast iron, but its fibrous structure means that it can be worked when hot and is resistant to tension. It is subject to rust (the formation of iron oxides on the surface). *Cast iron*, which is the same as pig iron, can be poured directly from the

[576] Oxford Dictionary of Science, 2005

furnace, but by Hazledine's time was mostly obtained by reheating pig iron with limestone to get rid of slag attached to the iron. Cast iron contains around 2.1% - 4% carbon, and also 1% - 3% silica. It melts at around 1200°C, so is useful for moulding, but its crystalline structure can make it brittle, especially if it is subjected to tension. It is not subject to rust.[577] It had been known since antiquity that reheating pig iron under certain circumstances could also produce *steel*. Exactly why this happened was poorly understood, but by the early seventeenth century more reliable methods of steel production were introduced. It was not until 1850s and 1860s, however, with the introduction of the Bessemer converter and the Siemens open hearth process, that large quantities of steel became available.[578] The carbon content of steel is between cast and wrought iron, being 0.2% – 1.7%. It has a crystalline structure like cast iron, and hence it is pourable, but it can be 'tempered' (hardened) by sudden cooling in water, so in many ways steel is the ideal form of iron.

Iron production[579]

Furnace (now 'blast furnace') – where iron was produced from the raw materials

Forge – where pig iron was converted to bar iron by heating and hammering (see Chapter 2). This traditionally happened in two stages (*finery and chafery*), but after the 1780s usually by *puddling and rolling*. Here the fuel was kept separated from the iron (it is thus an indirect method) and the molten metal stirred ('puddled') and then passed through rollers when hot.

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[577] Day and Tylecote 1991, p.261
[578] Larke 1949
[579] Gale 1979; www.topforge.co.uk/Glossary.htm

Foundry – where pig iron was reheated and purified in an air furnace (such as a cupola) and cast into the required components.

Jack arch - a segmental brick arch spanning between iron beams, thus forming a vault

Railroad/railway - usually an edge-railway, though it could run on L-shaped rails. Horse-drawn prior to steam power

Sough - a drain, sewer or adit (opening into a mine or a drainage channel within it)

Tramroad – a horse-drawn railway with L-shaped rails

Trunk – a drainage channel, often made of wood

Watermill parts (Figure 23)[580]

Breastshot wheel – where the water enters at about the level of the wheelshaft, the wheel being driven by both the impulse and the weight of the water

Clasp arm construction – two pairs of arms attached to the inner rim of the waterwheel to form a square at the centre that boxes the shaft (Hazledine's normal practice)

Compass arm construction – the arms attached to the inner rim of the waterwheel are mortised through the shaft (as in a wagon wheel)

[580] Based on Watts 1999, p.122ff, with additional information from Syson 1980

Crown wheel (also known as flywheel in Hazledine's time) – a horizontal-face gear, usually with cogs projecting upwards, for running the sack hoist, dressing mill etc

Launder – a trough that leads water onto a wheel

Leat – a manmade channel bringing water to the mill

Overshot wheel – a waterwheel driven by water directed to the top of the wheel, and turning it by the weight of water in its buckets (Hazledine's normal practice)

Penstock – a sluice or hatch that regulates the flow of water onto a waterwheel

Pitwheel – the primary driven gear, usually fixed to the shaft of the water wheel, with its lower end turning in a pit

Rynd – an iron fitting on which the upper, moving, millstone is hung

Spindle – a small diameter shaft (usually of iron by Hazledine's time)

Spurwheel drive – a gearing form in which a number of drives (e.g. for two millstones) can be taken off the periphery of a spur gear

Stone nut – smaller cog taking the drive from a spur wheel to drive the millstones

Undershot wheel – a waterwheel driven by the impulse of water striking the floats at or near the bottom of the wheel

Wallower – the first gear driven by the pitwheel

Wheelshaft – the main horizontal driveshaft on which the waterwheel is mounted

Whitesmith - a worker in tinned or white iron; a tinsmith; a polisher or finisher of metals[581]

Windmill parts (Figure 24)[582] –

Brakewheel – the primary gear mounted on the windshaft, on which the brake acts

Curb (or live curb) – circular iron rim attached to the top of the tower on which the cap rotates via iron wheels (Figure 26, p.57)

Fantail – a small wind wheel set at right angles to the sails to turn the mill automatically into the wind (not used by Hazledine)

Poll end (or canister) – outer end of a windshaft to which the sails are attached

Sails[583] - Hazledine used traditional *common sails* (canvas stretched over a wooden frame). *Patent sails*, using shutters controlled from inside the mill, were not reliable until at least the second decade of the 19th century.

Wallower – the first gear driven by the brakewheel

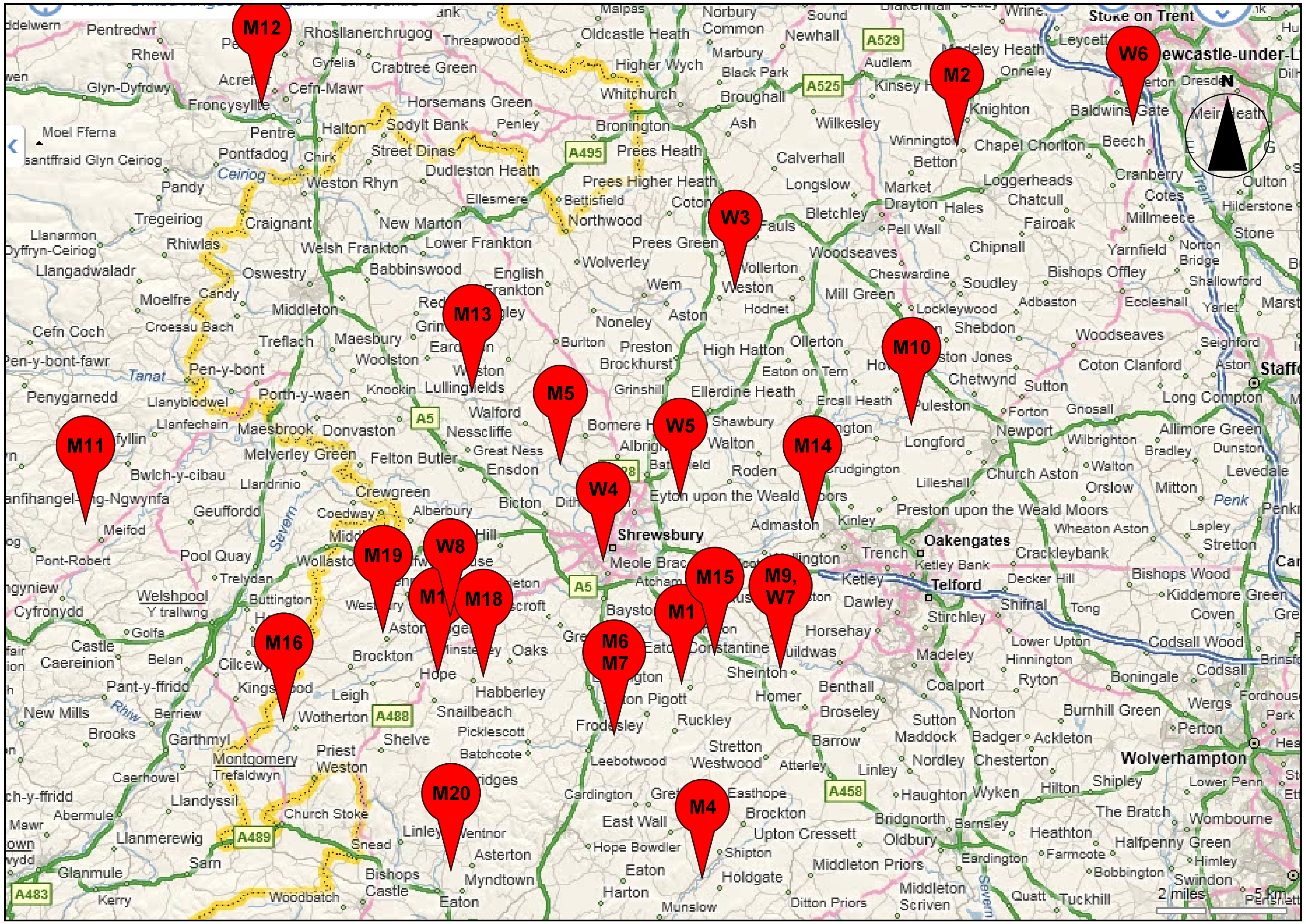
Windshaft – the main driveshaft that carries the sails at its outer end and is turned by them

[581] *Chambers' Dictionary,* 1998 Edition
[582] Based on Watts 1999, p.122ff
[583] Telford 1798; Burne et al 1943; Vince 1987, pp.18-21

APPENDIX 3

GAZETTEER OF MILLS ASSOCIATED WITH WILLIAM HAZLEDINE

LOCATION OF MILLS ASSOCIATED IN SHROPSHIRE AND ADJACENT AREA



Key –
M1 – Pitchford
M2 – Oakley
M4 – Broadstone
M5 – Fitz
M6 – Longnor corn
M7 – Longnor paper
M9 – Shinewood
M10 – New Caynton
M11 – Pontysgawrhyd
M12 – Felin Benjamin
M13 – Platt
M14 – Long
M15 – Cound
M16 – Stockton
M17 – Hogstow
M18 – Habberley
M19 – Aston Rogers
M20 – Whitcot
W3 – Hawkstone
W4 – Kingsland
W5 – Uffington
W6 – The Toft
W7 – Shinewood
W8 - Asterley

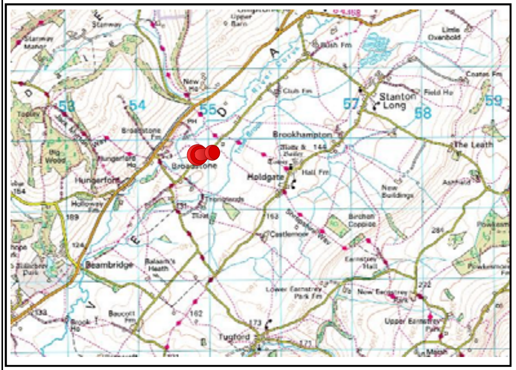
GAZETTEER OF MILLS ASSOCIATED WITH WILLIAM HAZLEDINE

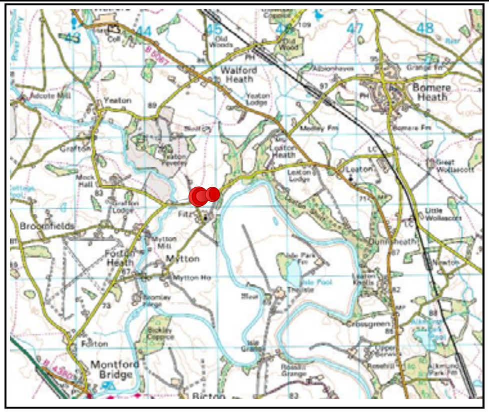
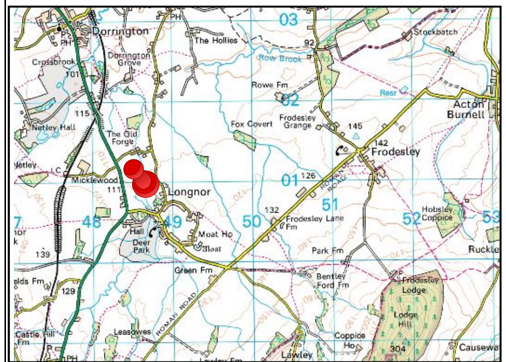
A. WATER MILLS WITH DOCUMENTARY EVIDENCE[584]

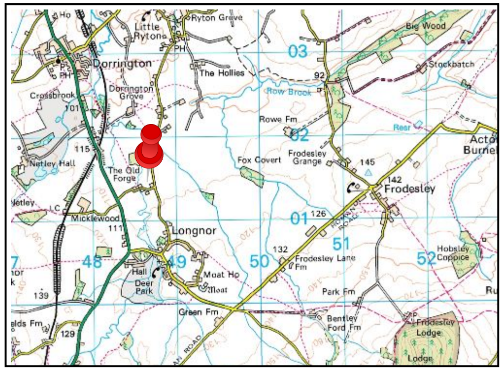
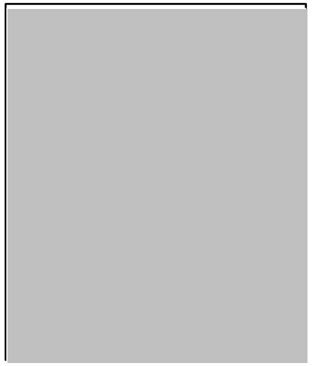
(Sites marked with * discussed more fully in the text; 'date' is date when work performed)

Site (map no)	Date	Summary and References	Location (site marked with pin)	Visual record
M1 Pitchford, Shropshire, SJ 533056*	1786	Hazledine sold old rye mill on the site 1786; took over as tenant of forge 1789. Rebuilt estate bridge to forge 1797; last known association with forge 1809 (SC 15.7.1786; NLW Pitchford Hall accounts - 1887, 2103, 2104; 139/6/13 (p.22); VCH Vol. X 1968, pp.116,121; SMRNO06849)		No known visual record
M2 Corn mill at Oakley, Staffs, SJ 699366	1789	Possibly Hazledine's first new water corn mill, built for Sir John Chetwode (or Chetwynd) of Oakley Hall. Now converted into a residence – nothing known about the machinery (Telford and Burne 1936, p206; Telford 1798, p.39; Riley 1991, pp.42-3)		 Oakley Mill c1990 (Riley, p.43)

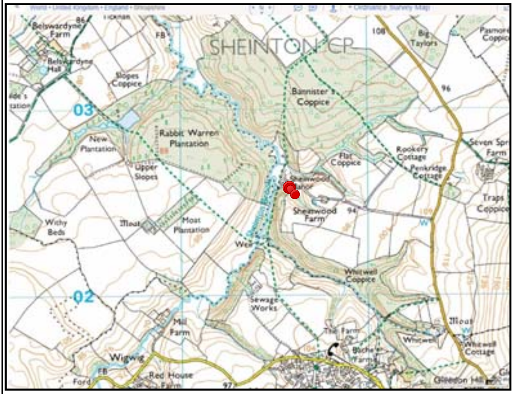
584 Barton, 2007 adds Shackerley to this list on the basis that the tenant of this East Shropshire mill was William Hazledine in 1793. However, this appears to be a different William Hazledine, since his wife was Elizabeth and he had died by 1809 (SA 1781/2/208-9, 212, 220)

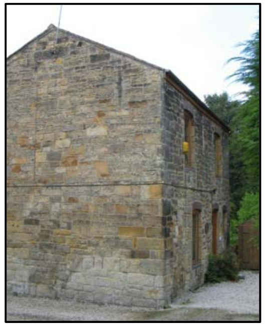
M3 Corn mill at Newhall, near Nantwich, Cheshire, approx SJ 609454	1790	Built for Sir Robert Cotton. Site completely redeveloped by Newhall Dairies (Telford and Burne 1936, p206; Telford 1798, p.39; Norris, p.68)		No known visual record
M4 Broadstone Corn Mill, Corvedale, Shropshire, SO 547900*	1794	Built for Richard Grant, on the River Corve. Now converted to private house, but much of the original machinery remains intact. (Telford and Burne 1936, p206; Telford 1798, p.39; Boucher 1963; Tucker 1991, p.63; SMRNO15778)		 Broadstone Mill 1963 (Boucher 1963)

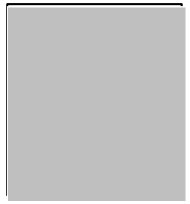
M5 Fitz Bone Mill, Shropshire, SJ 444181	1794	Hazledine produced estimate and plans for building new bone mill to communicate to old water wheel shaft. Building remains, but machinery is gone. (Wharton 1976c; SA 552/11/3739/1; SMRNO15595)		Fitz Mill (Wharton 1976c)
M6 Longnor Corn Mill, Shropshire, SJ 486006	1795	Hazledine's drawings for rebuilding appear among estate papers. No information on whether the work was carried out. Now converted to private house. No machinery remains, but said to have been a double mill. (SA 367/Box 31.29; Wharton 1976d; Judd 1953)		 Longnor corn mill 2010 (the author)

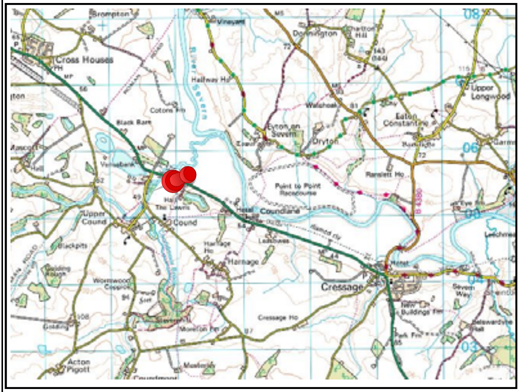
M7 Longnor Forge/ Paper Mill, Shropshire, SJ 486015	1800	Hazledine leased this former forge and converted it into a paper mill. Lease given up 1825; mill and contents advertised for sale 1825, but may have continued for some time under different management. Now converted to private house (SJ 7.5.1800; SA D3651/D/31/57; SC 25.2.1825; Lloyd 1937-8, 1949-50; Shorter 1949-50[585]; Grounds 2009, p.221; SMRNO04536)		 Longnor Forge 2010 (Estate Agent's advert)
M8 Queenbatch Corn Mill, Shropshire, SO 440903	1803	Rebuilt to Hazledine's design with two pairs of four foot millstones. Leased to Jasper Jones of Ryton. Now converted to private house; some machinery remains (SA 837/94; Tucker 1991, p.51)		 Queenbatch Mill (Tucker 1991)

[585] Shorter and Lloyd incorrectly suggest that Hazledine also made paper at Upton Forge

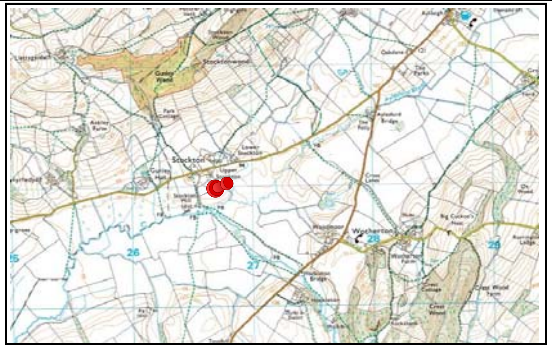
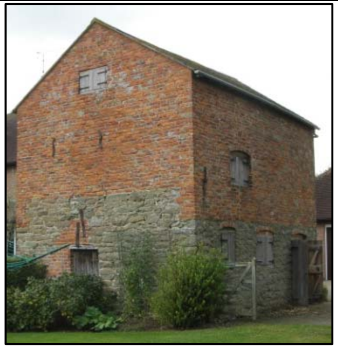
M9 Shinewood corn mill, Shropshire, SJ 615027*	1806	Mill rebuilt with four pairs of stones. Now converted into private house; some machinery remains. (SJ 12.2.1806; Andreae 1990)		 Shinewood Mill 1990 (Tim Booth)
M10 New Caynton mill/ forge, Shropshire, SJ 693230	Pre-1809	Hazledine's partnership with Samuel Brayne at Caynton Mills dissolved April 1809. Whether Hazledine performed any millwrighting work there not known. Building is said now to contain two waterwheels and some machinery remains (SC 14.4.1809; SMRNO15640; Trinder 1996, p.244; Wharton 1976b; www.britishlistedbuildings.co.uk/en-361897-new-caynton-mill-chetwynd)		New Caynton Mill (Wharton 1976b)

M11 Pontys-gawrhyd corn mill, nr Meifod, Powys, SJ195155*	1810	Built in Hazledine style. Much of the machinery remains and is being restored. Nearby Derwen corn, grist and clover mill (SJ221106) was built shortly before. Hazledine's foundry supplied spare parts, including castings, for both mills, suggesting the original work was done by them. Almost nothing of Derwen remains (Wadley, Wadley and Barton 2004; Tim Booth, personal communication; Garth record books, Powys County Archives, M/D/GA/1/1 (June 3rd & July 11th 1829, May 12th & June 6th 1830))		 Pontysgawrhyd Mill, 1997 before restoration (People's Collection of Wales)
M12 Felin Benjamin corn mill, Cefn Mawr, Clwyd SJ 275423	1811	Mill was bought by Hazledine. No information as to whether he did any work on it. Eventually sold by family 1890. Now converted to two cottages. (Dave Metcalfe (copy of deeds) and Steve Wadsworth (personal communication)).		 Felin Benjamin, now converted to cottages (the author)

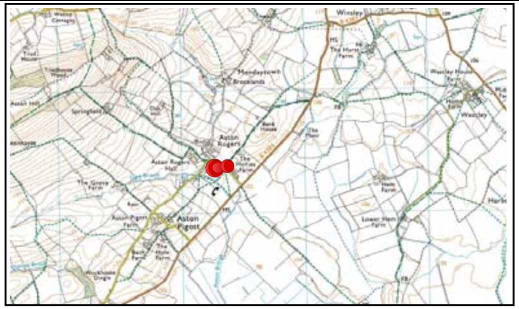
M13 Platt Mill, Ruyton-XI-Towns, Shropshire, SJ 397221	1812	Hazledine produced comprehensive estimate to repair and rebuild the mill machinery and buildings (£150 6s 9d). No documentary evidence remains that this was carried out, but timber trusses of present building on the site are similar to Hazledine's other work (SMRNO08034; SA 6001/16915; Tim Booth, personal communication)		  Platt Mill, 2011, outside view and bedroom showing typical 'Hazledine' roof truss arrangement (Estate Agent's advert)

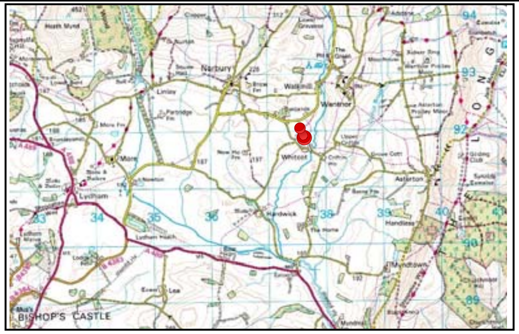
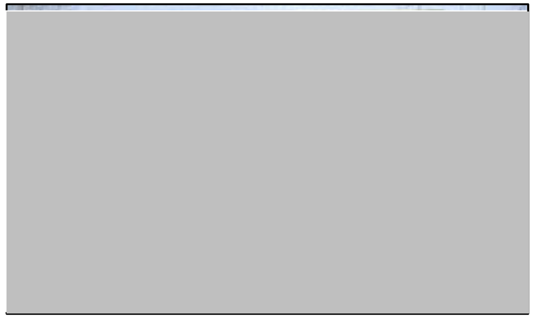
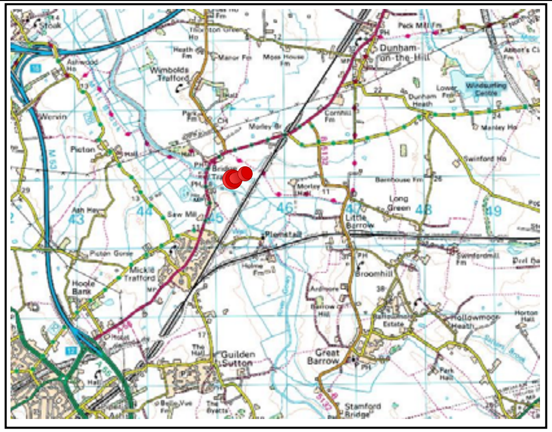
M14 Long (Longdon-on-Tern) , Shropshire, corn mill, SJ 617154*	1816	Hazledine designed and built new double mill with four pairs of stones after demolition of the old – estimate of £594 13s 9d. Mill now demolished (Staffs record office D593/L/4/6 & 7; SA Lilleshall Estate records 972/fiche 2311 & 5735, 972/3/18/224; SMRNO07140)		No known visual record
M15 Cound corn mill Shropshire, SJ 556056	1810 - 1820	Shropshire MP and noted eccentric John Cresset Pelham (1769-1838) asked Hazledine to demolish the mill to bring it nearer the water. Hazledine refused, but eighteen months later Pelham relented and Hazledine rebuilt the mill 'at the cost of many hundred pounds.' Hazledine himself was leasing the mill in 1830. Some of the machinery remained in 1977; since then it has been converted into a dwelling and it is not known if any machinery survives. (SC 6.11.1840; William Salt Library Stafford 350/40/3; SMRNO00523)		 Cound Mill 2010 (the author)

B. WATER MILLS WITHOUT DOCUMENTARY EVIDENCE[586]

M16 Stockton Corn Mill, Shropshire, SJ 266008	Early C19th	Inside workings survive in reasonable condition and are suggestive of Hazledine's work. Now used as garden store. SMRNO15515		 Stockton Mill (the author)
M17 Hogstow corn mill, Shropshire, SJ 366031	1814	Previous mill burned down 1814, surviving rebuilt double mill suggestive of Hazledine's work, but remaining machinery is late (SMRNO00526; Wharton 1976a)		 Hogstow Mill (Wharton 1976a)

586 I am indebted to Tim Booth for help with this section

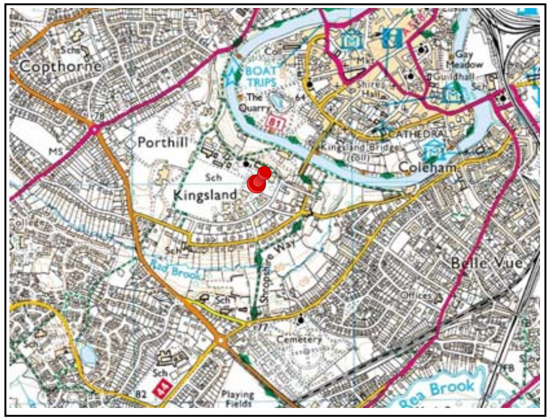
M18 Habberley corn mill, SJ 403036	Not known	Converted to a house. Minimal remains SMRNO15605		 Habberley Mill (www.rea-valley.com)
M19 Aston Rogers corn mill, SJ 343064	Not known	Converted to a house, but most of machinery remains, though some is later (SMRNO13718)		 Aston Rogers Mill (Alan Stoyel)

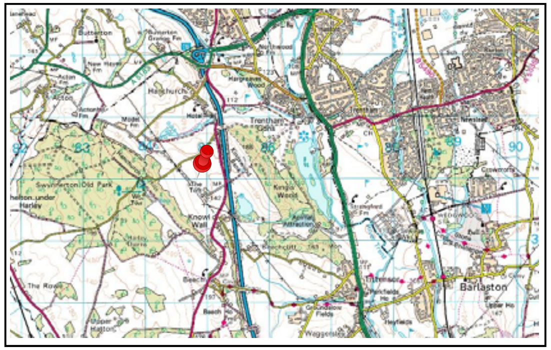
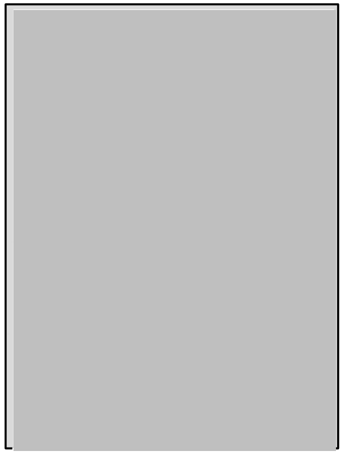
M20 Whitcot corn mill, SO 377918	Not known	Much machinery survives, but is of a later date SMRNO20681; Tucker 1991, p.52		 Whitcot Mill (Alan Stoyel)
M21 Trafford corn mill, Mickle Trafford, Cheshire, SJ 449705	Early 1800s	Two full sets of machinery in the same building renewed for Earls of Shrewsbury (http://www.britishlistedbuildings.co.uk/en-404433-trafford-mill-mickle-trafford; Malcolm Padmore, personal communication)		 Trafford Mill (Google Images)

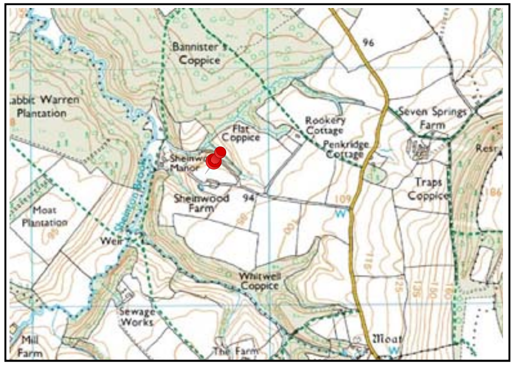
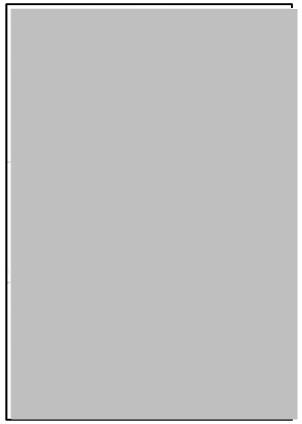
C. WINDMILLS WITH DOCUMENTARY EVIDENCE

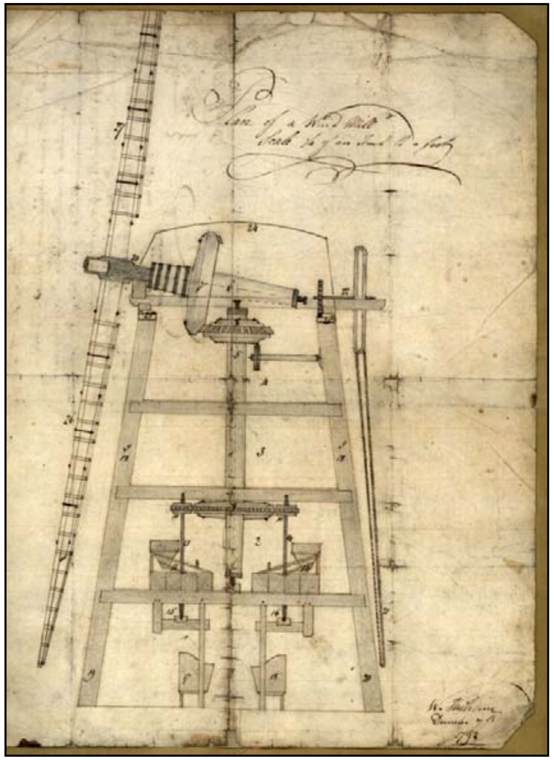
W1 Newhall, near Nantwich, Cheshire, approx SJ 609454	?1790	Built for Sir Robert Cotton, probably at the same time as the water mill above, to provide back up in dry seasons. Site redeveloped as above (Telford and Burne 1936, p212; Telford 1798, p.124)		No known visual record
W2 Cheshire, no site given	?	Mill built for Sir Thomas Broughton. No further identification (Telford and Burne 1936, p212; Telford 1798, p.124)		

W3 Hawkstone Park, Shropshire, SJ 566297*	?1795	Built for Sir Richard Hill as part of the Hawkstone Park 'follies' in picturesque 'Dutch' style. Mill used for grinding linseed for animal feed, pumping water up to Hawk Lake, and later as a bone mill. Some machinery remains and tower is protected by modern cap. (Telford and Burne 1936, p212; Telford 1798, p.124; Rodenhurst 1803; Morriss 1997; Gregory 2005; Seaby & Smith 1984; SMRNO14399)		 Hawkstone Mill Tower 2010 (the author)

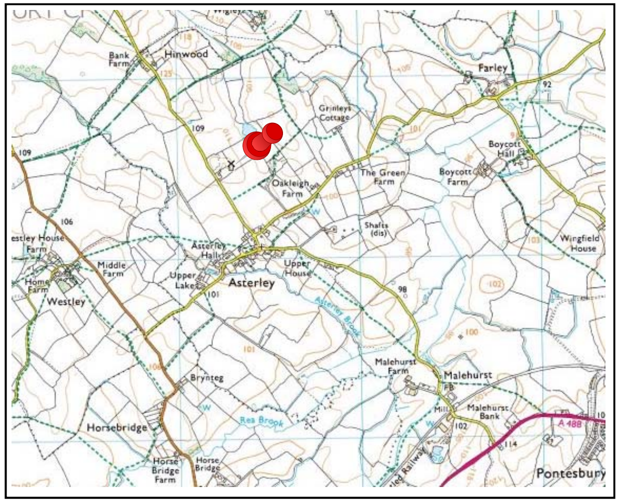
W4 Kingsland, Shrewsbury House of Industry, SJ 484117	1796	Associated with the House of Industry farm. Hazledine and John Simpson removed the machinery of Uffington windmill, built new tower and installed the machinery from Uffington. Paid £630 14s 8d, expenses £445 11s. Rented out 1807. Farm sold 1826. Mill demolished 1861. No remains (Telford and Burne 1936, p212; Telford 1798, p.124; www.workhouses.org.uk; SA PL2/2/1/1-2; SA PL2/3/6/1; SC 20.4.1796 & 18.12.1807; Trinder 2006, p.108; Barker 1919)		 Kingsland windmill (top left) prior to 1845 (Barker, 1919)

W5 Uffington Windmill , SJ 528139*	1796	Was a corn mill and also to provide water for the slitting mill in dry seasons. Machinery removed as above (SC 18.4.1794; SA PL2/3/6/1)		No known visual record
W6 The Toft, Trentham, Staffs SJ 850397	1801	Estimate of £992 18s 4d for windmill with two pairs of stones (one French, one Derbyshire) for making flour on the first floor and one shulling mill for making oatmeal on the ground floor, using Mow Cop stones. Mill only lasted during the boom years for agriculture in the Napoleonic wars, being dismantled in 1819. No remains (Staffs RO D593/L/1/19/3; Lead 1975; Job 1985, pp.38-9)		 The Toft Mill, redrawn from Hazledine's estimate (Job 1985, p.39)

W7 Shinewood Windmill, Shropshire,SJ 615027	1806	Built or rebuilt at the same time as water mill, with two pairs of stones, to ensure continuous working in dry seasons. Date ceased to function unknown (SJ 12.2.1806)		 Estate plan 1806 (Trevor Hill)

Unidentified	In the Tyne and Wear Archives (DX 717/1) there is a drawing of a windmill signed by Hazledine in December 1792 entitled ‘plan of a windmill’. This may have been a specimen drawing rather than a plan of an actual windmill. The provenance of the document is unknown.		Hazledine’s 1792 windmill plan (Tyne and Wear Archives DX 717/1)
Unidentified	Having described the first four windmills detailed above, Telford (1798) stated that Hazledine had built ‘several others which it is needless to mention’. One possibility is Waterloo Mill, Hadnall, Shropshire (SJ 523210), built 1787 (Seaby and Smith)		

D. WINDMILL WITHOUT DOCUMENTARY EVIDENCE

W8 Asterley , Shropshire , SJ 373075	1809	Was in derelict condition and is now being fully restored. Proportions of the tower are similar to other Hazledine mills; surviving cap rollers similar to Hawkstone (SMRNO17511; Peter Lewis and Tim Booth, personal communications)		 Asterley Windmill 2007 (the author)

APPENDIX 4

GAZETTEER OF AQUEDUCTS AND BRIDGES ASSOCIATED WITH WILLIAM HAZLEDINE

A. AQUEDUCTS

(Sites marked with * discussed more fully in the text; 'date' is date of opening)

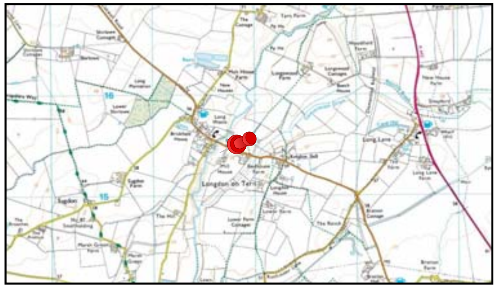
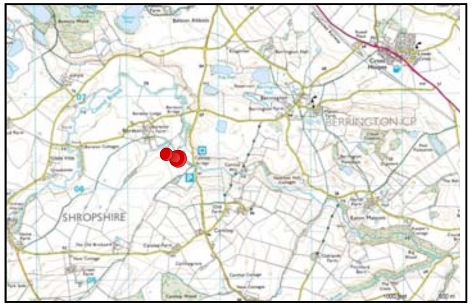
Site (map no)	Date	Summary and references	Location (site marked with pin)	Visual record
A1 Vyrnwy SJ 254197*	1797	Masonry aqueduct, carries Montgomery Canal over River Vyrnwy (with Simpson). Problems with foundations resulted in partial collapse and rebuilding. (Hughes 1988; TNA RAIL 852/11)		 Vyrnwy Aqueduct 2011 (the author)
A2 Chirk* SJ 287373	1801	Carries Ellesmere Canal over River Ceiriog. 10 piers, 710ft (220m) long, 70ft (21m) high. Iron base with masonry sides. See text (chapter 7)		 Chirk Aqueduct (and viaduct) c1850 by George Hawkins (IGMT)

A3 Pont- cysyllte* SJ 253409	1805	Carries Ellesmere Canal over River Dee. 18 piers, 1007ft (305m) long, 116ft (35m) high. Full iron trough See text (chapter 7)		 Pontcysyllte Aqueduct 2010 – canal view (the author)
A4 Nantwich SJ 641526	1830	Carries Birmingham and Liverpool Canal over Nantwich to Chest road. One cast iron arch, 29ft (8.8m) between masonry abutments, 15ft (4.6m) headroom (www.engineering-timelines.com; Quenby 1992, p.72ff)		 Nantwich Aqueduct 2009 (Google Images)

A5 Stretton* SJ 871107	1833	Carries Birmingham and Liverpool Canal over A5 on the Shropshire/ Staffordshire border. 30ft (9.1m) arch (www.engineering-timelines.com; Quenby 1992, p.72ff)		Stretton Aqueduct (Google Images)

B. SMALL CAST IRON ARCH BRIDGES WITH DOCUMENTARY EVIDENCE

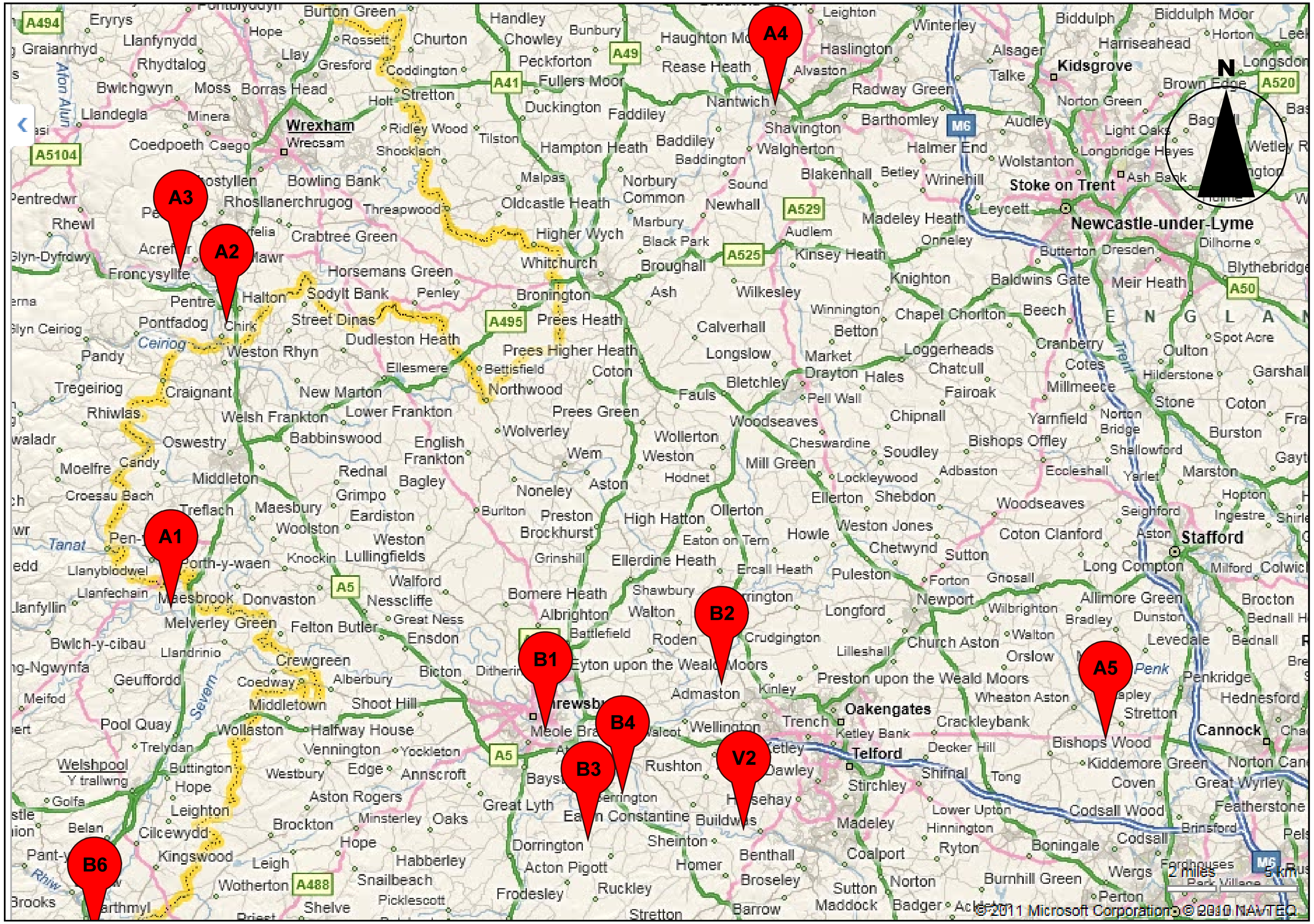
Site (map no)	Date	Summary and references	Location (site marked with pin)	Visual record
B1 Meole Brace, outskirts of Shrews-bury SJ 491107*	1811	Road bridge over Rea Brook. 55 ft (16.8m) span, 4 ribs. Telford (Stanton) design. Lasted till 1933 (SA DP108; Blackwall 1985; Glover 2007)		Meole Brace Bridge (Shropshire Archives)

B2 Long Mill, Longdon on Tern, Shropshire, SJ 617155*	1812	Road bridge leading to Long Mill. Span 28 feet (8.5m), 4 ribs. Widened 1847, demolished 1883 (www. discovershropshire.org.uk – article on Long Mill bridges)		No visual record known
B3 Cantlop, near Pitchford, Shropshire, SJ 517063*	1813	Road bridge over Cound Brook. Span 31ft (9.5m), 4 ribs. Still in place, though bypassed (SA DP33; Blackwall 1985, p.49; SJ 14.5.1812)		 Cantlop Bridge 2010 – ironwork detail (the author)
B4 Cound, Shropshire, SJ 558057*	1818	Road bridge over Cound Brook (now A458). Same design and dimensions as Meole Brace. Replaced 1967, two ribs used for Hall Park Way pedestrian bridge, Telford (SA 227/5; Blackwall 1985)		 Ribs from Cound Bridge incorporated into Hall Park Way Bridge, Telford (the author)

SMALL CAST IRON ARCH BRIDGES WITHOUT DOCUMENTARY EVIDENCE

B5 Ha’penny, Dublin*	1816	Pedestrian bridge over the River Liffey, Designed and built at Coalbrookdale (SJ 2.6.1816), but virtually identical to the Telford/Hazledine design. 43 metres (141 ft) long, 3.35 metres (11.0 ft) rise, 3.66 metres (12.0 ft) wide. Arch rib, spandrel and handrail design identical to bridges B1-4	 Dublin city centre	 Ha’penny Bridge, Dublin (Wikimedia)
B6 Dolforgan, Kerry, Powys, SO 144901*	1818	Estate carriage bridge over River Mule. Different arch rib design to bridges 1-4, but same railings. Now redundant, but restored. (www.bbc.co.uk/wales/mid/sites/kerry/pages/dolforganhall_bridge.shtml; plaque at bridge)		 Dolforgan Bridge, Kerry, railing design (the author)

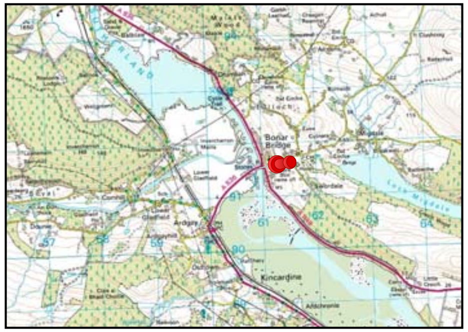
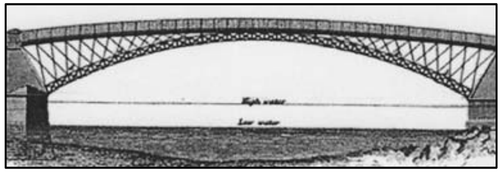
LOCATION OF AQUEDUCTS AND BRIDGES IN SHROPSHIRE AND ADJACENT AREA



Key –
Aqueducts
A1 - Vyrnwy
A2 - Chirk
A3 - Pontcysyllte
A4 - Nantwich
A5 – Stretton

Bridges
B1 – Meole Brace
B2 – Long Mill
B3 – Cantlop
B4 – Cound
B6 – Dolforgan
V2 – Severn towpath

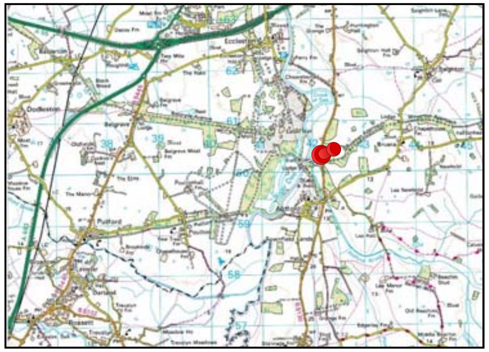
C. LARGE CAST IRON ARCH BRIDGES IN ASSOCIATION WITH TELFORD AND TO HIS STANDARD DESIGN

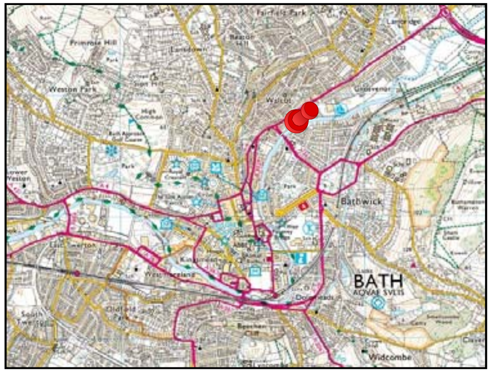
Site (map no)	Date	Summary and references	Location (site marked with pin)	Visual record
C1 Bonar Ferry, Sutherland, NH 609917*	1813	Road bridge - one iron arch of 150 ft (45.7m), two masonry arches. Lightweight lattice spandrel design. Cast and trial erection at Plas Kynaston (Paxton and Shipway 2007, pp.211-13; Paxton 2007; SC 5.6.1812)		 Bonar Bridge – iron arch (Telford's Atlas)
C2 Craigellachie, Grampian, NJ 285452*	1814	Road bridge over River Spey. Iron arch identical to Bonar. Full details in text. Refurbished 1963, now closed to vehicles (Paxton and Shipway 2007, pp. 130-132; Paxton 2007, pp.16-17; Lowson 1967a, b)		 Craigellachie Bridge – ironwork detail (RCAHMS)

C3 ‘Waterloo’, Bettws-y-coed, Gwynedd, SH 799557*	1816	Road bridge over River Conwy. One iron arch of 105ft (46m), with exceptional spandrel castings. Remains in use after strengthening (Quatermain et al 2003, pp.79-81)		 Waterloo Bridge – casting detail (‘Visit Wales’ website)
C4 River Esk (‘Metal Bridge’), Cumbria, NY 354649*	1820	Road bridge over River Esk for Carlisle to Glasgow road. One span of 150 ft (as Bonar) and two of 105ft (as Waterloo). Demolished 1911 (www.engineering-timelines.com/scripts/engineeringItem.asp?id=883)		 Esk Bridge – original plaque (Tho Telford 1820) (Engineering timelines website)

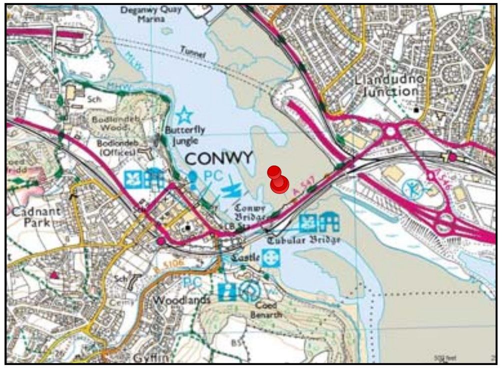
C5 Mythe, near Tewkesbury, Glos, SO 889337*	1826	Road Bridge over River Severn. One arch of 170ft 51.8m. Different handrail castings. Remains in use after strengthening (McKenzie, 1838)		 Mythe Bridge (the author)
C6 Holt Fleet, near Ombersley, Worcs, SO 824634*	1828	Road Bridge over River Severn. 150 ft span (as Bonar). Remains in use after strengthening (Paxton 2007, p.18; Sievewright 1986, pp.136-8; Cragg 2010, p.144)		 Holt Fleet Bridge (the author)

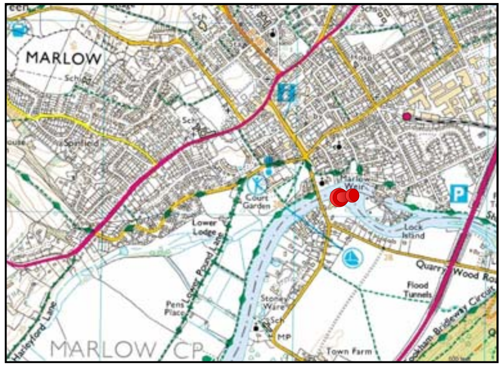
D. LARGE CAST IRON ARCH BRIDGES NOT ASSOCIATED WITH TELFORD

Site (map no)	Date	Summary and references	Location (site marked with pin)	Visual record
D1 Eaton Hall, near Chester, SJ 418601*	1824	Estate carriage bridge over River Dee. Built to Telford design, with decorative spandrels. One arch as Bonar. Hazledine did both contracting and ironwork. Remains in use, never refurbished (Chester and Cheshire archives, Eaton Estate Account Book, EV387, 1824; inscription on bridge)		 Eaton Hall Bridge, spandrel decorations, typical handrails and date inscription (the author)
D2 Laira, near Plymouth, Devon, TA 044882*	1827	Road bridge over tidal River Plym. Designed by JM Rendel. Five arches, total span 452ft (137.8m). Replaced 1962 (Rendel 1830 & 1836; Welch 1966; Perkins 1979)		 Laira Bridge, 1829 (SA MI 5519/2)

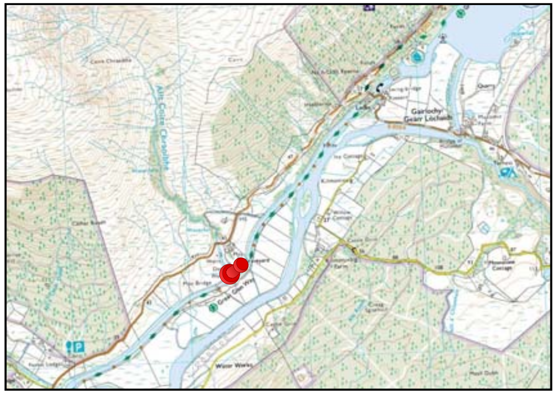
D3 Cleveland, Bath, Avon, SO 753657*	1827	Road bridge over River Avon. Designed by Henry Goodridge. 110ft (33.9m) span, 36ft (11.1m) width. Hazledine was contractor for the whole structure. Strengthened twice, but still in full use Cossons and Trinder 2002, p.86; SC 4.8.1826, 5.10.1827, Dodds et al 1995		 Cleveland Bridge, Bath, 1832 By Thomas Elliott (Victoria Art Gallery, Bath)

S. SUSPENSION BRIDGES

Site (map no)	Date	Summary and references	Location (site marked with pin)	Visual record
S1 Menai,* Gwynedd, SH 556714	1826	Road bridge over Menai Strait between mainland and Anglesey. Telford design. Span 176m (579 ft). Hazledine's works produced around 40,000 separate iron components over a four year period. Wrought iron chains replaced with steel 1938. Now carries local traffic. (Provis 1828; Paxton 1977, 1980; Day 2007)		 Menai Bridge, prior to 1840 (SA 901/1)
S2 Conwy,* Gwynedd, SH 785776	1826	Road bridge over mouth of River Conwy. Telford design. Built at same time as Menai. Span 100 m (328 ft). Original ironwork remains. Bridge now pedestrian only. Cared for by National Trust. (References as Menai)		 Conwy Suspension Bridge (walesdirectory.co.uk)

S3 Marlow, Bucks/ Berks,* SU 851860	1832	Road bridge over River Thames joining Marlow (Bucks) with Berks. Engineer was William Tierney Clarke, with whom Hazledine clashed about the design, with result that ironwork is similar to Menai and Conwy. Wrought iron chains replaced with steel in 1966. Three tonne traffic limit. (Smith 1991; Wadsworth and Waterhouse 1967; the author is not aware of a reliable comprehensive history or technical report)		 Marlow Bridge – 19th century print (YJL website)

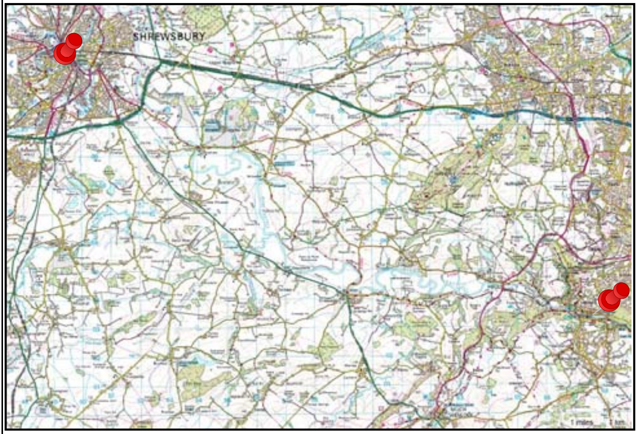
T. TURN (SWING) BRIDGES

Site (map no)	Date	Summary and references	Location (site marked with pin)	Visual record
T1 Moy,* Highland, NN 162826	1820	Only remaining example of a number of similar bridges across the Caledonian Canal designed by Telford. Still in use for pedestrians and farm traffic (Paxton and Shipway 2007, p.32)		Moy Bridge (Google Images)
T2 Princes and Georges Docks, Liverpool, grid reference not known	'1820s'	Not researched by the author. Hazledine bridges replaced in later 19th century. (Ritchie-Noakes 1984, p.164; Taylor et all 2009)		Plan of Princes Dock, 1847 (web.archives.org)

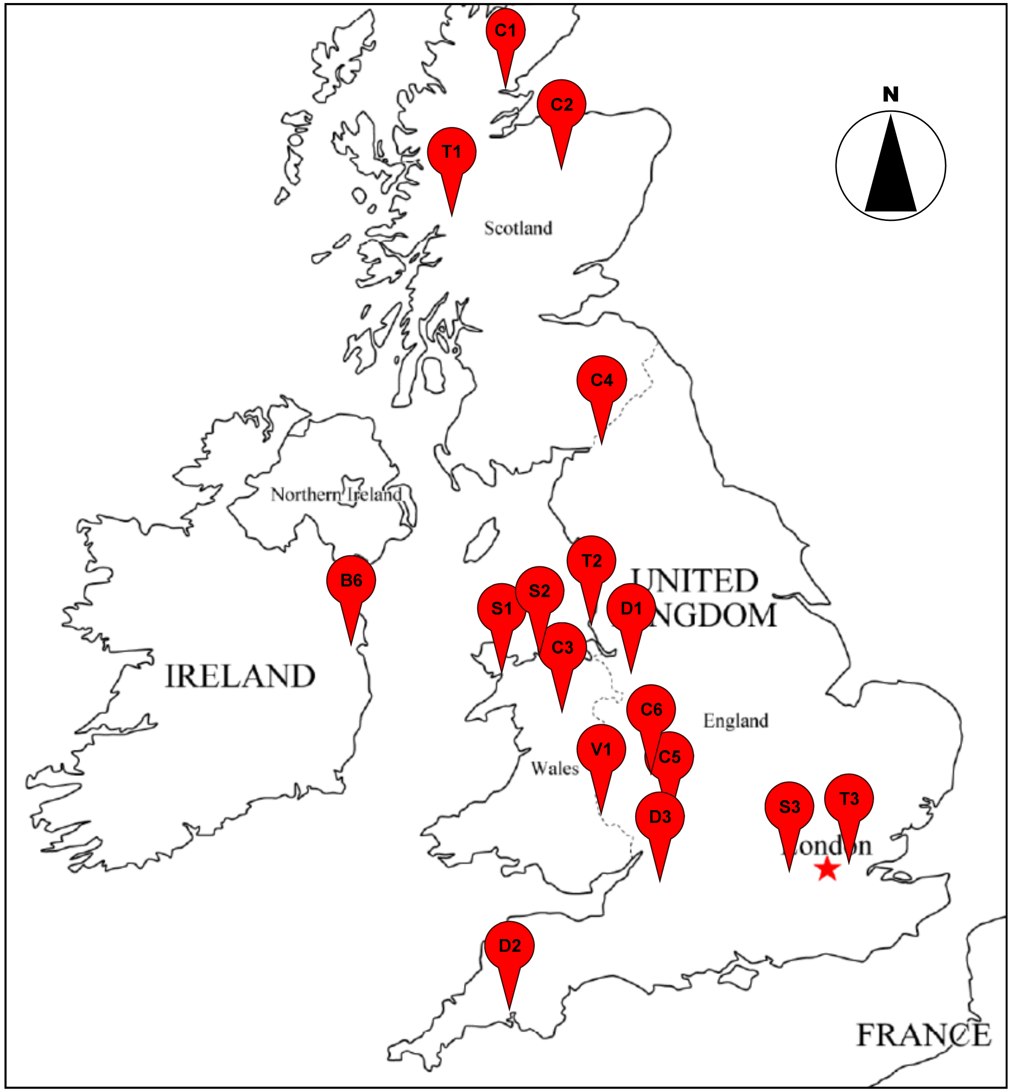
T3 Eastern Dock, London, Shadwell entrance, TQ 355805 (approx)	1831	Span of 46ft (14m), width of 16ft (4.9m). Later replaced by bascule bridge (Skempton 1981)		 Shadwell Basin, 2010 (entrance on left, with bascule bridge) (Wikimedia)

V. VARIOUS

Site (map no)	Date	Summary and references	Location (site marked with pin)	Visual record
V1 Kington Tramroad, Kington (Terminus, SO 314491)*	1820	Eight mile tramroad from Kington to Eardisley. Hazledine provided ironwork and probably also the bridges (Sinclair and Fenn 1995; Rattenbury and Cook 1996)		 Original iron bridge over the River Arrow (Rattenbury and Cook 1996)

V2 River Severn Towpath,* Coalbrook-dale to Shrewsbury	1809	Horse towing path along the south side of the Severn from Coalbrookdale to Shrewsbury. 6 ft (1.83m) wide. Hazledine was contractor for the whole, including bridges and gates. No bridges survive (SA 7112; SC 15.12.1809; Trinder 2005, p.64)		No known images

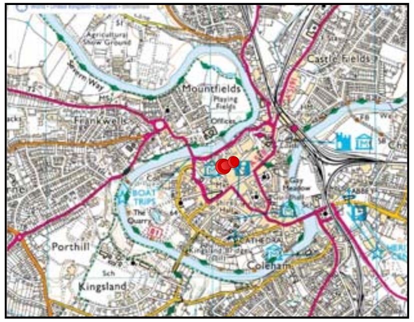
OUTLINE MAP OF LOCATION OF BRIDGES BUILT BY WILLIAM HAZLEDINE BEYOND SHROPSHIRE

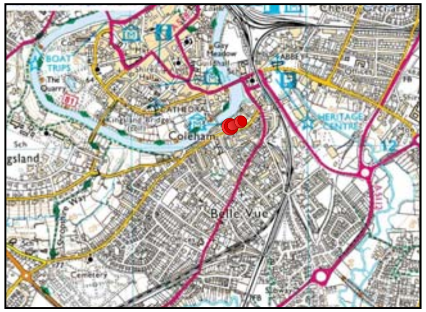
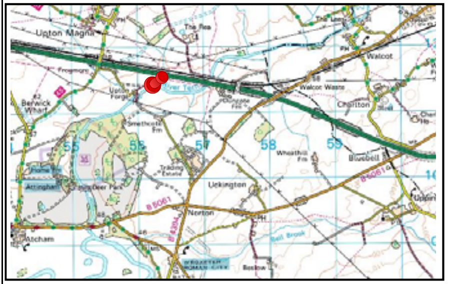


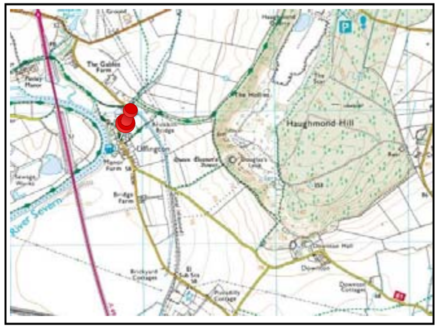
Key –
C1 – Bonar
C2 – Craigellachie
C3 – Waterloo (Bettws-y-Coed)
C4 – Esk
C5 – Mythe (Tewkesbury)
C6 – Holt Fleet (Ombersley)
D1 – Eaton Hall (Chester)
D2 – Laira (Plymouth)
D3 – Cleveland (Bath)
S1 – Menai suspension
S2 – Conwy suspension
S3 – Marlow suspension
T1 – Moy turn bridge
T2 – Liverpool docks
T3 – Shadwell basin, London docks
V1 – Kington Tramway
B6 – Ha'penny Bridge, Dublin

APPENDIX 5
GAZETTEER OF IRONWORKING SITES ASSOCIATED WITH WILLIAM HAZLEDINE

Sites marked with * discussed more fully in the text; 'date' is date of opening

Site (Map no)	Date	Summary and references	Location (site marked with pin)	Visual record
1.Cole Hall Foundry, Shrewsbury, approx SJ 490126*	?1787	Foundry set up in partnership with Robert Webster. Partnership folded c1792 once Hazledine wanted to expand the business. Foundry presumably closed then (SC 30.10.1840; Elliott 1979, pp. 6, 8, 129-130)		No known visual record
2. Pitchford Forge, Shropshire, SJ 533056*	1789	Hazledine sold old rye mill on the site 1786; took over as tenant of forge 1789. Rebuilt estate bridge to forge 1797; last known association with forge 1809. Presumably demolished after this. (SC 15.7.1786; NLW Pitchford Hall accounts - 1887, 2103, 2104; 139/6/13 (p.22); VCH Vol. X 1968, pp.116,121; SMRNO06849)		No known visual record

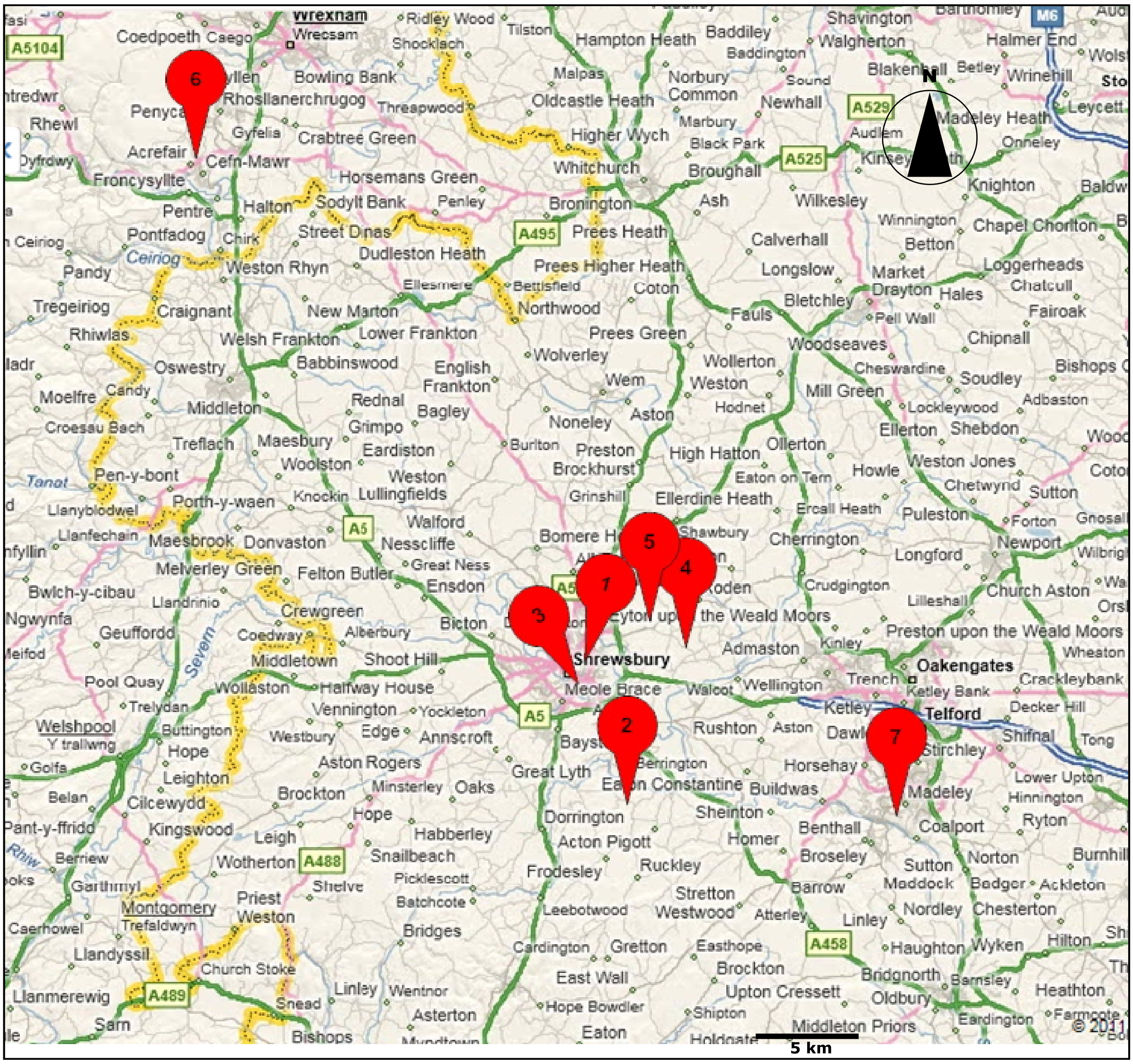
3. Coleham Foundry, Shrewsbury, SJ 495121*	1793	Hazledine built the foundry from scratch and developed it into one of the most important in the country, employing several hundred workers. After Hazledine's death in 1840 the foundry remained in operation until 1935 under various owners, when most was demolished except some offices beside the road (pictured) (Fully referenced in Chapter 5 & 6; SMRNO01495)		 Coleham Foundry 2009 – the only remaining part of the foundry is now incorporated into the shops (the author)
4. Upton Forge, Shropshire, SJ 559113*	1800	Hazledine made this his main forge site till his death in 1840. Fully discussed in Chapter 7. Forge workers still mentioned in 1841 census, so probably continued for a short time after 1840. (Detailed in the text; SMRNO01613; SA – 1841 census records)		 Upton Forge – former Forgemaster's house (the author)

5. Uffington slitting mill, Shropshire, SJ 528139	1800	This came with the lease for Upton. Hazledine used this until 1818, when he gave up the lease (SC 18.4.1794; SA D3651/D/9/6/1-8; SMRNO15624)		Uffington slitting mill 1777 (area marked 99.1/2) - SA 3182/1
6. Plas Kynaston Foundry, Clwyd, SJ 277427*	c1803	Hazledine leased mines at Plas Kynaston from c1796. Foundry built to supply ironwork for Pontcysyllte Aqueduct. All major bridges for Scotland, Wales and north of England cast there (refs in Chapter 9). Foundry contained 4 air furnaces and 1 cupola, steam-powered grinding mill, lathes etc. Lease on mines given up 1823; Hazledine still listed as proprietor of foundry 1835.[587] (SJ 21.9.1796; SA Bridgwater Papers 212/Box 366; E Smith 1932; Edwards 1965; Kelly's N. Wales directory 1835; www.plaskynastongroup.org/home/the-history-page)		Plas Kynaston Foundry 1936 (Shropshire Archives)

[587] The foundry was presumably sold after Hazledine's death, if not before. It was eventually bought by Mansanto in 1948, who demolished it (Quenby 1992, p.64)

7. Calcutts iron works (furnace, forge and foundry) Broseley, SJ 686030	1817 or 1818	Hazledine took over rundown works with two furnaces in blast. 1822 tons iron produced in 1823. Gotha Canal lock gates (1819) and Laira Bridge (1827) ironwork founded there. Hazledine still proprietor in 1832 according to trade directory, but Hulbert says he had premises 14 years (i.e. 1831). Demolished 1836 (VCH Vol. X, pp.275-6; IGMT 3542.3, TE8; Welch 1966; Hulbert 1837, p.343; Pigot's Shropshire Dictionary 1832; SMRNO03818)		 Calcutts from upstream 1788 By Wilson Lowry (IGMT, S Smith 1979, p.30)

LOCATION OF SITES ASSOCIATED WITH WILLIAM HAZLEDINE AND IRON WORKING



Key –

1. Cole Hall Foundry
2. Pitchford Forge
3. Coleham Foundry
4. Upton Forge
5. Uffington Slitting Mill
6. Plas Kynaston Foundry
7. Calcutts

APPENDIX 6

DIRECTORY OF PEOPLE ASSOCIATED WITH WILLIAM HAZLEDINE

Relationships are to William Hazledine (abbreviated to 'Hazledine') unless otherwise stated. Roman numerals after a name (e.g. John II) relate to the Hazledine family tree (Figure 3, p.14).

Austin, Elizabeth (née Hazledine, daughter) (1794 – 1823) - married James Austin 4.2.1819, and died in Jamaica. Her son William Hazledine Austin (1822-1898) lived with his grandparents at their home in Dogpole House after her death.[588]

Bage, Charles Woolley (1751 – 1822) – a wine merchant, surveyor, philanthropist, Mayor of Shrewsbury 1807, and instrumental in bringing gas lighting to Shrewsbury. But he is best remembered as the designer of the Flax Mill at Ditherington, Shrewsbury (and later mills in Castlefields and Kingsland, Shrewsbury).[589]

Brown, Captain Samuel (1776 – 1852) saw service in the Royal Navy during the Napoleonic wars, during which he promoted the use of chain cables to secure ships at anchor. After he retired from the Navy he went into business manufacturing chain cables, and then began to experiment with bar-chain suspension bridges. The first of suspension bridge built to his design was Union Bridge across the Tweed in 1820. The deck that he designed was neither heavy nor stiff enough to easily withstand oscillations, and a number of his bridges failed, most notably the one at Montrose (see Chapter 10). His design did, however, influence Telford, and hence Menai and Conwy Bridges.[590]

[588] SA St Julian's Shrewsbury, fiche P256/49; Hazledine's will, SA D55.5 v.f. (hereafter called 'will')
[589] Skempton and Chrimes 2002; Dictionary of National Biography (DNB); Gameson 1954
[590] Day 1985, p.154

Carline, John II (1761 – 1838) – Shrewsbury builder and sculptor who provided masonry work for Cound Bridge, and probably also sculpted John Simpson. He was a leading Freemason.[591]

Davidson, Matthew (1755-1819) – childhood friend of Thomas Telford, for whom he worked in overseeing first the building of first Montford Bridge, then the Ellesmere Canal, and finally the Caledonian Canal.[592]

Dodson, John (1767 – 1831) – surveyor, builder and 'gentleman', who acted as Steward at Attingham Hall. He probably built the bridge at Cound that was replaced in 1818. He was Hazledine's partner at Upton Forge from 1800 – 1819.[593]

Gollins, Jane (neé Hazledine, youngest sister) (1773 – 1854) – married Thomas Taylor in 1800 (no issue), then John Gollins in 1806; they had one son and five daughters.[594]

Hazledine, Eleanor (nee Brayne, wife) (1762 – 1826) – was from Tern Hill, Shropshire. Her mother's maiden name was Hazledine, so she was probably related to her husband. The couple were very close. Her death was said to have been precipitated by her husband's accident, when he severely broke his arm.[595]

Hazledine, John II (grandfather) (1694 – 1767) – the first of the family who was definitely a millwright. He was born in Waters Upton, but lived most of his married

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[591] JL Hobbs, 1960. Carlines – Architects, Builders and Sculptors, *Shropshire Magazine*, **March** 1960, p.17, and **April** 1960, p.15; Pattison 2004, p.17ff; SA 227/5; Freemasons' Minute Books
[592] Skempton and Chrimes 2002; Rolt 1979, 96ff; IGMT 1981.3588
[593] See chapter 8; www.discovershropshire.org.uk
[594] Information from descendents, including Gollins family Bible
[595] SA Drayton-in-Hales Parish Records, fiche no P97/142, P97/125, P97/82; SC 30.10.1840

life at Moreton Forge, where he was probably forge carpenter in addition to being a millwright.[596]

Hazledine, John III (uncle) (1729 – 1797) – was also a millwright, to whom Hazledine was apprenticed. A man of high professional and moral reputation.[597]

Hazledine, John IV (brother) (1760 – 1810) – after millwrighting apprenticeship to his father, he became 'an eminent engineer and ironmaster.'[598] Around 1795 he established an iron foundry in Bridgnorth in partnership with his brother Robert and brother-in-law Thomas Davies (later joined by John Urpeth Rastrick).[599] This soon became a significant concern, and is best remembered for building a number of Richard Trevithick's early locomotives.[600] John Hazledine took out a patent for cold rolling of iron in 1798, a significant improvement at the time.[601] The foundry was also at the forefront of developing portable and other threshing machines,[602] and John Hazledine took out a patent on a new type of plough.[603] There is no documentary evidence that he collaborated professionally with his brother.

Hazledine, John V (son) (1793 – 1870). When he became a burgess of Shrewsbury in 1826 he is described as an 'ironfounder', but by 1832 he was described as a 'gentleman', so around 1830 he presumably ceased to be part of the iron business.[604] Married his cousin Rhoda Brayne in 1827,[605] and they lived in Moreton

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596 See chapter 3 for references
597 *Shrewsbury Chronicle* (SC) 30.10.1840 & 6.11.1840
598 *Monthly Magazine or British Register,* December 1st 1810, p.476
599 www.discovershropshire.org.uk; Tonkin 1947
600 Trevithick 1872, pp.366-7; Gwilt 1998
601 Patent no. 2244, copy at SA C20; Roberts 1978, pp.5-6
602 *Gentleman's Magazine*, 1810, p.659
603 Patent no. 3422, copy at SA C20
604 Shrewsbury Burgess Roll, SA 3365/67B, entries B393 and B412
605 *Monthly Magazine*, October 1827, p.444

Villa, Coleham, until 1864, when they built an even larger house, the Woodlands, opposite Lord Hill's Column, Abbey Foregate.[606] Elected onto the Town Council in 1835, he became a magistrate and then Mayor in 1854-55.[607] After his father's death he inherited much of his father's property, and the coal business, which he ran till his death.[608]

Hazledine, Robert (younger brother) (1768 – 1837) – joined his oldest brother (John IV) in partnership at the Bridgnorth foundry. After his brother died and Rastrick left, the foundry rapidly declined in importance and was declared bankrupt in 1820.[609]

Hazledine, Thomas (youngest brother) (1771 – 1842) – was also based in Bridgnorth, and worked at one time in the foundry. Nothing else is known about him.[610]

Hazledine, William IV (father) (1734 – 1818) – is fully described in chapter 3.

Hughes, Mary (nee Hazledine, oldest daughter) (1790 – 1867) – married John Hughes ('gentleman') 1828. After her father's death she inherited Dogpole House and also other property.[611]

Jenkinson, Charles Cecil Cope (1784 – 1851) – half brother of Prime Minister Lord Liverpool, who inherited Pitchford Hall in 1807, and so became Hazledine's landlord. The two evidently became close, and Jenkinson (who became Lord

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[606] Trinder 2006, pp. 79-81, 68-69
[607] SC 1.1.1836; www.shrewsburytowncouncil.gov.org
[608] Will; IGMT Lilleshall Company 1998.329 (DLIL/3) 744
[609] Tonkin 1947; *London Magazine* April 11th 1820, p.718
[610] Tonkin 1947
[611] St Mary's Shrewsbury parish register 6.4.1828; Shrewsbury Burgess Roll SA 3365/67B, B412; Will

Liverpool on the death of his brother in 1828) introduced Hazledine to Princess Victoria and her mother.[612]

Provis, William (1792 – 1870) – one of Telford's earliest pupils, who is best known as the engineer who supervised the building of the Menai Bridge, and its later strengthening. He married Harriot [sic], the daughter of Thomas Stanton (q.v.).[613]

Simpson, John (1755 – 1815) – mason and builder, who arrived in Shrewsbury in 1790 from Erlestoke in Wiltshire (where he had overseen the rebuilding of Erlestoke Manor, designed by George Steuart) to superintend the building of St Chad's church.[614] He became very friendly with both Hazledine and Telford, working closely with both on many projects.[615] He was also a builder on his own account, for example erecting at least part of the Ditherington Flax Mill.[616] He named Ann's Hill (St Michael's St, Shrewsbury) and Jane's Place (Coton Hill, Shrewsbury) after his two daughters.[617] Telford (who was his executor) commissioned the bust of Simpson in St Chad's church.[618]

Stanton, Thomas (1782-1846) – was appointed by Telford to manage the finances of the Ellesmere Canal Company in 1798, and eventually rose to be the Agent (General Manager). For many years he acted as deputy County Surveyor for Shropshire in Telford's absence, supervising the repair and rebuilding of many stone

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612 Gash 1984, pp.33, 102-3; SC 30.10.1840

613 Provis 1828; Provis 1841; Skempton and Chrimes 2002

614 SA 1084/67; Simpson married Jane Perret at Erlestoke on 3.7.1788 (www.familysearch.org, accessed 31.10.2011). Details of Erlestoke Manor from: 'Parishes: Erlestoke', A History of the County of Wiltshire: Volume 7 (1953), pp. 82-86.
URL: http://www.british-history.ac.uk/report.aspx?compid=115462, accessed: 31 October 2011.

615 Pattison 2007

616 Trinder 1992

617 SC, Shropshire Notes and Queries 18.10.1901

618 Watton's Cuttings, Vol.3, p.398, SA 8184

bridges.[619] His brother John was a contractor and a partner of Hazledine's in their transport, coal, lime and other interests at Wrenbury, Cheshire.[620]

Stuttle, William (d. 23.2.1827) – was 'upwards of 25 years principal manager for Mr Hazledine of this town [Shrewsbury]; he superintended [the construction of] the great aqueduct at Pontcysyllte on the Ellesmere Canal, and many cast iron bridges in England, Scotland and Wales. A more faithful and upright man never lived.'[621]

Stuttle, William, junior (1800 – 1862) – was responsible for the ironwork of the Eaton Hall Bridge (1824), and the erection of Laira Bridge after his father's death in 1827. He took over as manager of Coleham Foundry after Hazledine's death in 1840 when the family failed to sell it, and seems to have run it until his death.[622]

Telford, Thomas (1757 – 1834) – moved to Shrewsbury in 1786, and soon after became close friends with Hazledine. The two collaborated on many projects, as detailed in the text.[623]

Taylor, Mary (younger sister) (1766 – 1837) – married William Taylor in 1794, and spent most of her life at High Hatton between Shawbury and Market Drayton.[624]

Watson, Ann (née Hazledine, daughter) (1797 – 1880) – married John William Watson, solicitor of Wellington, in 1820. Like her sister, she inherited much property.[625]

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[619] Skempton and Chrimes 2002; Blackwall 1985;
[620] Will
[621] SC 2.3.1827
[622] www.familysearch.org (birth); SA will no 148, 1862; www.engineering-timelines.com; Perkins 1979; Slater's Directory of Shropshire 1844; Bagshaw's Directory of Shropshire 1851
[623] Pattison 2007; Rolt 1979; Burton 1998
[624] Shawbury Parish Register; in the will of John Hazledine of Bridgnorth he leaves money to 'my sister Mary Taylor of High Hatton' (Public Record Office 11/1525)
[625] *New Monthly Magazine and Universal Register,* December 1820, p.709; Shrewsbury Burgess Roll, SA 3365/67B, 4.9.1832

Webster, Robert (1755 – 1832) – clockmaker and inventor who went into partnership with Hazledine at Cole Hall, Shrewsbury around 1786. This partnership soon folded. Webster finished his life as a brush maker.[626]

[626] Elliott 1979, pp.6, 129-130; SC 30.10.1840

BIBLIOGRAPHY

Primary Archival Sources

Private Collections

William Hazledine senior's notebooks – loaned by Hazledine family

Minute Books of Freemasons' Salopian Lodge 525, by courtesy of the Secretary

Newspapers

Aris's Birmingham Gazette (Birmingham City Archives)

Bucks Herald (Centre for Buckinghamshire Studies)

Gentleman's Magazine (http://www.archive.org/stream/gentlemansmagaz/)

Monthly Magazine (*www.archive.org/.../monthlymagazineo60lond/)*

New Monthly Magazine and Universal Register

(www.archive.org/.../newmonthlymagaz53unkngoog/)

St James Chronicle (*www.worldvitalrecords.com/indexinfo.aspx?)*

Salopian Journal (Shropshire Archives)

Shrewsbury Chronicle (Shropshire Archives)

Public Archives

Birmingham City Archives

Boulton and Watt Archive

MS 3219/6/161 & MII/5/10 (list of forges)

General correspondence – 'H' (Hallen) MS 3147/3/43/7&8; 'H' (Hazledine) MS 3147/3/392/38 (microfilm reel 243); 'R' (Ryder) MS 3147/3/380/73-75 (microfilm reel 240)

Patent specification, no 4333

Centre for Buckinghamshire Studies

Marlow Bridge file, CBS Q/AB/43/

Marlow Bridge dissertation, CBS L486:62

Chester and Cheshire Archives

Eaton Estate records, EV387, 1824

Gloucestershire Archives

Mushet correspondence, D2646/62 & 97

Herefordshire Record Office

Knight family collection, T74 431/2

National Library of Wales, Aberystwyth

Tour Journal of Sir Richard Colt Hoare, Vol. 1, 1801, Cardiff Library deeds 3.127

Cwrt Mawr file 823D, Iron Forge letter book (Ffatri forge)

Glansevern Estate records (3), miscellaneous letters 1847 (Plas Kynaston)

Pitchford Hall files, Accounts – 1887, 2103, 2104; Vol. 1, 139/6/13 (Estate plan)

Powys Castle deeds (5) 7635, May 22nd 1810 (limeworks)

Upton Forge, Cilybebyll 2, no. 202

Powys County Archives, Llandrindod Wells

Garth Estate records, M/D/GA/1/1 (June 3rd, July 11th 1829; May 12th, June 3rd & 9th 1830)

Public Record Office

John Hazledine's will, PRO 11/525, 1810

Shropshire Archives

Apley Castle collection, SA 625/Box 15

Attingham Collection, SA 112/5/17/1; SA 112/11/box15/65; SA 112/12/Box 23/125; SA 112/5/10/3-4, 7-8; SA 112/14/70/75

Bridgwater papers, SA 212/Box 366

Census Return, 1841

Charles Bage correspondence, 6001/2657/2

Corbet of Adderley, SA 327/2/4/2/78 (Market Drayton wharf)

Corbet of Longnor, SA 367/Box 31.29 (Longnor Mill)

Corbet of Moreton Corbet, SA 322/6/2; 322/6/4; 322/6/6 (transcription SA qC44.2); 322/6/9; 322/9/12; Estate Map SA 2609/2; SA 6000/18287

Corbet of Sundorne, SA 6000/3100, 3230, 5894, 5912, 5920, 18209, 18223-39, 18289; SA 3182/1 (Estate Map 1777)

Fitz Mill, SA 552/11/3739/1

Harward and Evers collection, SA 1396/3; 1496/424 & 425

Hunt of Boreatton, SA6001/16915 (Platt Mill)

Jonathan Scoltock's bricklaying book, SA Q/M/2

Lilleshall Estate, SA 972/fiche 2311 & 5735, 972/3/18/224

Lloyd of Leaton Knolls collection, 103/3/77 (Charles Bage)

Morris, Joseph, *Genealogical Manuscripts connected with the County of Salop*, Vol. 8 p.4010, SA microfilm 153

Parish records

a. Baptisms, marriages, burials –

Drayton-in-Hales, SA P97/A

High Ercall, SA P129/A (transcript SA S9/746)

Pitchford, SA P219/A (transcript SA S9/297)

Rodington, SA P230A

Shawbury, SA P241/A

Shrewsbury,

St Chad's, SA P253/A (transcript SA S9/230H)

St Julian's, SA P256/A (handwritten transcripts 5b, otherwise unclassified)

Swan Hill Independent Chapel

a. Baptism/burial transcripts, C55 3834
b. Transcripts of grave plots from Public Record Office, nonconformist registers Vol. 3, 4613/39

Upton Magna, SA P289/A

Waters Upton, SA P290/A (transcript SA S9/746)

b. Poor law records –

Shawbury, SA P241/L

c. Trustees' minute books –

Shrewsbury, St Chad's, SA 1048/63, 67, 68

d. Churchwarden's accounts

Baschurch, SA P22/B/3/4, 5

Patent documentation, SA 6000/18119 (William Hazledine); SA C20 (John Hazledine)

Phillips, W, *Shropshire Men,* Vol. 5, pp.268, SA Microfilm 167

Photograph file, SA PH/S/30/8 (Stokesay Bridge)

Powys Castle archive, SA 552/12/386

Quarter sessions reports, SA DP108 (Meole Brace Bridge), DP33 (Cantlop Bridge)

Queenbatch Mill, SA 837/94

Richard Watson bankruptcy, SA 6000/3362

Salt and Co, Solicitors, SA D3651/D/5/28 (Moreton Forge); SA 3651/B/9/5/6/16, 3651/D/14/120 (Manor of Deytheur); SA D3651/D/5/214, D3651/D/14/113 D3651/D/5/228 & 246, SA D3651/D/5/237 (Coleham); SA D3651/D/5/486 (timber); SA D3651/D/31/85 (Plas Kynaston); SA D3651/D/9/6/1-8 (Upton Forge); D3651/D/13/17 (Dodson); D3651/D/31/57 (Longnor Forge); SA D3651/D/5/562 (Bonar Bridge);

Shackerley Estate, SA 1781/2/208-9, 212, 220

Shrewsbury Burgess Roll, SA 3365/67B

Shrewsbury House of Industry, SA PL2/2/1/1-2; SA PL2/3/6/1 (also Uffington windmill)

Shropshire Hearth Tax record 1672 (transcript), SA C63

Shrewsbury Towpath Trust, SA 7112

Sir Thomas Jones Mansion documents, SA 311/10-14, 39, 40, 41

Sprott, Stokes and Turnbull collection, 1709/16/box 226 (Simpson)

Stobbs Collection, SA 163/63 (Moreton Forge); SA 227/4, 5 (Cound Bridge)

Swan Hill House file, SA 4457/9

Wace, Morgan and Salt, SA 4762/3/6-7 (Coleham Brewery)

Watton's Cuttings, Vol. 3, SA 8184

Will of William Stuttle, Junior, 1862, 148

William Hazledine file, SA 901/1

William Hazledine's will, SA D55.5 v.f. (copy)

Staffordshire Record Office

Lilleshall Estate – D593/L/4/6,7 (Long Mill); D593/L/1/19/3 (The Toft)

Harward and Evers - D695/1/12/36 (ironworks); D695/3/49 (Richard Watson)

The National Archives, Kew

Birmingham and Liverpool Junction Canal, RAIL 808/1&4

Ellesmere Canal, RAIL 827/1-7

Montgomeryshire Canal, RAIL 852/5, 11

Shrewsbury Canal, RAIL 868/1

Tyne and Wear Archives

Fryer Family of Newcastle, DX 717/1

William Salt Library, Stafford

Cound corn mill, 350/40/3

Other Archives

Institution of Civil Engineers (ICE)

Telford, T., 1798. *On Mills - a report for the Board of Agriculture*

Thomas Telford correspondence, T/EG 96, 125 (Dublin custom house); T/EG 306, 310 (Edinburgh and Glasgow Union Canal)

Ironbridge Gorge Museum Library and Archives (IGMT)

Lilleshall Company Collection 1998.320 (DLIL/3/236 & 247) (coal)

Thomas Telford correspondence (copies), IGMT 1981.3587, 3588 (Matthew Davidson file); 1982.471.19 (Gotha Canal)

Printed Primary Sources

Andreae, C., 1990. *Historical and Structural History of Sheinwood Mill, Shropshire.* Unpbl MSc dissertation, Ironbridge Institute.

Baxter, Alan and Associates, 2006. *Ditherington Flax Mill, Shrewsbury, Structural Engineering Appraisal - Main Report.* Unpubl Archive Report for English Heritage.

Clark, C. and M. Horton, 1989. Duncote Farm Atcham - An Archaeological Evaluation in advance of the A5 bypass. *Ironbridge Institute Research Paper* **41**.

Clark, K., 1990. Duncote Farm Atcham - Site Narrative. *Ironbridge Institute Research Paper* **52**.

Davies, D., 1964. *Plas Kynaston*. Wrexham Local Studies Library.

Frost, P., 2003. Moreton Mill - Archaeological Building Assessment. *Shropshire Historic Environment Record.*

Glover, G., 2007. Thomas Telford and the Iron Bridges of Shropshire. *Thomas Telford in Shropshire* (CD produced by Shropshire Archives).

Hayman, R., 2003. *The Shropshire Wrought-Iron Industry c1600-1900. A Study of Technological Change.* University of Birmingham, PhD.

Hill, T. C., 2003. *The Charcoal-fired Iron Industry in Shropshire from the 16th to the early 18th Centuries*. Shropshire Archives qC 24.1.

Judd, E. H., 1953. *Catalogue of old water mill sites in Shropshire*. Shropshire Archives 3756/147.

King, P., 2003. *The Iron Trade in England and Wales 1500-1815 : the charcoal iron industry and its transition to coke*. University of Wolverhampton, PhD.

Lea, E., 2005. *Shawbury - the village and its people*. Private publication.

MacLeod, M., B. Trinder, M. Worthington, 1988. *Ditherington Flax Mill, Shrewsbury*. The Ironbridge Institute.

Morriss, R. K., 1997. *Hawkstone Park Windmill, an Archaeological Analysis and Survey*. Mercian Heritage Series. 29.

Reed, A. and C. Bennett, 2005. *Waters Upton - a look into the past*. Private publication

Shropshire Directories
Pigot's, 1832
Slater's, 1844
Bagshaw's, 1851

Tavener, N., 2001. *Land between Roman Road and Porthill Road, Shrewsbury*. Marches Archaeology.

Secondary Sources

Angerstein, R. R., 2001. *Illustrated Travel Diary 1753-55*. Science Museum.

Anon., 1853. Obituary of William Tierney Clark, 1783-1852. *Minutes of Proceedings of the Institution of Civil Engineers* **12**: 153-157.

Anon., 1955. William Hazledine, Shrewsbury Ironmaster. *Shropshire Magazine* September: 13-16.

Aplin, H., 1984. *Norfolk Corn and other Industrial Windmills*. Norfolk Windmills Trust.

Awty, B. G., 1981. The Continental Origins of Wealden Ironworkers, 1451-1544. *The Economic History Review* **34** (Nov): 524-539.

Ball, S., 1980. *The Montgomery Canal - Its History and Restoration*. Shropshire Union Canal Society Ltd.

Barker, J., 1919. Kingsland and the Shrewsbury Show. *Trans Shropshire Archaeol Soc, 4th Series* **VII**: 173-188.

Barnes, M., 2007. Thomas Telford, project manager. *Civil Engineering* **160(5)**: 61-64.

Barton, P., 2007. William Hazledine, miller, millwright, ironfounder and entrepreneur. *Melin - Journal of the Welsh Mills Society* **23**: 31-49.

Baugh, G.C. (Ed), 1998. *Victoria County History of Shropshire, Vol. X: Wenlock, Upper Corvedale and the Stretton Hills.* Oxford University Press

Blackwall, A., 1985. *Historic Bridges of Shropshire*. Shropshire Libraries and Highways & Transport Department, Shropshire County Council.

Booth, D.T.N., 2011. *Watermills on the River Rea in South Shropshire.* Birmingham, Midland Wind and Water Mills Group.

Boucher, C., 1963. Broadstone Mill, Corvedale. *Trans Newcomen Soc* **36**: 159-164.

Bracher, T. and R. Emmett, 2000. *Shropshire in the Civil War*. Shropshire Books.

Braid, D., 1991. Wilkinson and New Willey Ironworks, Broseley. *Wilkinson Studies* **1**: 3-20.

Brown, P., 2007. Thomas Telford and the Ellesmere Canal, 1793-1813. *Journal of the Railway and Canal Historical Society* **(July)**: 611-617.

Brown, R. and J. Hunt, 1994. *Marlow, a Pictorial History*. Phillimore.

Burne, E. L., J. Russell, and Rex Wailes, 1943. Windmill Sails. *Trans Newcomen Soc* **24**: 147-161.

Burton, A., 1998. *Thomas Telford*. London, Aurum.

Burton, A., 2007. Thomas Telford and the Gota Canal. *Journal of the Railway and Canal Historical Society* **(March)**: 544-547.

Castleden, R., 1994. *British History - a Chronological Dictionary of Dates*. London, Parragon.

Chaplin, R., 1961. Tern Forge. *Shropshire Newsletter* **14:** Unpaginated.

Chaplin, R., 1969. A Forgotten Industrial Valley. *Shropshire Newsletter* **36**: 1-6.

Cossons, N. and B. Trinder, 2002. *The Iron Bridge*. Phillimore.

Coulton, B., 1989. Tern Hall and the Hill Family, 1700-75. *Trans Shrops Archaeol Soc* **LXVI**: 97-105.

Cox, R., 2009. Telford in Ireland: work, opinions and influence. *Engineering History and Heritage* **162(1)**: 51-60.

Cragg, R., 2010. *Civil Engineering Heritage West Midlands*. Phillimore

Daintith, J (Ed.), 2005. Oxford Dictionary of Science. Oxford.

Day, J. and R. Tylecote, 1991. *The Industrial Revolution in Metals*. London, The Institute of Metals.

Day, T., 1985. Samuel Brown in North-East Scotland. *Industrial Archaeology Review* **7(2)**: 154-170.

Day, T., 1998. The 19th Century Iron Bridges of North East Scotland. *Industrial Archaeology* **24(2)**: 23-25.

Day, W., 2007. Telford's Menai and Conwy suspension bridges, Wales. *Proceedings of the Institution of Civil Engineering* **160(5)**: 26-30.

De Courcy, J. W., 1991. The Ha'penny Bridge in Dublin. *The Structural Engineer* **69(3)**: 44-47.

De Haan, D., 2004. The Iron Bridge - New Research in the Ironbridge Gorge. *Industrial Archaeology Review* **XXVI(1)**: 3-19.

De Saulles, M., 1986. *The Book of Shrewsbury*. Barracuda.

Denton, J. and M. Lewis, 1977. The River Tern Navigation. *Journal of the Railway and Canal Historical Society* **(July)**: 56-64.

Derry, J. W., 1963. *Reaction and Reform, 1793 - 1868, England in the Early Nineteenth Century*. London, Blandford Press.

Dictionary of National Biography, 2004. Oxford.

Dodds, N., L. Locke, and R. Welsford, 1995. Recent strengthening work on Cleveland Bridge, Bath. *The Structural Engineer* **73(5)**: 69-75.

Ede, J. F., 1962. *The History of Wednesbury*. Wednesbury Corporation.

Edwards, I., 1965. Iron Production in North Wales - the Canal Era, 1795 - 1850. *Transactions of the Denbighshire Historical Society* **14**: 141-84

Elliott, D. J., 1979. *Shropshire Clock and Watchmakers*. Phillimore.

Evans, C., 1998. A Skilled Workforce during the Transition to Industrial Society: Forgemen in the British Iron Trade, 1500-1850. *Labour History Review* **63**: 143-159.

Evans, C., 1999. Work and Workloads during Industrialization: The Experience of Forgemen in the British Iron Industry 1750-1850. *International Review of Social History* **44**: 197-215.

Eyton, R., 1858. *Antiquities of Shropshire, Vol. I* . John Russell Smith.

Eyton, R., 1859. *Antiquities of Shropshire, Vol. II*. John Russell Smith.

Farries, K. G., 1981. *Essex Mills, Millers and Millwrights*. Skilton.

Gale, W., 1979. *The Black Country Iron Industry*. London, The Metals Society.

Gameson, F. R., 1954. The Story of Charles Bage. *Shropshire Magazine* **January**: 27-28.

Gash, N., 1984. *Lord Liverpool*. London, Wiedenfeld and Nicolson.

Gaydon, A. T. (Ed), 1968. *Victoria County History of Shropshire, Vol VIII: Condover and Ford Hundreds*. Oxford University Press.

Gerhold, D., 2009. Hallens, Iron Platers and Frying Pan Makers. *International Journal of the History of Engineering and Technology* **79(1)**: 34-58.

Gibb, A., 1935. *The Story of Telford*. London, Alexander Maclehose & Co.

Green, H., 1981. The Linen Industry of Shropshire. *Industrial Archaeology Review* **5(2)**: 114-125.

Gregory, R., 2005. *The Industrial Windmill in Britain*. Phillimore.

Grounds, D., 2009. *Son and Servant of Shropshire, the Life of Archdeacon Joseph (Plymley) Corbett*. Logaston.

Gwilt, C., 1998. *A Detailed History of Bridgnorth Foundry*. Bridgnorth Publications and Design.

Hadfield, C., 1960. *The Canals of South Wales and the Border*. Phoenix House.

Hadfield, C., 1969. *The Canals of the West Midlands*. David and Charles.

Hadfield, C., 1969. Telford, Jessop and Pontcysyllte. *Journal of the Railway and Canal Historical Society* **15(4)**: 69-74.

Hadfield, C., 1993. *Thomas Telford's Temptation*. Cleobury Mortimer, M&M Baldwin.

Hailstone, C., 1987. *Hammersmith Bridge*. Barnes and Mortlake History Society/Fulham and Hammersmith Historical Society.

Hall, J., 1925. Joshua Field's Diary of a Tour in 1821 through the Midlands, with Introduction and Notes. *Trans Newcomen Soc* **6:** 1-41.

Hayman, R., 2005. *Ironmaking - the history and archaeology of the iron industry*. Tempus.

Hayman, R., 2008. Charcoal ironmaking in nineteenth-century Shropshire. *Economic History Review* **61(1)**: 80-98.

Hill, M. C., 1959. Iron and Steel Bridges in Shropshire. *Trans Shrops Archaeol Soc* **LVI**: 106.

Hilton, B., 2006. *A Mad, Bad and Dangerous People? England 1783 – 1846*. Oxford University Press.

Howell, T., 1826. *Shrewsbury to Holyhead*. Shrewsbury, T Howell.

Hughes, S., 1988. *The Archaeology of the Montgomeryshire Canal*. RCAHMW.

Hulbert, C., 1837. *The History and Description of the County of Salop*. Shrewsbury, Charles Hulbert.

Hulbert, C., 1839. *Manual of Shropshire Biography*. Shrewsbury, Charles Hulbert.

Hunt, R., 1806. *Oration Delivered at Pontcysylte [sic] Aqueduct, 26.11.1805*. Shrewsbury, J & W Eddowes.

Hyde, C. K., 1973. The Iron Industry of the West Midlands in 1754: Observations from the Travel Account of Charles Wood. *West Midlands Studies* **6**: 39-40.

Ince, L., 1991. *The Knight Family and the British Iron Industry*. Merton, Fame Productions.

James, J., 1987. Some steps in the evolution of early iron arched bridge designs. *Trans Newcomen Soc* **88**: 153-187.

Job, B., 1985. *Staffordshire Windmills*. Birmingham, Midland Wind and Water Mills Group.

Johnson, H. and A. Skempton, 1955. William Strutt's Cotton Mills, 1793-1812. *Trans Newcomen Soc* **30**: 179-205.

Jones, W., 2006. *Dictionary of Industrial Archaeology*. Sutton.

Kain, R., J. Chapman, and R. Oliver, 2004. *The Enclosure Maps of England and Wales, 1595-1918.* Cambridge University Press.

King-Hele, D., 1999. *Erasmus Darwin*. DLM Press.

Larke, W., 1949. The Steel Age - a short historical survey. *Monthly Statistical Bulletin* **24(2)**, unpaginated.

Laurie, I. C., 1985. Landscape Gardeners at Eaton Park, Chester: II. *Garden History* **13(2)**: 126-155.

Lead, P., 1975. William Hazledine's Windmill, the Toft, Trentham. *Journal of the Staffordshire Industrial Archaeology Society* **6**: 17-22.

Lloyd, L., 1937-38. Paper-making in Shropshire, 1656-1912. *Trans Shrops Archaeol Soc* **XLIX**: 121-187.

Lloyd, L., 1949-50. Paper-Making in Shropshire, Supplementary Notes. *Trans Shrops Archaeol Soc* **LIII**: 153-163.

Lowson, W. W., 1967a. The reconstruction of the Craigellachie Bridge. *The Structural Engineer* **45**: 23-29.

Lowson, W. W., 1967b. The Reconstruction of the Craigellachie Bridge (Discussion). *The Structural Engineer* **45**: 287-289.

Mackenzie, W., 1838. Account of the Bridge over the Severn, near the town of Tewkesbury, in the County of Gloucester, designed by Thomas Telford, and erected under his superintendence (including plates). *Transactions of the Institution of Civil Engineers* **2 (1838)**: 1-14.

Maunsell, G, 1946. Menai Bridge Reconstruction (includes plates and appendix). *Journal of the Institution of Civil Engineers* **25(3)**: 165-193.

Mawson, B., 2009. Learning from bridge failure - in 1838. *Bridge Engineering* **162(2)**: 95-99.

McCombe, C., 1981. *The Development of the Cupola*. Foundry Trade Journal.

Minshull, T., 1803. *The Shrewsbury Visitor's Pocket Companion and Salopian Guide*.

Morriss, R. K., 1991. *Canals of Shropshire*. Shropshire Books.

Mushet, D., 1840. *Papers on Iron and Steel*. London, John Weale.

Norton, P. and M. Hill, 1970. *New Saint Chad's and its Architect*. Shrewsbury, St Chad's Church.

Osborn, F. M., 1952. *The Story of the Mushets*. London, Thomas Nelson.

Owen, H. and J. Blakeway, 1825. *A History of Shrewsbury*. London, Harding, Lepard and Co.

Page, R., 1979. Richard and Edward Knight: Ironmasters of Bringewood and Wolverley. *Transactions of the Woolhope Naturalists' Field Club* **XLIII (1)**: 7-17.

Pasley, C., 1840. Description of the state of the suspension bridge at Montrose, after it had been rendered impassable by the hurricane of 11th of October 1838; with remarks on the construction of that and other suspension bridges, in reference to the action of violent gales of wind (including plate). *Transactions of the Institution of Civil Engineers* **3(1840)**: 219-227.

Pattison, A., 2004. *On Severn Shore - the story of the Drill Hall, Coleham, Shrewsbury*. Barnabas Community Church.

Pattison, A., 2007. Thomas Telford's Shrewsbury Team: Thomas Telford, William Hazledine and John Simpson. *Journal of the Railway and Canal Historical Society* **199**: 664.

Paxton, R., 1977. Menai Bridge (1818-1826) and its influence on Suspension Bridge Development. *Trans Newcomen Soc* **49**: 87-110.

Paxton, R. A. 1980. *Menai Bridge 1818-26 - Evolution of Design, in Thomas Telford, Engineer, ed. A. Penfold* : *84-116*. London, Thomas Telford Ltd.

Paxton, R. A., 2007. Thomas Telford's cast-iron bridges. *Civil Engineering* **160 (May)**: 12-19.

Paxton, R. and J. Shipway, 2007. *Civil Engineering Heritage: Scotland Highlands and Islands*. London, Thomas Telford.

Perkins, K., 1979. William Hazledine - Ironfounder of Shrewsbury. *Rendel's News* **(Jan/Feb)**: 10-14.

Phillips, J. A. and C. Wetherell, 1991. The Great Reform Bill of 1832 and the Rise of Partisanship. *The Journal of Modern History* **63**: 621-646.

Pidgeon, H., 1851. *Memorials of Shrewsbury*. JH Leake.

Provis, W., 1828. *An Historical and Descriptive Account of the Suspension Bridge Constructed over the Menai Straits in North Wales*. Alexander Maclehose, London.

Provis, W., 1841. Observations of the effect of wind on the suspension bridge over the Menai Strait, more especially with reference to the injuries which its roadways sustained during the storm of January 1839. *Transactions of the Institution of Civil Engineers* **3(5)**: 74 - 77.

Quatermain, J., B. Trinder, and R. Turner, 2003. *Thomas Telford's Holyhead Road: the A5 in North Wales.* Council for British Archaeology.

Quenby, R., 1992. *Thomas Telford's Aqueducts on the Shropshire Union Canal*. Shrewsbury, Swan Hill Press.

Randall, J., 1879. *Broseley and its surroundings*. Salopian and West Midland Journal.

Rattenbury, G. and R. Cook, 1996. *The Hay and Kington Railways*. Railway and Canal Historical Society.

Raven, M., 2005. *A Guide to Shropshire*. Market Drayton, Michael Raven.

Rayner, M. (Ed), 2006. *Sheinton Shropshire, Geology, Landscape, History and Archaeology*. Sheinton Heritage Project.

Rendel, J., 1830. The Iron Bridge at Plymouth. *Trans. Plymouth Atheneum* **1**.

Rendel, J., 1836. Particulars on the Construction of Lary Bridge, Near Plymouth (including plate). *Transactions of the Institution of Civil Engineers* **1(1836)**: 99-108.

Rendel, J., 1841. Memoir of the Montrose Suspension Bridge. *Transactions of the Institution of Civil Engineers* **3(1841)**: 122-127.

Riley, G., 1991. *The Water Mills of the Borough of Newcastle*. University of Keele/ Borough of Newcastle under Lyme.

Ritchie-Noakes, N., 1984. *Liverpool's Historic Waterfront*. HMSO.

Roberts, W. M., 1978. *Cold Rolling of Steel*. Marcel Dekker.

Robinson, D.H., 1980. *The Wandering Worfe.* Albrighton, Waine Research Publications

Robinson, D.H., 1988. *The Sleepy Meese.* Albrighton, Waine Research Publications

Rodenhurst, T., 1803. *A Description of Hawkstone*. London, John Stockdale.

Rolt, L. T. C., 1979. *Thomas Telford*. London, Pelican.

Ruddock, T., 1979. *Arch bridges and their builders*. Cambridge Univ. Press.

Seaby, W. and A. Smith, 1984. *Windmills in Shropshire, Hereford and Worcester*. Stevenage Library.

Seaward, S., J. Rendel, H Palmer, C Vignoles, and J. Walker, 1841. Discussion - Memoir of the Montrose Suspension Bridge. *Transactions of the Institution of Civil Engineers* **1**:127-129.

Shorter, A. H., 1949-50. The Excise Numbers of Paper-Mills in Shropshire. *Trans Shrops Archaeol Soc* **LIII**: 145-152.

Sievewright, W., 1986. *Civil Engineering Heritage, Wales and the West of England*. London, Thomas Telford.

Sinclair, J. and R. Fenn, 1995. *The Border Janus: a New Kington History*. Cadoc Books.

Skempton, A, 1980. *Telford and the Design for a New London Bridge, in Thomas Telford, Engineer, ed. A Penrose: 62-83*. London, Thomas Telford Ltd.

Skempton, A, 1981. Engineering in the Port of London, 1808 - 1834. *Trans Newcomen Soc* **53**: 73-96.

Skempton, A. and M. Chrimes (eds), 2002. *A Biographical Dictionary of Civil Engineers in Great Britain and Ireland*. London, Thomas Telford.

Skempton, A. and H. Johnson, 1962. The First Iron Frames. *Architectural Review* **(March)**: 175-186.

Smiles, S., 1861. *The Life of Thomas Telford*. London, John Murray.

Smith, D., 1991. The Works of William Tierney Clark (1783-1852), Civil Engineer of Hammersmith. *Trans Newcomen Soc* **63**:181-207

Smith, E., 1932. Joshua Field's Diary of a Tour in 1821 through the Provinces - part II. *Trans Newcomen Soc* **13**:15-50.

Smith, S., 1979. *A View from the Iron Bridge*. Ironbridge Gorge Museum Trust.

Smith, W., 1970-1. The Contribution of the Gibbons Family to Technical Development in the Iron and Coal Industries. *West Midlands Studies* **4**: 46

Syson, L., 1980. *The Watermills of Britain*. David and Charles

Taylor, A., C. Plant, J. Dickerson., 2009. Wellington Street Swing Bridge, Hull, UK. *Engineering History and Heritage* **162(2)**: 67-79.

Telford, T. and E. Burne, 1936. On Mills. *Trans Newcomen Soc* **17**: 205-214.

Tonkin, M. S., 1947. Trevithick, Rastrick and the Hazledine Foundry, Bridgnorth. *Trans Newcomen Soc* **26**: 171-183.

Tredgold, T., 1824. *A Practical Essay on the Strength of Cast Iron and other Metals.* London, J Taylor.

Trevithick, F., 1872. *The Life of Richard Trevithick*. London, E & FN Spon.

Trinder, B., 1979. The First Iron Bridges. *Industrial Archaeology Review* **3(2)**: 112-121.

Trinder, B., 1980. *The Holyhead Road - An engineering project in its social context.* London, Thomas Telford.

Trinder, B., 1981. *The Industrial Revolution in Shropshire*. Phillimore.

Trinder, B., 1983. *A History of Shropshire*. Phillimore.

Trinder, B., 1992. Ditherington Flax Mill, Shrewsbury - a Re-evaluation. *Textile History* **23(2)**: 189-223.

Trinder, B., 1996. *The Industrial Archaeology of Shropshire*. Phillimore.

Trinder, B., 2005. *Barges and Bargemen*. Phillimore.

Trinder, B., 2006. *Beyond the Bridges - the Suburbs of Shrewsbury 1760-1960*. Phillimore.

Trinder, B., 2008. William Reynolds: Polymath - A Biographical Strand through the Industrial Revolution. *Industrial Archaeology Review* **XXX** (17-32).

Tucker, G., 1987. Millstone making in England. *Industrial Archaeology Review* **IX**: 167-188.

Tucker, G., 1991. *Some Watermills of South West Shropshire*. Birmingham, The Midland Wind and Watermills Group.

Vince, J. 1993. *Watermills and how they work*. Sorbus.

Wadley, D., J. Wadley, and P.Barton, 2004. Pontysgawrhyd Mill, a later Tudor corn mill in Montgomeryshire. *Montgomeryshire Collections* **92**: 57-68.

Wadsworth, H. and A. Waterhouse, 1967. Modern techniques and problems in the restoration of Marlow suspension bridge. *Proceedings of Institution of Civil Engineers* **37(2)**: 297-316

Ward, O., 1982. Millstones from La Ferte-sous-Jouarre, France. *Industrial Archaeology Review* **VI(3)**: 205-210.

Watts, M., 2000. *Water and wind power*. Shire.

Watts, M., 2002. *The Archaeology of Mills and Milling*. Tempus.

Watts, M., 2008. *Corn Milling.* Shire.

Welch, C., 1966. The Iron Bridge at Plymouth. *Trans Devon Association* **98**: 370-385.

Wharton, A., 1976a. Hogstow Corn Mill, Minsterley. *Shropshire Magazine* **June**: 19.

Wharton, A., 1976b. New Caynton Mill. *Shropshire Magazine* **July**: 13.

Wharton, A., 1976c. Fitz Mill. *Shropshire Magazine* **August**: 15.

Wharton, A., 1976d. Longnor Corn Mill. *Shropshire Magazine* **October**: 14.

Williams, R., 2004. *Limekilns and Limeburning*. Shire.

Yorke, T., 2008. *Bridges Explained*, Countryside Books.

The following books and journal articles have been consulted, but are not referenced in the text.

American Foundrymen's Society, 1954. *The Cupola and its Operation*. Chicago.

Anon, 1998. William Merlin Hazledine - Ironmaster. *Steel Times* **March**: 113.

Beckett, D., 1987. *Telford's Britain*. David and Charles.

Birch, A., 2006. *The Economic History of the British Iron and Steel Industry, 1784-1879*. Routledge.

Cohen, P., 1979. Origins of the Pont Cysyllte Aqueduct. *Trans Newcomen Soc* **51**: 129-142.

Curl, J. S., 1999. *Oxford Dictionary of Architecture*. Oxford University Press.

Dodd, A.. 1929. The North Wales Coal Industry during the Industrial Revolution. *Archaeologia Cambrensis* **LXXXIV**: 197-228.

Edgerton, D., 2008. *The Shock of the Old*. Profile Books.

Fearn, J., 2001. *Cast Iron*. Shire.

Forrest, H., 1924. *Shrewsbury Burgess Roll*. Parish Register Society.

Gregory, R., 1992. The Use of Power in the Early Industrial Development of Hull. *Industrial Archaeology Review* **XV (1)**: 7-20.

Hadfield, C. and A. Skempton, 1979. *William Jessop, Engineer*. David and Charles.

Hammersley, G., 1973. The Charcoal Iron Industry and Its Fuel, 1540-1750. *The Economic History Review* **26(4)**: 593-613.

Hay, D., 1996. *Oxford Companion to Local and Family History*. Oxford University Press.

Hodson, H., 1992. The Iron Bridge: its manufacture and construction. *Industrial Archaeology Review* **XV(1)**: 36-44.

Howell, P., 1984. The Jubilee Tower on Moel Famau. *Architectural History* **27**: 331-343.

Hyde, C. K., 1974. Technological Change in the British Wrought Iron Industry, 1750-1815: A Reinterpretation. *The Economic History Review* **27(2)**: 190-206.

Johnson, B., 1953-54. The Iron Industry of Cheshire and North Staffordshire, 1688-1712. *Trans North Staffs Field Club* **LXXXVIII**: 32-55.

King, P, 2005. The Production and Consumption of Bar Iron in Early Modern England and Wales. *The Economic History Review* **58(1)**: 1-33.

Langdon, J. and M. Watts, 2005. Tower Windmills in Medieval England: A Case of Arrested Development? *Technology and Culture* **46(4)**: 697-718.

Mutton, N., 1965-8. The Forges at Eardington and Hampton Loade. *Trans Shrops Archaeol Soc* **58**: 235-243.

Nelson, G., 1990. *Highland Bridges*. Aberdeen University Press.

Pellow, T. and P. Bowen, 1988. *Canal to Llangollen*. The Landscape Press.

Priestley, S., 2005. The Maintenance of the Pontcysyllte Aqueduct. *Journal of the Railway and Canal Historical Society* **(November)**: 170-174.

Russell, J., 1982. The Wilsons - A Line of Engineers. *Industrial Archaeology Review* **6(3)**: 224-234.

Shaw, M., 2009. *The Lead, Copper and Barytes Mines of Shropshire*. Logaston Press.

Skilton, C., 1947. *British Windmills and Watermills*. London, Collins.

Sutherland, R., 1997. *Structural Iron, 1750-1850.* Ashgate.

Trinder, B., 1977. *'The Most Extraordinary District in the World'.* Phillimore.

Tylecote, R., 1976. *A History of Metallurgy*. London, The Metals Society.

Vince, J., 1987. *Discovering Windmills*. Shire.

Wanklyn, M., 1996. The Impact of Water Transport Facilities on the Economies of English River Ports, c.1660-c.1760. *The Economic History Review* **49(1)**: 20-34.

Ward, A., G. Godber, and M. Hill, 1952. *A Guide to the Shropshire Records.* Shropshire County Council.

Weale, J. (Ed.), 1843. *The theory, practice, and architecture of bridges of stone, iron, timber, and wire: with examples of the principles of suspension*. London, Architectural Library.

White, R., 1968. *Waterloo to Peterloo.* London, Peregrine Books.

Wilson, E., 1975. *The Ellesmere and Llangollen Canal: An Historical Background*. Phillimore.

Woodward, G., 1997. The Brunels and the Grosvenor Bridge, Chester. *Trans Newcomen Soc* **69**:129-146

Websites
British Listed Buildings
1. Trafford Mill
http://www.britishlistedbuildings.co.uk/en-404433-trafford-mill-mickle-trafford (accessed 16.12.2010)
2. Caynton Mill
www.britishlistedbuildings.co.uk/en-361897-new-caynton-mill-chetwynd (accessed 4.12.2010)

Caledonian Canal
1. The Scots Magazine and Edinburgh Literary Miscellany
   http://www.archive.org/details/scotsmagazinean02unkngoog (Jan 2012)
2. Encyclopaedia Britannica 1824 edition
   http://books.google.co.uk/books (accessed Jan 2012)

Chepstow Bridge
Transport Heritage website
http://www.transportheritage.com/find-heritage-locations.html (accessed 11.2.2011)

Conwy Bridge
Wales Directory website
http://www.walesdirectory.co.uk/Towns_in_Wales/Conwy_Town.htm (accessed 22.1.2010)

Craigellachie Bridge
RCAHMS website
http://canmore.rcahms.gov.uk/en/site/16336/details/craigellachie+telford+bridge/ (accessed 3.6.2011)

David Mushet
Significant Scots website
www.electricscotland.com/history/men/mushetdavid.htm (accessed 21.8.2010)

Discovering Shropshire's History
www.discovershropshire.org.uk/html
Long Mill Bridge (accessed 3.3.2007)
Moreton Mill (accessed 21.9.2009)
Shrewsbury Town Wall (22-44 Wyle Cop) (accessed 3.3.2007)
Thomas Jones of Jones Mansion under the Wyle (accessed 4.1.2010)

Ditherington Flax Mill
Revolutionary Players website
www.search.revolutionaryplayers.org.uk/ (accessed 2.9.2008)

Dolforgan Bridge, Kerry
BBC Wales website
http://www.bbc.co.uk/wales/mid/sites/kerry/pages/dolforganhall_bridge.shtml (accessed 27.10.2009)

Eaton Hall Bridge
Engineering Timelines website
http://www.engineering-timelines.com/scripts/engineeringItem.asp?id=785 (accessed 5.11.2009)
Esk (Metal) Bridge
Engineering Timelines website
http://www.engineering-timelines.com/scripts/engineeringItem.asp?id=883 (accessed 6.6.2011)

Five Kilns Llanymynech
Archenfield Archaeology website
http://archaeologydataservice.ac.uk/catalogue/adsdata/oasisreports/archenfi2/ahds/dissemination/pdf/archenfi2-31202_1.pdf (accessed 1.11.2009)

Iron production
Wortley Top Forge website
www.topforge.co.uk/Glossary.htm (accessed 2.11.2010)

John Simpson
Marriage - www.familysearch.org, accessed 31.10.2011
Erlestoke Manor - 'Parishes: Erlestoke', A History of the County of Wiltshire: Volume 7 (1953), pp. 82-86. URL: http://www.british-history.ac.uk/report.aspx?compid=115462, accessed: 31.10.2011.

Marlow Bridge
Marlow Town council website
http://www.marlowtown.co.uk/bridge.html (accessed 25.1.2010 - this link no longer exists)

Mayors of Shrewsbury
Shrewsbury Town Council website
http://www.shrewsburytowncouncil.gov.uk/live/welcome.asp?id=714 (accessed 17.12.2004)

Nantwich and Stretton Aqueducts
Engineering Timelines website
www.engineering-timelines.com (accessed 21.7.2011)

National Archives Currency Converter
www.nationalarchives.gov.uk/currency/default0.asp (accessed between 2009 & 11)

Old Market Hall, Shrewsbury
http://www.oldmarkethall.co.uk/Accessible/AboutOMH/repairs.htm (accessed 26.7.2005)

Plas Kynaston
Plas Kynaston Canal Group website
www.plaskynastongroup.org/home/the-history-page (accessed 1.1.2011 - this link no longer exists)
Pontcysyllte Aqueduct
World Heritage Application (Wrexham Council)
www.wrexham.gov.uk/assets/pdfs/heritage/aqueduct/nominationdocument.pdf (accessed January 2010)

Building of the aqueducts (RCAHMW)
www.rcahmw.gov.uk/HI/ENG/Heritage+of+Wales/World+Heritage+Wales/Pontcysyllte+Aqueduct+%26+Canal (accessed 6.1.2010)
http://vimeo.com/2267361 (accessed 6.1.2010)

Sand casting
http://en.wikipedia.org/wiki/Sand_casting (accessed 8.3.2011)

Secret Shropshire (images from Shropshire Archives)
www.search.secretshropshire.org.uk (accessed at various times, 2009-11)

Shrewsbury House of Industry
The Workhouse website
www.workhouses.org.uk/shrewsbury (accessed 7.12.2010)

Shropshire windmills
Windmill world website
http://www.windmillworld.com/uk/shropshire.htm (accessed 31.12.2010)
Wikipedia
http://en.wikipedia.org/wiki/List_of_windmills_in_Shropshire (accessed 31.12.10)

Thomas Telford
Engineering timelines website
http://www.engineering-timelines.com/who/Telford_T/telfordThomas7.asp (accessed March 2011)
Scotsites ebooks http://www.scotsites.co.uk/ebooks/lifeoftelfordchapter14.htm (accessed March 2011) (Bonar Bridge)

Victoria County History of Shropshire, Volume X
www.british-history.ac.uk/report.aspx?compid=22879 (accessed 26.7.2005)

Waterloo Bridge, Bettws-y-Coed
Visit Wales website –
http://activity-holidays.visitwales.co.uk/508/welsh-bridges/
(accessed October 2010)

William Crosley
Engineering Timelines website
http://www.engineering-timelines.com/scripts/results.asp?engineer=290 (accessed 5.11.2009)

William Strutt
Byegone Derbyshire Website
www.bygonederbyshire.co.uk/famousresidents/Strutt-William-sky-s-limit/article-1763814-detail/article.html (accessed 21.3.2011)