The Workshops of the Cutlery Industry in Hallamshire 1750-1900

Volume 2

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CONTAINS PULLOUTS

Table of Contents

Volume 1

Volume 2

List of Figures

Chapter 6: Power

List of Tables

Chapter 6: Power

Chapter 7: Reuse

List Of Maps

The Structural and External Characteristics of the Cutlery Workshops.

The functional appearance and uniformity of many small-scale industrial buildings have deterred previous historians and archaeologists from examining them in detail.[1] Geoff Timmins' research into handloom weavers' cottages in Central Lancashire[2] was one of the early studies of small-scale workshops, but little else was published in the 1980s. Only in the last eight years has more interest been shown; Glenys Crocker has analysed the buildings of the Godalming knitting industry[3] and Marilyn Palmer, who in addition to her own research on the framework knitters of the East Midlands,[4] has encouraged numerous undergraduates to examine the regional and functional characteristics of the buildings used by industries such as footwear,[5] hosiery,[6] silk,[7] and nailmaking.[8] Unfortunately few of these studies have been published.

This chapter sets out the structural and external characteristics of the cutlery workshops illustrated by examples from fieldwork and documentary sources. The data presented do not include detailed assessments of individual structures or company histories but draw on information from a variety of sites to create a greater understanding of the relationship between the processes and the building. The human dimension will be added in the following chapter which assesses the internal characteristics. Questions asked include: can the cutlery workshops be identified from external characteristics alone; and was

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[1] Caffyn, L. 1986 Workers' Housing in West Yorkshire 1750-1920 RCHME supplementary series 9 London p1

[2] Timmins, J.G. 1979 *Handloom Weavers' cottages in central Lancashire: some problems of recognition* Post Medieval Archaeology 13 pp251-272

[3] Crocker, G. 1991 *The Godalming Knitting Industry and its workplaces* Industrial Archaeology Review XVI no1 p33-54

[4] For example Palmer, M. 1989 *Houses and Workplaces: the framework knitters of the East Midlands* Knitting international Vol. 96 no1150 31-35

[5] Perry, V.A. 1993 The Archaeology of the Domestic Workshops of the Boot and Shoe Industry in Leicester and its Satellite Villages 3rd year dissertation, University of Leicester and current research by Gary Campion PhD student, University of Leicester.

[6] Palmer, M. and Neaverson, P. 1992, Industrial Landscapes of the East Midlands Phillimore, Chichester p10-12 and Gary Campion, current research.

[7] Kerr, H. 1994 The nineteeth century silk-ribbon weaving industry of Coventry and North Warwickshire Unpublished 3rd year dissertation, University of Leicester

[8] Faulkner, D. 1991 Chainmaking and Nailmaking: the domestic industries of the Black Country Unpublished 3rd year dissertation, University of Leicester.

the choice of materials and structural features dictated by the function of the building?

Size

The first impression of any building is its size. This section makes the same general division, as in chapters two and three of, "small", "medium" and "large".

Small Scale

Small-scale workshops usually consist either of a single room in a single storey building (Figure 1) or up to four rooms in a two storey structure such as the courtyard workshops to be found in the town, for example Stan Shaw's workshop in Garden Street. (Figure 2). Externally, fieldwork and map evidence has demonstrated that these buildings usually measure between five and a half and eleven yards (5 - 10m) in length and three to five and a half yards (3 - 5m) wide.

Figure 1: Single storey Workshop: Nook Lane, Stannington (1995)

Figure 2:Two storey courtyard workshop: Stan Shaw's Garden Street workshop (1994)

Medium Scale

The second type of building is the small scale 'works'. Examples of these are Kendal Works (tenanted), A Wright and Son, Sidney Street (Figure 3a) and Victoria Works, Gell Street (Figure 3b). Externally they measure between eleven and twenty yards (10-18m) long and three and six yards wide (2.74-5.5m). The width of the building was restricted by the need to use natural light for illumination of the workshops. These buildings have two to three storeys and sometimes a cellar.

Water-powered sites can also be considered as medium-scale works although these are usually single story and can be divided into 'ends' or separate grinding 'hulls' (Figure 4a & 4b).

Figure 3a: A Wright and Son, Sidney Street (2 storey works)

Figure 3b: Victoria Works, Gell Street (3 storey)

Figure 4a: Shepherd's Wheel, River Porter. Note the two 'ends' which were sub-let.

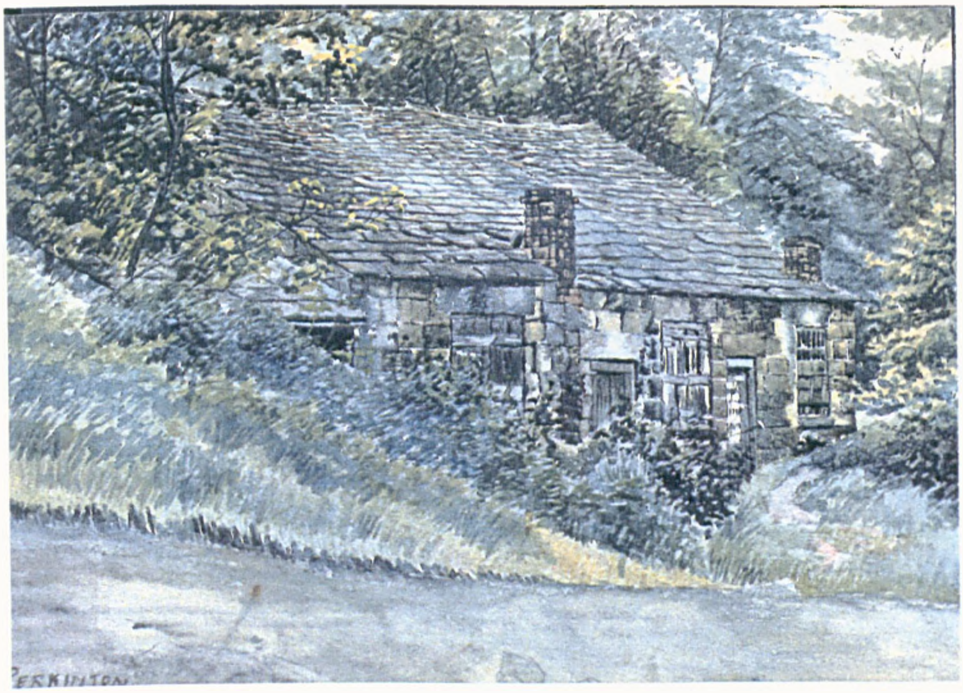

Figure 4b: Wheel at Whiteley Wood, River Porter, painted by Perkinton.

Large Scale

Examples of large integrated structures are James Dixon's Cornish Place (Figures 5 a & b) and Butcher's Works (Figure 6), and tenement wheels such as Union Wheel and Soho Wheel. Large-scale sites consist of buildings greater than twenty yards in length, although their width may not be significantly different from medium scale structures. The maximum width recorded is 8.3 yards wide (7.59m),[9] restricted by the problems of internal lighting. Large-scale works can also consist of ranges of buildings, usually between two and five storeys in height, accommodating a larger workforce or, if tenanted, a number of small firms.

Figure 5a: Cornish Place. The building in this complex range between three and five storeys. The frontage is only three storeys.

[9] Plan number CA206/ 2284 Mr Gaunt's Grinding Wheel.

Figure 5b: Cornish Place. The workshop range facing the river is five storeys.

Figure 6: Butcher's Wheel, Arundel Street has a four-storey front elevation.

The three scales of building identified reflect the changing nature of the accommodation used by the cutlery and related trades throughout the period studied. The larger scale works do not appear until the advent of steam power which made the grouping of workshops necessary, in order to make the best use of the power source (Power sources will be considered in Chapter 7). While these buildings have become the prominent survivors of the industry of the nineteenth century, the small and medium scale workshops were more numerous, as was shown in Chapter One.

Structural Considerations

Brickwork

Chapter Three identified the sources of bricks used in the urban workshops of the cutlery industry. This section examines the relationship of bonding to the function of the building and the brick types used.

Bonding

The bonding of bricks directly influences the strength of the structure. In the majority of cases the smaller workshops were built using Common Bond. This is where four to five rows of stretchers are separated by a course of headers. (Figure 7 a+b) Occasionally English Bond is found (Figure 7 c+d) in which there are alternate courses of headers and stretchers and Flemish Bond (Figure 7 e+f) where headers and stretchers alternate in the same course. All of these bonds would form a nine inch thick wall. Two other types of bond are found in Sheffield. One is a running bond (figure 7g) with either single or pairs of headers set at random intervals in order to strengthen the wall (Figure 7 h+i). The other, again based on the running bond, has some courses made up of half a course of headers and half of stretchers (Figure 7 j+k). These last two bonds have not been seen in either the workshops of the Prescot watch and file trade or the boot and shoe workshops of Leicester. For this reason they are grouped as Sheffield bonds, A and B.

Certain types of bond are only found in particular sizes of buildings associated with the industry. English bonding is the strongest as it avoids continuous

Figure 7a: Common Bond (from Ching FDK 1995 op cit p20)

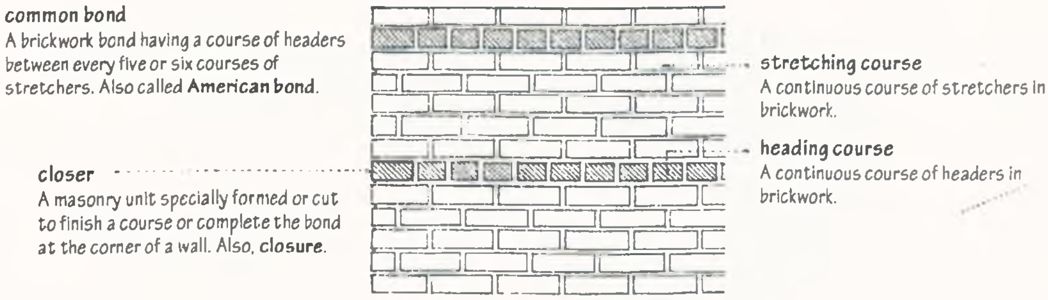

Figure 7b: Common Bond used in the construction of the workshop block at Kendal Works.

Figure 7c: English Bond (from Ching FDK 1995 op cit p20)

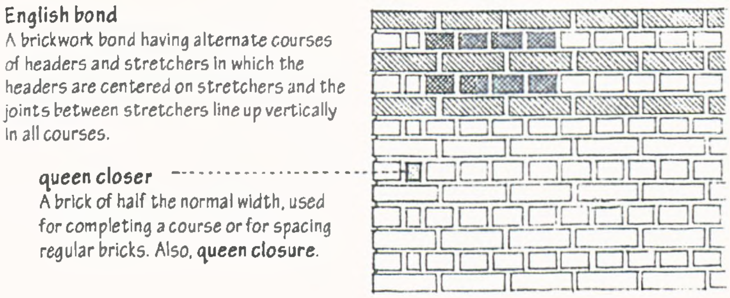

Figure 7d: English bond used in the construction of Alpha Works, Carver Street

Figure 7e: Flemish Bond (from Ching FDK 1995 op cit p20)

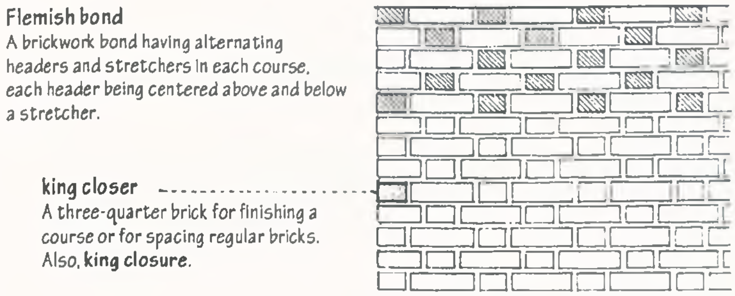

Figure 7f: Flemish Bond used in the construction of James Dixon's frontage block.

Figure 7g: Running Bond which is not used in the construction of the cutlery workshops but on which Sheffield A and B Bonds are based (from Ching FDK 1995 op cit p20).

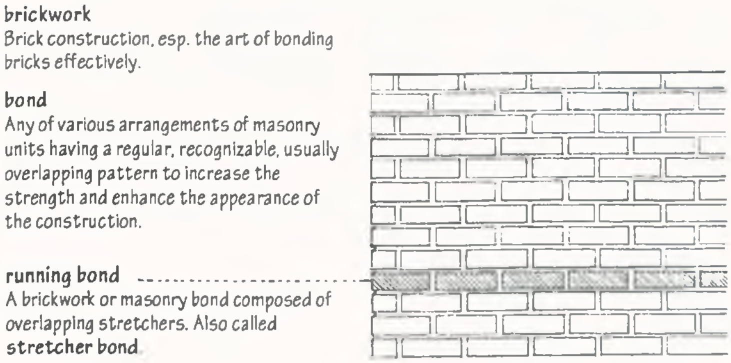

Figure 7h: Sheffield A Bond

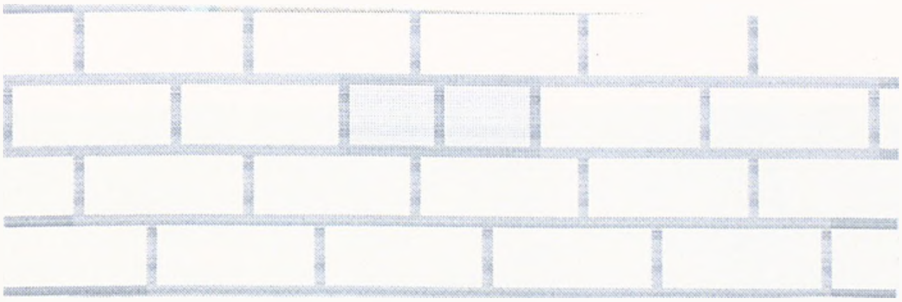

Figure 7i: Sheffield A Bond used in the construction of the Manager's Office at Eye Witness Works.

Figure 7j: Sheffield B Bond

Figure 7k: Sheffield B Bond used for the end wall of Kendal Works warehouse and office block.

vertical joints.[10] Flemish bond is also strong, although vertical joints can be closely spaced, making it weaker than English bond.[11] Its main advantage is that it is much more economical when expensive facing bricks are used 'as it only requires 64 bricks per square yard,... against 72 per square yard required for English bond'.[12] These two bonds are only found on large and medium scale buildings such as Alpha Works, Eye Witness Works, and the frontage of Kendal Works. Load bearing walls of large structures carry more weight per square yard at ground level than the smaller workshops examined. The strength of English and Flemish bonds was only used in warehouse blocks where the weight of goods waiting to be packed and sold could amount to hundreds of tons.

Common bond was used because it produces a 'fair' face on both sides. As this is the most frequently used bond in Sheffield, it was probably the most economical for the majority of workshops which were speculatively built. Bonding appears to have had no specific connection with function, apart from adding strength to some warehouses, but Flemish and English bonds have not been found on workshop buildings.

Sheffield bond appears to have been used in either frontages or workshop buildings. Its benefits are unclear, although the use of headers in parts of the wall improves its strength over running bond.

Brick Type

Size of brick

Irregularities in the size of bricks within a wall could indicate that the bricks were clamp fired. Table 1 demonstrates the variations in size that occur in some of the workshops around the town centre of Sheffield. The average size of brick used was 9'x 3' x 4'. Variations of more than a quarter of an inch possibly indicate that the bricks were made in a clamp kiln as and when required on the site, but weathering may also cause variations in brick size.

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[10] Middleton, G.A.T. eds. (1900-1924) **Modern Buildings, their planning, construction and equipment** Caxton Vol. 1 p82

[11] ibid p98

[12] ibid p98

Place	Bond	Length	Width	Depth
Eldon Street	Sheffield	9'	2.75'	4'
Trafalgar Street	Common	9.25'	3'	4.5'
Aberdeen Wks.	Flemish	9'	3'	4'
Canning Street[13]	Sheffield	9.25'	3'	4.5'
Harrison Bros. and Howson	English	9'	3'	4.5'
Kendal Wks. (front)	Flemish	9'	2.75	4.25'
Kendal Wks. (side)	Sheffield	9-10'	2.5-3'	4.25-4.5'
Carver Lane	Common	8-8.5'	2.25-2.5	3-4.25
Leah's Yard	Sheffield	9'	2.75'	4.5'
Butcher's Wks (Eyre Lane)[14]	Common	9'	2.75'	4'
Butcher's Wks. (2)	Common	8.5-9.5'	2.5-3'	4.25-4.5'
Butcher's Wks. (3)	Common	8-9'	2.75-3'	4-4.5'
Butcher's Wks. (4)	Common	9-9.5'	3'	4-4.5'
Butcher's Wks. (front)	Sheffield	8.5-8.75'	3'	4-4.25'
Challenge Wks.	Flemish?	9'	3'	4.25'
Sylvester Wks. (front)	Sheffield	8.75-9'	3'	-
Sylvester Wks. (back)	Sheffield	8-10'	2.5-3'	4-4.5'
TE Eastwood[15] (Mary's Road)	Common	9'	3'	4-4.5'
Taylor's Eye Witness (St Thomas Street)	Sheffield	9'	2.75:'	4'
TEW (1)[16]	Sheffield	9.25'	2.75'	4.5'
TEW (2)	Flemish	9'	3.25'	4.25'
TEW(3)	Flemish	9-9.25'	3'	4.5'
TEW(4)	Flemish	9.5'	2.75-3'	4.5
Beehive Wks.	Sheffield	9'	2.75'	4.25'
Egerton Street	Common (variant)	8.75-9.25'	2.75-3'	-
Kirkanson's	Common	8.25-9.25'	2.25-3'	3.5-4'
Kirkanson's at base	Common	10'	4.5'	5'
52 Garden Street	Common	9	3	4
Wall Kay and Son	Sheffield	9'	2.75'	4.5'

Table 1: The type of bonds and size of bricks that occur in the workshops around Sheffield relating to the Sheffield trades.

[13] Billy Thornton's Saw Piercing Workshop
[14] The side elevation consists of four parts.
[15] Manufacturers of tools
[16] Like Butcher's Wheel this building has several phases.

Flavell refers to a note by Fairbank estimating that from two and a half solid (ie cubic) yards of clay, 1000 bricks could be made and estimated that c8500 bricks were required for four rooms, ie two up two down.[17] Hence sixteen cubic yards of clay would be required for one building.

Brick Texture

Three types of brick texture have been found. Type **B1**[18] is a brick made with irregular inclusions. The face of this type of brick does not weather well and in many instances where the face of the brick has been eroded the bricks appear to be pitted. (Figure 8 a-c) This type of brick can be found on workshops such as those at the back of Kendal Works and Elliot's, Sylvester Place, in addition to the workshops in Garden Street. In colour they are usually brown.

Type **B2** are less prone to erosion and are usually a pale brown-red colour. Their texture has the appearance of dried mud possibly because they have cracked from over baking. This brick type occurs in workshops such as those at 52 Garden Street, Taylor's Eye Witness Works and Dixon's Cornish Place (Figure 9 a-c). These bricks are also prone to black discoloration caused by air pollution.

Type **B3** is a much better class of brick and is likely to be the most modern. It has a smooth but not glazed face which shows little or no sign of erosion. This type of brick can be seen on workshops such as the front of Butcher Wheel, the packing shops of Taylor's Eye Witness and Eastward's on Mary Street (Figure 10 a-c).

All the workshops with **B1** type bricks were built in the second quarter of the 19th century. Kendal Works and the workshops in Garden Street are dated to c 1840 while the workshops at the back of Elliot's are dated 1845.[19] The **B2** type bricks are found on buildings dating from the mid 19th century. The

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[17] Flavell, N. 1996 op cit. p 285. Figure based on Flavell's calculations that quarter of a million bricks would build 30 houses of the type specified.

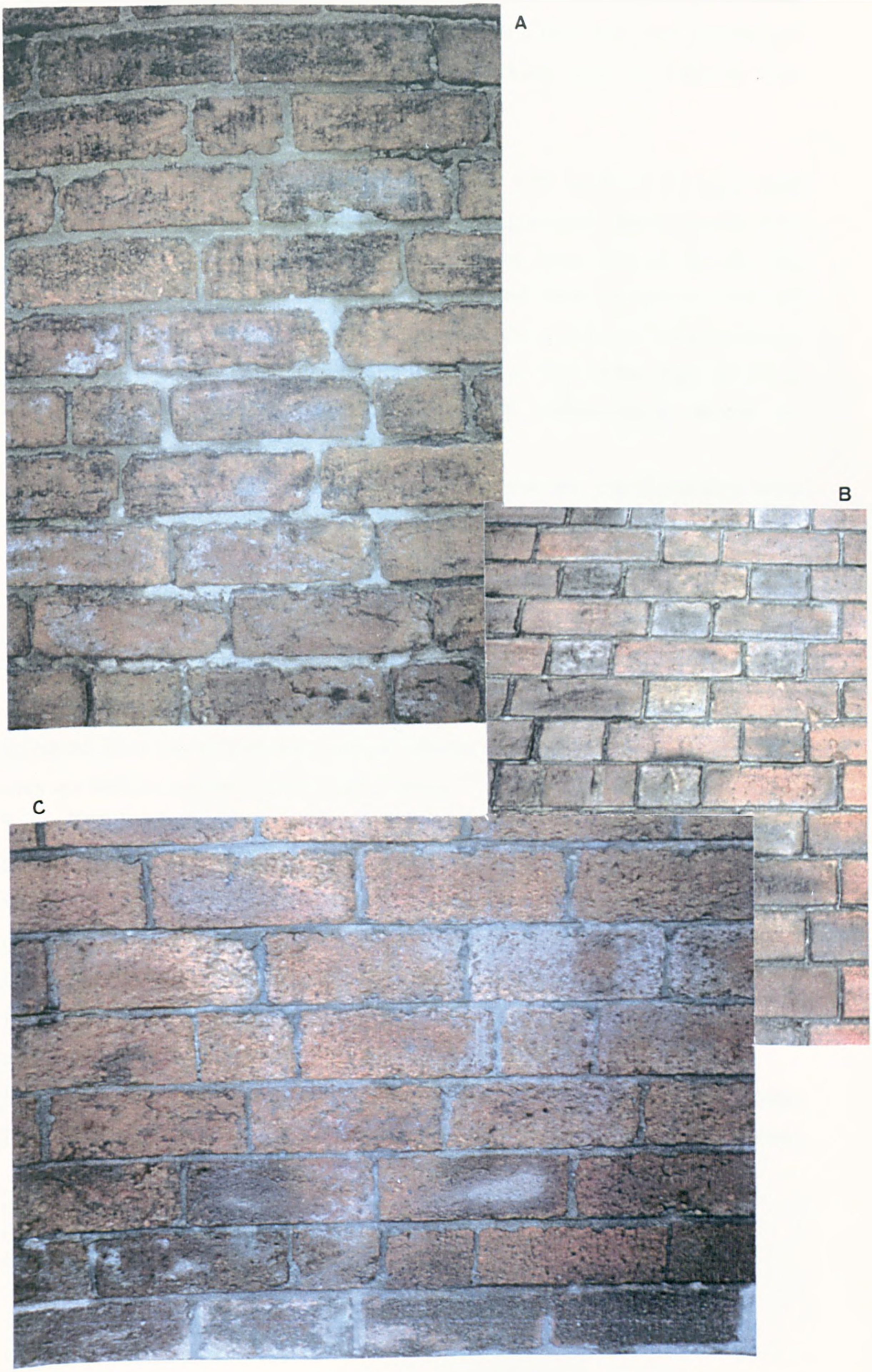
[18] Typologies are the author's own

[19] English Heritage 1995 **Statutory List of Buildings of Special Architectural or Historic Interest** English Heritage P749

Figure 8: B1 Type Bricks. **A:** Elliot's 1840 Workshop Block, Sylvester Street, **B:** 50 Garden Street, **C:** Kendal Works, workshop block, Carver Lane.

Figure 9: B2 Type bricks. **A:** Eye Witness Works, Milton Street, **B:** Cornish Place, Ball Street elevation, **C:** 52 Garden Street.

Figure 10: B3 Type Bricks. **A:** Butcher's Wheel, Arundel Street, **B:** Eye Witness Works, packing Shop, **C:** Elliot's Frontage, Sylvester Street.



workshops at 52 Garden Street were built c1840[20], Taylor's Eye Witness Manager's Office c1852 and Dixon's Cornish Place dates to c1860. The buildings in which **B3** type bricks are found are of a later date. The frontage of Butcher's Wheel was built c1860 and the packing shop at Taylor's Eye Witness around 1875.

It is therefore possible to suggest that structures with bricks of B1 type with the large inclusions are the earliest buildings dating around 1840 or earlier. It is these types of bricks which are most likely to have been fired on the site. B2 type bricks have a much greater range of dates and their use extends beyond those of B1 type into the 1860s. Type B3 bricks are used in the later buildings and are of superior quality to the first two types. The technology of brick making did not change overnight however and archaeologists should be aware that brick types overlap in date.

In conclusion, the types of brick and bonding used are not distinctive from those in other types of structures, although stronger bonds within large complexes used by the cutlery industry may indicate some buildings were used as warehouses.

Stone Walls

Most stone used in the construction of rural workshops was sandstone and gritstone from the surrounding area, as shown in chapter four. In most cases they are laid in 'random rubble built courses,'[21] as at Bingley Cottage or Nook Lane. This is where the stone is worked roughly to courses but of irregular height. Where regular courses appear on the external face, as at James Vickers workshop, Stannington, rubble is used to make up the thickness of the wall (Figure 11). Where ashlar[22] has been used on buildings such as Sheaf and Globe Works, the courses are regular and in both cases "plain" faced on the frontage. On other works such as Eye Witness and Venture Works an ashlar effect was sometimes created using plaster (Figure 12).

Stone was also used for decorative features such as door surrounds, jambs, lintels and sills and for highlighting string courses as at Sylvester Wheel (see

[20] Sheffield Ratebooks 1840-41

[21] Newbould, H.B. 1930 **Modern Building Practice** Caxton, London p207

[22] Large square cut stones.

Chapter 3 on 'constructional polychromy'). Local stone may not have been suitable for this type of work and therefore good quality ashlar blocks were imported by rail from the mid-nineteenth century.

Figure 11: Internal face of rubble built wall at James Vickers' Workshop, Stannington. The external face is made up of dressed stone.

Figure 12: Plaster made to look like ashlar blocks, Venture Works, Arundel Street

Cast Iron Columns and Brick Jack Arches.

To add strength and fireproofing to large-scale works, cast iron columns and brick jack arches were introduced. Cast iron could be used for columns because it was strong in compression.[23] The use of such columns can be seen clearly in the upper storeys of Butcher's Wheel (Figure 13 a&b) and in Cornish Place. Unlike the decorative columns found in some of the textile mills recorded by Giles and Goodall[24] those that remain in the cutlery workshops are purely functional. The appendix to the fourth report of the Commission on Children's Employment noted that 'in the town where space is valuable, the workrooms are built back to back, and floor above floor, the lower rooms being often vaulted to support the machinery above'.[25] This was the case in the ground floor workrooms at Butcher's Wheel.[26] Details of the cost of

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[23] Ching, F.D.K. 1991 **Building Construction Illustrated** Van Nostrand Reinhold New York 12.10

[24] Giles, C. and Goodall, I. 1992 **Yorkshire Textile Mills 1770-1930** RCHME London p68-69

[25] Parliamentary Paper Appendix to the 4th Report on Children's Employment 1865 para. 41.

[26] Giles, C. 1996 op cit. p10

Figure 13a: Cast iron columns, Butcher's Wheel

Figure 13b: The practice of reinforcing structures with metal beams was continued in the second floor packing house at Butcher's Wheel . Here, instead of cast iron, steel joists have been used.

installing a fireproof system of floors and ceilings are illustrated in the Soho Minute Books of 1828 following a fire. The quotes given by Messrs. Thackery and Perkins were £30 for the brickwork and £65 for the ironwork.[27] Further fireproofing was added in 1844 to the north west side of the wheel. The minute book for 15th January records that Mr Unwin's plans showed 'the chamber floors to be fireproofed brick arches and the roof laths and spars wrought iron and cast metal' and the cost £1100.[28] This type of fireproofing had been developed for the textile mills, William Strutt had first used the method in his Derbyshire cotton mills in the early 1790s.[29]

Floors

Floor structures and coverings varied according to the size of the building. Single storey buildings usually had stone or dirt floors; the majority of multi-storeyed premises which had timber floors, although the ground floors were sometimes flagged.[30] Her Majesty's Chief Inspector in 1887 wrote 'According to what we read in the 'History of Hallamshire' the condition of the various workshops was very bad in 1750. 'the workshops had mud floors in the bottom rooms'.[31] There appears to have been no reason other than what the builder or owner could afford as to whether the covering was dirt or stone. In these smaller workshops wooden pallets were sometimes placed on the floor to stop the cutlers' feet getting cold.

Floors in multi-storeyed buildings were usually supported by a wooden joist system, resting on the internal skin of the wall, on which wooden planking was laid. These were often patched over time or overlaid with cardboard as at Kendal Works (Figure 14)[32]! Willie Kugler recalled that at his father's workshop c1920 was 'there were great gaps in the floor so that if he dropped

[27] Soho Grinding Wheel Minute Book, Sheffield Archives. MD 709 1820-37
[28] MD 717 Sheffield Archives
[29] Giles, C. and Goodall, I. 1992 Yorkshire Textile Mills 1770-1930 HMSO RCHME p64
[30] See Figure 3, Chapter 5.
[31] Parliamentary Papers Industrial Revolution: Factories No 21 Session 188-89 Irish University Press The annual report of HM Chief Inspector 31st Oct. 1887 p36
[32] The cardboard is likely to be a short-term measure, placed on the floor when it was obvious the firm would soon have to move out.

Figure 14: The floor at Kendal Works which has been patched many times.

any tools there was a good chance that he would have to fetch them from the 'chasers' downstairs.'[33]

The joists were supported by the external walls. They were not always visible, and the ceilings which were directly attached to the joists, were a mixture of plaster and grinding swarf, as at Kendal Works. In the Fairbank Field and Building books most of the carpentry jobs relating to smithies contain details of the cost of floor framing, the number of joists required and the cost of laying the floor boards. For example at Jeremiah Beet's Smithy[34] the floor framing (4.42 x 4.48yds), seven joists (4.48 yds. each) a summer,[35] laying the floor boards and nailing cost £1-6-3. At John Pitt's workshop and warehouse in Trafalgar Street, the floor joists were to be six and a half by two and a half in size and laid at a distance of eighteen inch centres.[36] According to Ching's estimations this would carry a live load of less than 40 lbs per square foot[37].

[33] Willie Krugler, engraver, Notes about his life and family, Hawley Collection, University of Sheffield
[34] BB38 p113 1769 Fairbank Collection, Sheffield Archives
[35] large beam
[36] CP3-32 Fairbank Collection, Sheffield Archives
[37] Ching, FD.K. 1991 op cit. 4.5 This assumes that the joists have simple spans. Today the minimum requirement for a manufacturing establishment is 125 lbs per square foot (Ching ibid.pA6)

The floor covering in the warehouse and shop were to be boards one inch thick and nine inches wide, grooved and tongued.

Where heavy work was carried out the floors were of concrete[38]. Timber floors would not have supported the grinding troughs in the upper storeys of Butcher's Wheel (Figure 15). Concrete floors supported on brick jack arches also added strength to the structure.

It is possible to conclude therefore that the weight of the machinery associated with certain processes carried on within a structure dictated the type of floor i.e. if grinding was to take place in the upper storeys of buildings the floors had to be strengthened but between the branches of the trades, e.g. penknife and table blade production, there is no distinction in the structure of the floor. In single storeyed buildings the floor covering was dictated by cost in addition to the needs of the industry. However neither of these factors were unique to the cutlery trades.

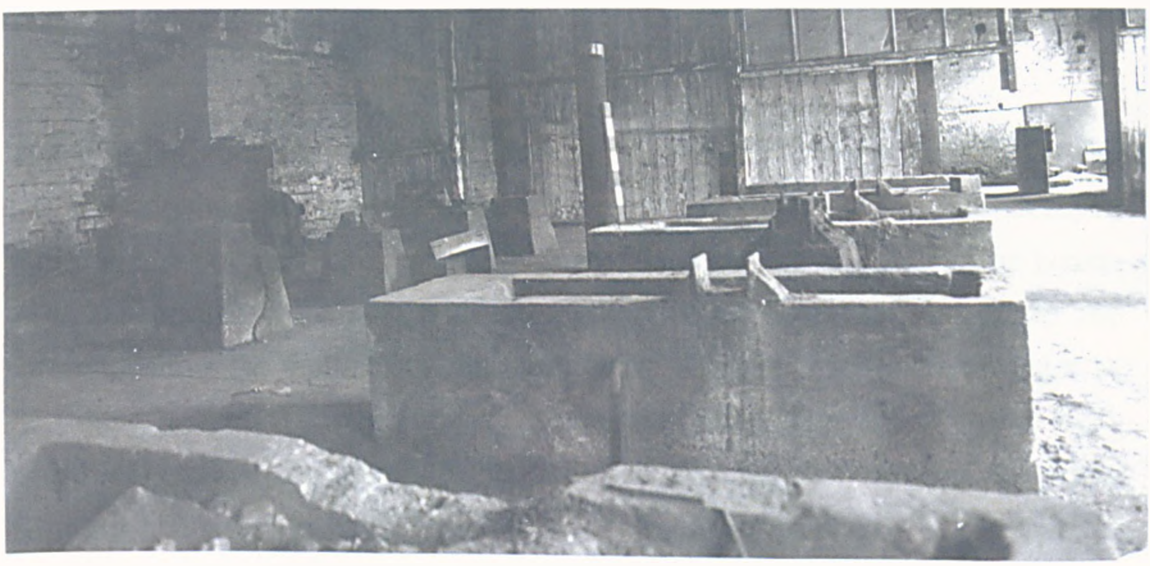

Figure 15: Where grinding was carried out on the upper storeys at Butcher's Wheel the floors were made of concrete supported by brick jack arches.

Roofs

Due to the dilapidated state of some of the buildings visited it has not always been possible to assess the roof structure of the workshops. Those that were identified fall into two categories, the use of the king post and the couple

[38] Lime ash may have been used at an earlier date for the same purpose

roof[39] (Figure 16 & Table 2). This summary is supported by evidence in the Fairbank Building and Field books but the couple-close roof may also have been used as indicated by the use of a roof frame (Table 3).

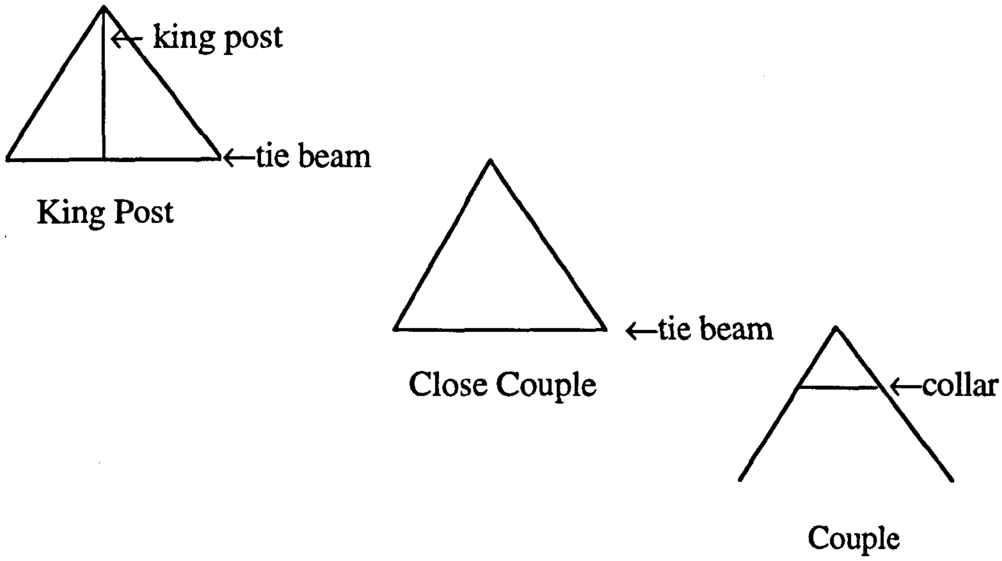

Figure 16: King Post, Close Couple and Couple roof structures

The type of roof structure does not appear to have been related to the function of the building, although king posts only appear in multi-storeyed buildings. A couple roof is the weakest structure but the addition of tie beams as in the couple close roof adds strength. Couple roofs are subject to the rafters pushing the walls of the building apart. King post roofs are stronger as they have a central support and tie beam and in the cases found in the field, additional trusses are usually added, further reducing the load on the walls. King post trusses are normally only used for spans over 20 feet[40] as in the medium and large scale works which were always multi-storeyed structures.
Roof structure is therefore not connected with the processes carried on within the building but with the physical needs of the building. Larger buildings require stronger roofs as the forces imposed upon them are greater. They cannot therefore be considered as a characteristic feature of the buildings of the cutlery trades.

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[39] Middleton, G.A.T. (1900-1924) op cit. p95
[40] Byrant, H. 1930 Modern Building Practice Caxton, London p100

Site	Roof Structure
Nook Lane	Couple roof
James Vicker's 643 Stannington Road	Couple roof
Kendal Works	King Post
Butcher's Wheel	King Post
Steppings Lane, Grenoside	Couple roof
Kirkanson's, Garden Street	King Post
9 Woodside Lane, Grenoside	Couple roof
Rock Farm, Stannington	Couple roof
Truro Works	King post with V trusses[41]

Table 2: The type of roof structures found in workshops visited.

Job Title	Job Reference	Roof Structure
Thomas Watson's Workshop	1798-7-9-BB82-8	framing[42]
Thomas Holy's Workshop	1800-2-18-BB82-157	king post
Price Heptenstall's Smithies	1770-1-13-BB41-22	framing
John Wilson's Smithy	1770-2-26-BB41-98	framing
George Patterns' Workshops	1770-12-14- BB42-116	framing
Martin Briddock's Smithy	1772-4-9-BB45-144	framing
Richard Swallow's Smithies	1765-10-22-BB30-48	framing
Geo. Smith's Smithy	1765-10-29-BB30-60	framing
S Barlow's Smithy	BB32-p140	framing
John Meek's Smithy	BB38-p33	framing
S. Broadbent's Smithy	1769-2-15-BB38-51	framing
Edward Shepherds Smithy	1758-10-5-FB13-138	framing
John Hirsts Smithy	1761-12-10-FB20-134	framing

Table 3: A selection of roofing jobs from the Fairbank Papers.

Chimneys

The presence of chimneys can indicate a fireplace, a hearth or a steam engine depending on type. It can be difficult to distinguish between a fireplace chimney and a hearth chimney as they look the same (Figure 17 a+b) although, in the past, illustrations show that hearth chimneys within the town, in some situations, would be taller to increase the draught (Figure 18).

Groups of chimneys are also significant. On Ball Street for example, the number of chimneys, situated on the edge of the building, suggest that this part of Alfred Beckett's works was used for forging. Fireplace chimneys

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[41] RCHME report undated Historic Building Report: Truro Works p3

[42] Framing is the use of the couple or couple close roof structure.

Figure 17a: Hearth Chimney, Cross Hill, Ecclesfield. File cutter's workshop.

Figure 17b: Fireplace chimney on Wm. Bocking's Workshop, Gell Street

Figure 18: Topham's View of Sheffield from the site of the Midland Station 1866 shows the tall hearth chimneys to be found attached to some workshops in the town.

would not have been so numerous and this feature is not found elsewhere on the external facade of the works (Figure 19). One significant chimney type that should not be confused with the cutlery industry specifically is the crucible stack (Figure 20) although they did occur at integrated works such Well Meadow Street where Samuel Peace made steel and files and Michelthwaite and Co, manufacturers of steel, files and saws, Malinda Street.[43] Chimneys connected with the use of a steam engine may be located centrally within a yard or integrated into the building structure, for example at Eye Witness Works (Figure 21a). The chimney at Butcher's Wheel in 1896 stood at 120 feet[44] (36.58 metres) (Figure 21b); this was used by three engines located in the main buildings at opposite corners of the yard and one in a temporary wooden structure attached to the southern block. Goad's fire plans indicate that the bases of the chimneys were mainly square in section (Table 4).[45]

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[43] Bayliss, D. et al 1995 **A Guide to the Industrial History of South Yorkshire** Association for Industrial Archaeology p28

[44] Goad's Fire Plans 1896 Sheet 23 674/B1/24 Sheffield Archives

[45] Giles, C. and Goodall, I. 1992 op cit. p150

Figure 19: Hearth Chimneys, Alfred Beckett's, Ball Street.

Figure 20: Crucible Stack, Malinda Street.

The structure of the chimney seems to have dependent on its location. Where it formed part of the works it was probably square, but when located in the yard it could be round. It also depended on the amount of power required; taller chimneys produced more draught for larger engines.

Chimneys however rarely survive. Due to the danger of high chimneys collapsing and those situated within buildings seriously damaging the rest of the structure, many have been removed. Even those that were for fireplaces have become redundant with the introduction of portable electric heaters and the installation of central heating in some of the larger works.[46] Therefore internal checks should also be made where possible to ascertain if hearths and steam engines once existed. The different types of hearths will be discussed under internal evidence.

It can be concluded from the examination of structural features that no specific elements point to the use of a building by the cutlery industry. Structurally basic building principles applied to all the workshops examined emphasising the speculative nature of their erection. If the cutlery industry moved out of a building, it was easily adapted for other uses and vice versa.

[46] Plans for Howson Bros and Harrison 1905 AP85 1-9 Sheffield Archives

Works	Section of Chimney	Height of Chimney (feet)
Wm Hutton and Son	Octagonal	75
Argus Works	Round	125
Beehive Works	Round	80
Bone and Horn Works	Round	120
Bradbury and Son (silver)	Round	
Central Cutlery Works	Round	
Exchange Works	Round	70
Globe Cutlery Works, Carver Street	Round	
J Rodgers and Son	Round	90
Livingstone Works	Round	
Mappin Bros	Round	90
Mazeppa Works	Round	50
Monmouth Works	Round	60
Portobello Works	Round	95
W& S Butcher	Round	120
624 Rockingham Street	Square	40
79 Rockingham Street	Square	
A Millward and Son	Square	
Albion and Melbourne Works	Square	110
Cambridge Steam Power Works	Square	
Clarendon Works	Square	
Clintock Works	Square	
Colver Brothers, Grinding	Square	70
Continental Works	Square	100
Cross Rockingham Lane	Square	70
Ct 3 Sidney Street	Square	
Division Lane	Square	
Don Plate Works	Square	
Empire Cutlery Works	Square	
G & W Lowe knife factory	Square	40
G Travis and Co	Square	80
Hallamshire Works	Square	
John Sellers Cutlery Factory	Square	
Mongomery Works	Square	80
Sheaf Island Works	Square	50
Sidney Works	Square	
Soho Grinding Wheel	Square	125
Union Grinding Wheel	Square	90
Victoria Works	Square	
W Mammatt and Sons (Sheffield Plate)	Square	
Ward and Payne Edge Tool Factory	Square	
Wostenholm's	Square	100

Table 4: Sections of the chimney bases as shown on Goads Fire plans 1896.

A B

Figure 21: Chimneys for engines at A) Eye Witness Works and B) Butcher's Wheel

External or 'Envelope'[47] Features

External or envelope features include the roof cladding and any features which cut into the structure such as windows and doors.[48]

[47] Ching, F.D.K. 1991 op cit. p 2.8
[48] ibid p2.8

Roof Covering

The traditional roofing material in South Yorkshire was stone slate, which was subsequently replaced with cheaper Welsh Slate after the arrival of the railways in the 1840s.[49] Stone slates however continued to be used. It is difficult to assess if the roof is contemporary with the building but there appears to have been no other roofing materials used in the workshops studied apart from temporary coverings of corrugated metal sheets. Table 5 shows the roof coverings identified from paintings and buildings still standing.

It is possible to conclude from the data in the table that stone slates continued to be used in rural areas longer than in the town. In 1845, the Sheffield to Manchester railway was completed and Welsh slate appears on buildings after 1850.

Workshop	Roof Cladding
Rural	
Nook Lane, Stannington	Stone slate
643 Stannington Road	Stone slate
Shepherds Wheel	Stone slate
Nether Cut (painting)	Stone slate
Holme Wheel	Stone slate
Whiteley Wood (painting)	Stone slate
Bingley Cottage	Stone Slate
Mr Ellisons Workshop, Grenoside (photo: beginning of 20th century)	Stone slate
Urban	
132 Cross Hill, Ecclesfield	Welsh Slate
9 Woodside Lane, Grenoside	Welsh Slate
Aberdeen Works	Welsh Slate
Alpha Works, Carver Street	Welsh Slate
Butcher's Wheel	Stone slate
Cornish Place	Welsh Slate
Kendal Works	Stone slate on workshops, Welsh slate on office block
Morton's West Street	Stone Slate
Portland Works	Welsh Slate
Rockingham Lane (1960's)	Welsh Slate
Sylvester Works	Welsh Slate
Victoria Works	Welsh Slate
Wellington Street (1960's photo)	Welsh Slate

Table 5 The roof cladding of workshop identified by photographs, paintings, and fieldwork.

[49] See section of slate in Chapter 3.

Entrances

Entrances to the workshops varied according to the size of building and whether it was a tenement factory or an integrated works. If the building was owner occupied the entrance was more elaborate than those of the courtyard workshops and tenement factories.

Fieldwork has indicated that where the original frame exists, entrances to forges can be identified by the stable or 'Dutch' doors.[50] These had the advantage of letting air circulate while restricting floor-level draughts (Figure 22a). Batten doors were used to access the small scale workshops, used by other branches of the cutlery and related trades. These 'consisted of vertical boards nailed at right angles to cross strips'.[51] These doors were also used as entrances to workshop blocks in larger factories, whether single occupancy or tenement. In most workshops the width of the external door is c32 inches (80cm) (Figure 22b).

Figure 22a: Example of a Stable or Dutch door at forge in Garden Street.

[50] Ching, F.D.K. 1991 op cit.p7.3
[51] ibid p7.5

Figure 22b: Example of a batten door, James Vickers', Stannington.

Doors to the main offices were of better quality; that at Sylvester Works for example is a panelled door consisting of stiles and muntins (Figure 23 a-c)[52] as at Burgon and Ball and at Globe Works.

Goods entering larger works would usually pass through the cart entrance to the courtyard. These entrances would usually be detailed in stone and sometimes the name of the firm or works would appear (Figure 24 a+b). Cart entrances in rows of terraced houses usually indicate the presence of an industrial building behind. These however are not characteristic of the cutlery

[52] Ching, F.D.K. 1995 A Visual Dictionary of Architecture Van Nostrand Reinhold New York p 64

Figure 23: Doors to the offices of larger works were of better quality than those to the workshops and usually had decorative surrounds; **A:** Sylvester Works (Elliot's), **B:** Burgon and Ball, **C:** Globe Works.

A B

C

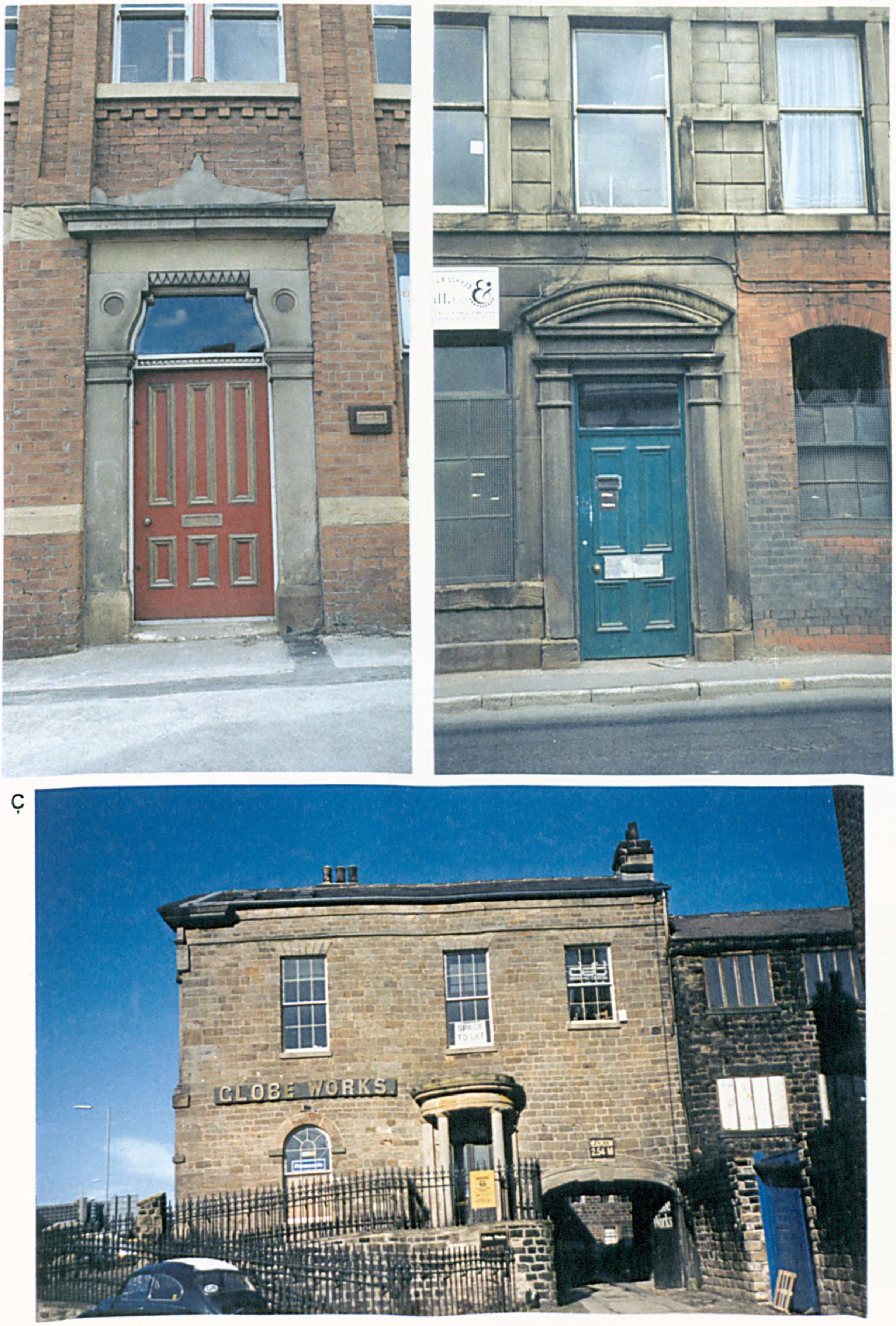
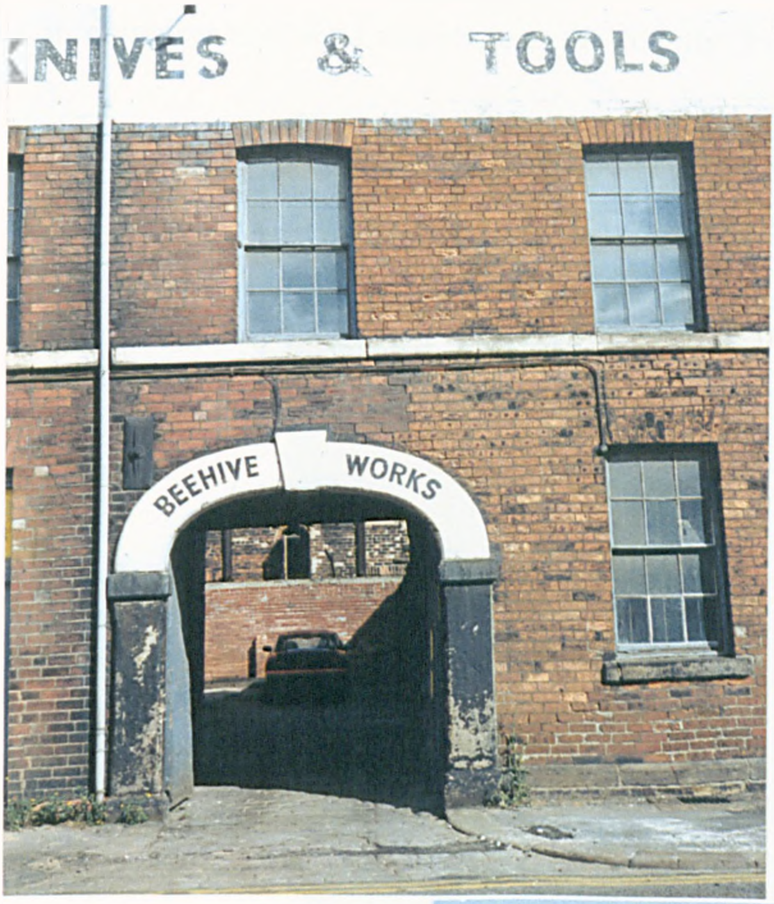


Figure 24: Courtyard entrances often displayed the name of the firm or works; **A:** Beehive Works, Milton Street **B:** Challenge Works, Arundel Street.

A



B

workshops and are more likely to represent builders' premises. The file cutters' workshop at 132 Cross Hill, Ecclesfield however was identified in this way. Cart entrances are found elsewhere in the country (Figures 25 a+b).

Figure 25a: Cart entrance to Fryer and Binyon's warehouse, Manchester (Jones E 1985;127).

One feature which is lacking from the majority of cutlery workshops and factories is the 'taking-in door' on the upper storeys as found in the boot and shoe and textile industries. From fieldwork and documentary evidence the majority of raw material and finished work appears to have been taken in and out through the main entrance to the building. In single storeyed buildings this was not a problem but Alan Day suggests that carrying sacks of work on his back and under his arms, wrapped in hessian, up narrow worn stone steps

Figure 25b: Cart entrance to Boulton Works, Longton, pottery manufactory (from Jones E 1985;39).

and along a narrow corridor resembling an "old fashioned railway carriage" at Union Works, "ruined his back".[53] With tenement factories in particular, it would not have been structurally feasible for every workshop to have a taking-in door. Another reason for their scarcity may be connected with the small quantity of goods handled by firms making a taking-in door and crane unnecessary.

Where taking-in doors in the conventional sense do exist, they are located in the warehouses of the larger works. An illustration of Wostenholm's Washington Works illustrates one with an external crane (Figure 26a) and field work has also identified their use at Butcher's Wheel (Figure 26b) and in a small two storey file cutters workshop at 132 Cross Hill Ecclesfield (Figure 26c). Other works have ground floor loading doors as at Eye Witness Works (Figure 27a), Kendal Works (Figure 27b), Butcher's Wheel (Figure 27c) and Victoria Works.

[53] Interview with Mr Day, 16th April 1996.

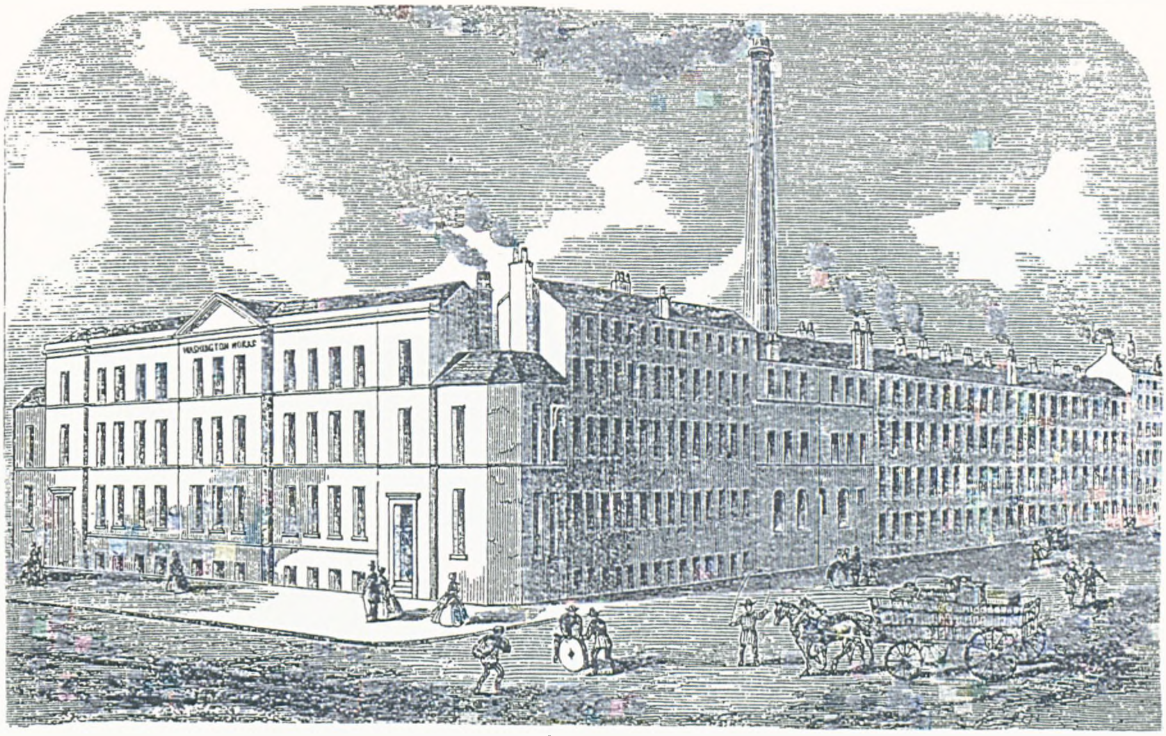
1

A

Figure 26a: Washington Works. Note the external crane on the Packing House (A1)


1
A

Figure 26b: Taking in doors are rarely seen on cutlery workshops. Where they do occur they are usually located in the packing shops and warehouses as at Butcher's Wheel.

1

A

Figure 26c: File cutter's workshop at 132, Cross Hill Ecclesfield, is the only example found of a small workshop with a taking in door (A1).

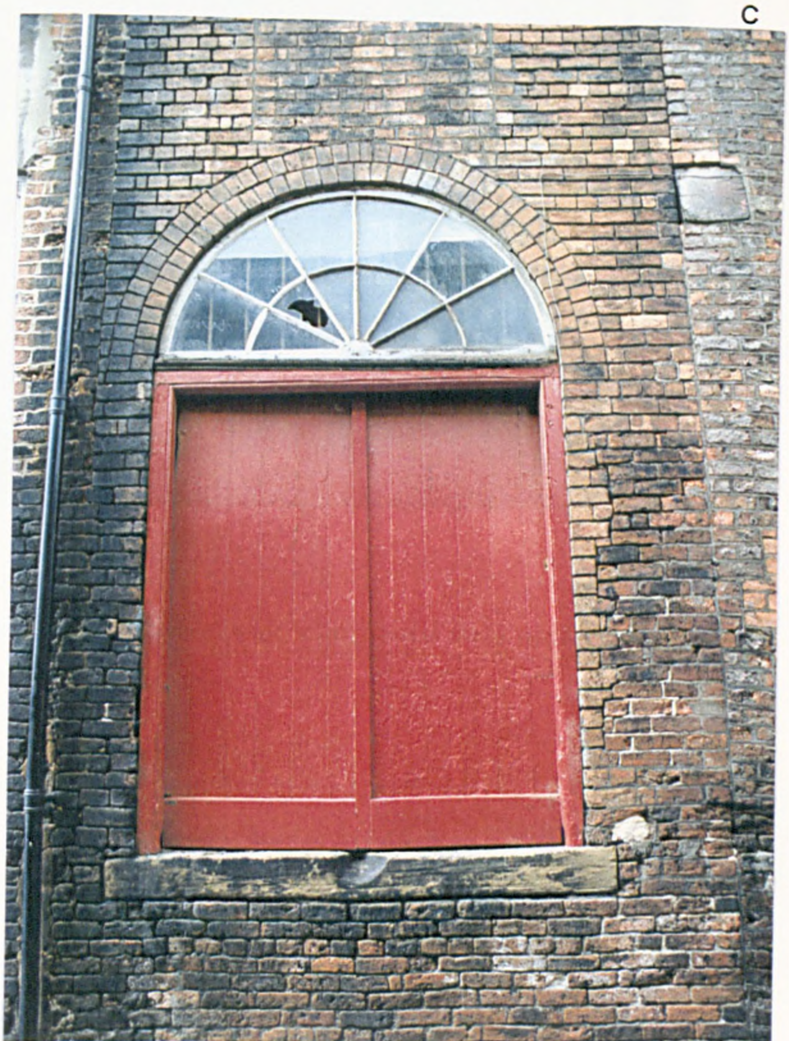
It can be concluded however that taking-in doors were not a characteristic feature of the buildings of the Sheffield trades. Structural considerations and the organisation of the tenement factories meant that they could not be provided to all the workshops. Staircases, both internal and external, were the alternative way of getting raw materials and goods to the upper stories. Loading doors were sometimes used by the larger firms at ground floor level. Internal lifting equipment will be considered in the next chapter.

Figure 27: Ground floor loading doors are a more common feature than taking in doors. Examples shown here are **A:** Eye Witness Works, **B:** Kendal Works, **C:** Butcher's Wheel.

B

A

C



Windows

The most characteristic external feature of the workshops associated with the cutlery trades are the windows. Five types of fenestration used to light workshops of the cutlery and related trades have been identified. Of these only two can be said to indicate a particular trade, those lighting workshops used for file cutting and grinding. This, however, does not rule out the use of buildings with different fenestration by those trades. The type of windows merely show the use for which the building was originally designed.

Typical Windows

The most common form of window type was made up of casements consisting of 6 or 8 (10in x 8in) small panes. Two or three casements are set in wooden frames with either a horizontal slide opening (Figure 28a) or an hinged outward opening (Figures 28b).

Figure 28a: Traditional cutlery workshop windows with a horizontal slide opening.

Figure 28b: Traditional cutlery workshop windows that open outwards. Note the hinges at A1.

The windows are grouped together in long ranges across the top stories of the building. They are not found on the ground floor as they were not deep enough to provide enough light especially when the building was situated in a crowded courtyard where little light could penetrate. These windows are found on most of the small scale workshops (Figures 29).

Figure 29: Typical Windows are usually found on the top storeys of buildings as at these workshops Rockingham Lane (JW Sibley Collection, Local Studies Library;1961)

The size of these windows was between 41 in x 36 in and 41 in x 54 inches. Very little decoration is found around these windows. Often they are just let into the brickwork but occasionally lintels may be visually articulated with a soldier course as in the workshops on Egerton Street (Figure 30a). On rare occasions a slight camber is imposed such as on the upper storey at Morton's (Figure 30b). This type of window is usually found on both sides of the workshop unlike the other types which are usually only found let into one wall.

Figure 30a: Decoration is rarely found above the typical windows of the cutlery workshop. The example above shows vertical bricks above windows in Egerton Street.

Figure 30b: Above the windows at Morton's cambered arches have been used to add simple decoration to the upper storey windows.

The typical Sheffield type of windows have not been seen on workshops of the Prescot watch or file trades, the Leicestershire boot and shoe industry, or the textile workshops of the period, with the exception of Carlton Mill, Sowerby Bridge (Figure 31), where identical windows are found but are set in stone jambs and mullions rather than wooden frames. These windows can therefore be identified as being characteristic of the cutlery workshops in this region.

Figure 31: One of the few examples where the windows are almost identical to the fenestration found on most cutlery workshops. This is Carlton Mill, Sowerby Bridge. (From Jones E, 1985;32)

'Low Shop' windows

These are much larger than the typical windows but are still made up of small panes. On the average window these number 30. The panes are grouped in pairs in wooden frames. This window type is found on the ground floor of buildings used by the Sheffield Trades to maximise the amount of light in these shops. (Figure 32a). In size these windows are c. 54 inches square and often the more typical windows will appear above the 'low shop', so called because these workshops carried the lowest rateable value in the rate books, and they were situated on the ground floor. Today few survive (Figure 32b); belonging to the poorest type of workshop they have usually been demolished along with the courtyards and the back-to-back houses of the workers.

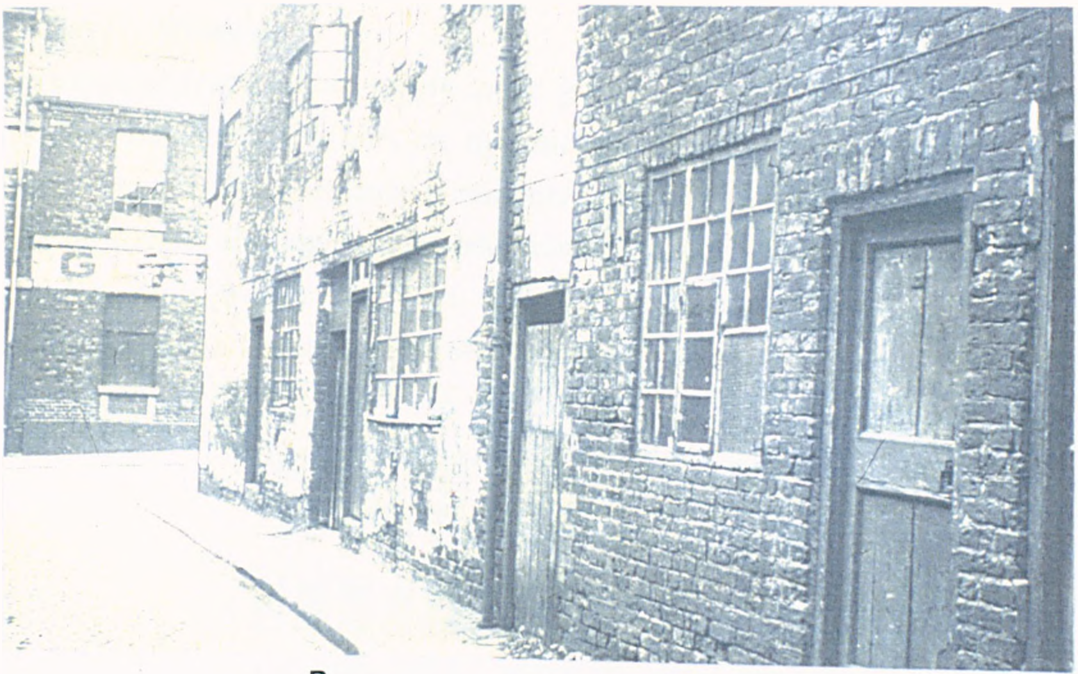


Figure 32a: "Low shop" windows (A1) Cross Rockingham Street, Sheffield (D Crossley, slide collection). Note the more typical windows above (B2)

Figure 32b: "Low Shop" windows rarely survive. Here are some at Elliot's, Sylvester Street, although not in their original form (A1). Again note the more typical windows above (B2).

Grinders' Windows

This type of fenestration occurs in the grinding wheels. These windows have no glass but have iron bars on to which oiled cloth could be placed in the winter months. They are most commonly found on the water powered sites in rural settings, although they occasionally occurred on the smaller scale grinding hulls within the town such as Mr. Gaunt's Grinding Wheel and Cutlers' Shop in Cambridge Street[54] (Figure 33 a&b).

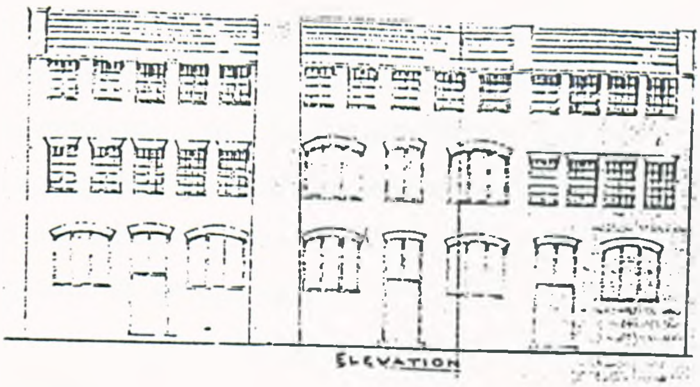


Figure 33: Grinders' windows were not glazed but usually had bars for security from which oiled cloths would be hung in winter to stop the draughts. (Sheffield Archives CA206/2284)

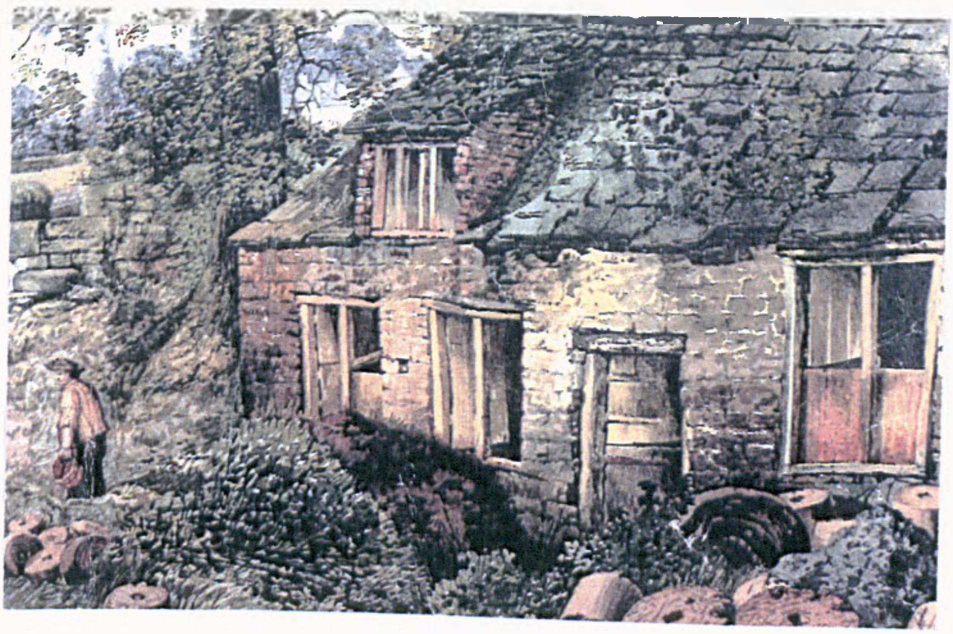


Figure 33b: Wheel at Endcliffe by Nicholson. (Kelham Island K1931.51) Some grinders' windows had shutters.

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[54] Building Registers plan no 2284 CA 206. Sheffield Archives.

The advantage of this type of window for this trade was that it allowed the dust to escape while also keeping the grinding hulls cool. It is recorded in the Children's Employment Commission reports of 1865 that even in winter a grinder could work up a sweat. In the larger wheel these windows were not used and the grinders, it is reported, smashed the glass out of the windows in order to improve the atmosphere within the workroom.[55]

File Cutters' Windows

These windows are specific to the file cutters' workshops of the Sheffield area (Figures 34). They are much larger than those found in the cutlers shops and bear more resemblance to the framework knitters workshops of Nottinghamshire (Figure 35a) and have some similarities to the watchmakers and tool makers workshops of Prescot (Figure 35 b&c). They consist of sets of 6 panes set together in groups of four or five in wooden casements. Once again their panes are small in size. In most cases they run the length of one side of the workshop.

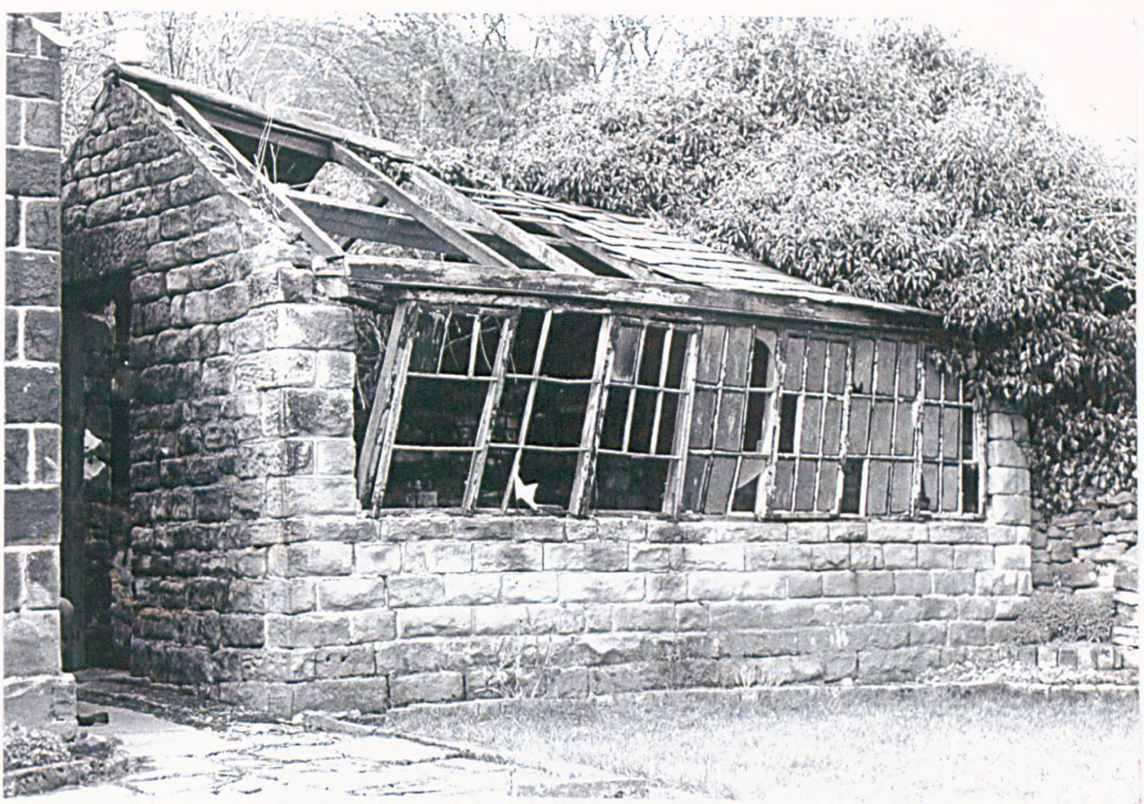

Figure 34a: Traditional file cutters' windows, Woodside Lane, Grenoside

[55] Appendix to the Fourth Report Mr. J.E.White's Report p 42.

Figure 35a: The file cutters' windows of Sheffield have similarities with those of the framework knitters of Nottinghamshire such as this one at Caythorpe. (M Palmer)

Figure 35b: File cutters' windows are also similar to the tool makers' workshops in Prescot, Lancashire. For example 20 Grosvenor Road, Prescot (SJ46939294).

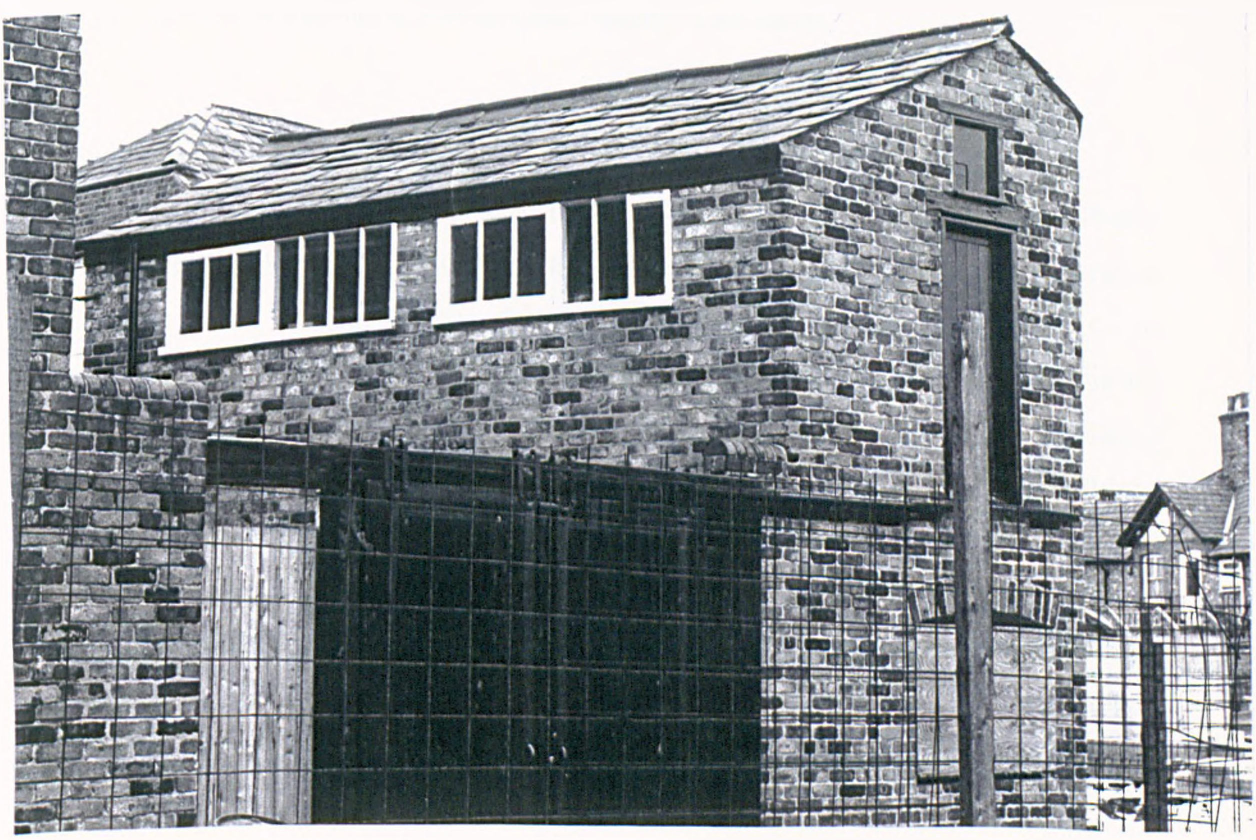

Figure 35c: There are also similarities with the watch makers' workshops in the same area, for example this workshop in Portico Lane, Prescot, Lancashire.

Office and Frontage Windows

The windows of this type are to be found in the manager's offices, warehouses and packing rooms of the larger firms. Usually they are Georgian windows with vertical sashes (Figure 36a). Sometimes they may be round headed as in Taylor's Eye Witness Works Offices or Kutrite Works (Figure 36b). This type of fenestration adds distinction to the frontage of the building and, as described in the last chapter, promotes the image of success, a building designed by an architect rather than following the vernacular. These windows consist of twelve panes of glass, six panes on each part of the sash. In size they are approximately 66 inches x 48 inches. This type of window, although it is to be found on buildings associated with the cutlery industry, will not in itself define a building as being used for that purpose as these windows were found in many houses and other public buildings of the period (Figure 36c).

Figure 36a: Office and Packing Shop windows at Gregory Fenton's Beehive Works, Milton Street.

This type of fenestration can therefore be said to be common with nearly all polite Georgian architecture of the period and is therefore not a particular characteristic of the cutlery industry. It is necessary therefore that where a building with Georgian sash windows is suspected to have associations with the cutlery industry that the other window styles are looked for.

In summary, window types one to four are characteristic of the cutlery industry. Workshops can thus be identified in the field despite similarities with some types elsewhere in the country. In some cases they can define the branch of the trade for which the building was intended. Where the more general window types are found other evidence has to be used to confirm the building's purpose, for example, documentary records, oral testimony or internal characteristics which will be considered in the following chapter.

Figure 36b: Kutrite Works, Smithfield. Note the round headed windows probably indicating a showroom, office or warehouse and the typical workshop windows above.

Figure 36c: Many of the windows found on office blocks and packing shops of the large and medium scale works resemble those found on Georgian town houses such as those in Paradise Square.

Conclusion

This chapter has shown that the structure and external features of the buildings of the cutlery industry were not particularly characteristic of the trade with the exception of the window types. From these the various branches of the trade could be identified, although not conclusively, as building functions varied over time. In order to clarify the use of the buildings internal features must also be examined.

Internal Features

The last chapter concluded that external appearance was not enough to assign a specific function to the workshops of the cutlery industry in the absence of documentary evidence. Internal evidence and spatial organisation are therefore vital if the processes carried out within a building are to be identified and working practices understood.

Several studies have been made which assess the processes and working conditions within the cutlery industry. The Royal Commissions of the nineteenth century[1] investigated children's employment in order to make recommendations for the Factory Acts. G.I.H. Lloyd's '*The Cutlery Trades*.'[2] examined the processes involved in making cutlery as well as the economic and social background to it. More recent studies have included '*On a Knife Edge*', which records workers' memories of the industry[3] and Sally Ann Taylor's thesis '*Tradition and Change, the Sheffield Cutlery Trades 1870-1914*'[4] which evaluated the evolution of processes in the period studied and their social effects. Ruth Grayson's '*Industrial Organisation in Nineteenth Century Sheffield*' and paper on the '*Independent Artisan in Sheffield*' both emphasised the continuity of the methods used within the industry,[5] and Joan Unwin's thesis on the pen and pocket knife industry examined that particular industry in detail.[6] Colin Turner has assessed briefly the workshops and the requirements of each trade[7] but none has looked in depth at the equipment needed or the layout of the workshops in relation to the methods of production.

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[1] Parliamentary Papers 1887 Workshops and Factories and the Children Employment Papers 1843, 1864 and 1865. Irish University Press

[2] Lloyd, G.I.H. 1968 reprint of 1913 **The Cutlery Trades** Cass and Co. Ltd. London.

[3] Jenkins, C. and McClarence, S 1989 **On a Knife Edge** Sheffield Libraries and Information Services, SCL Publishing Sheffield

[4] Taylor, S.A. 1988 **Tradition and Change, the Sheffield Cutlery Trades 1870-1914** Unpublished Ph.D. Thesis University of Sheffield.

[5] Unpublished papers 1993-4 .

[6] Unwin, M.J. 1989 **The Pen and Pocket Knife Industry, an investigation into the historical tradition basis of working practices and trade organisation.** Unpublished MA Thesis University of Sheffield

[7] Turner, C.A.1986 **A Sheffield Heritage: An Anthology of Photographs and Words of the Cutlery Craftsmen.** Division of Continuing Education, University of Sheffield and Sheffield Trades Historical Society Sheffield.

This chapter outlines the principal requirements for each branch of the cutlery trade, forging, grinding and hafting. As a comparison, some of the features associated with related trades, such as file making and saw-piercing, are included. It discusses what features are likely to survive in the archaeological record from each process. Finally it asks if the type of building can be identified from the internal organisation of workrooms and whether this had any effect on the processes carried out.

The Processes in Making 'Cutlery' of All Types

Forging

The first process in the production of a knife is the forging of the blade from a steel bar or rod. For larger blades, as found on table knives and tools, the forger is assisted by the striker. This is known as double-handed forging. Small blades, for example those found on pen or pocket knives could be hammered out by the forger alone. This was termed 'single-handed forging'. The forger heats the steel rod to a 'glowing red heat'[8] before forming it into the shape of a rough blade or 'mood'. This is then severed from the rod and reheated so that the shoulder of the blade and tang can be formed (Figure 1).

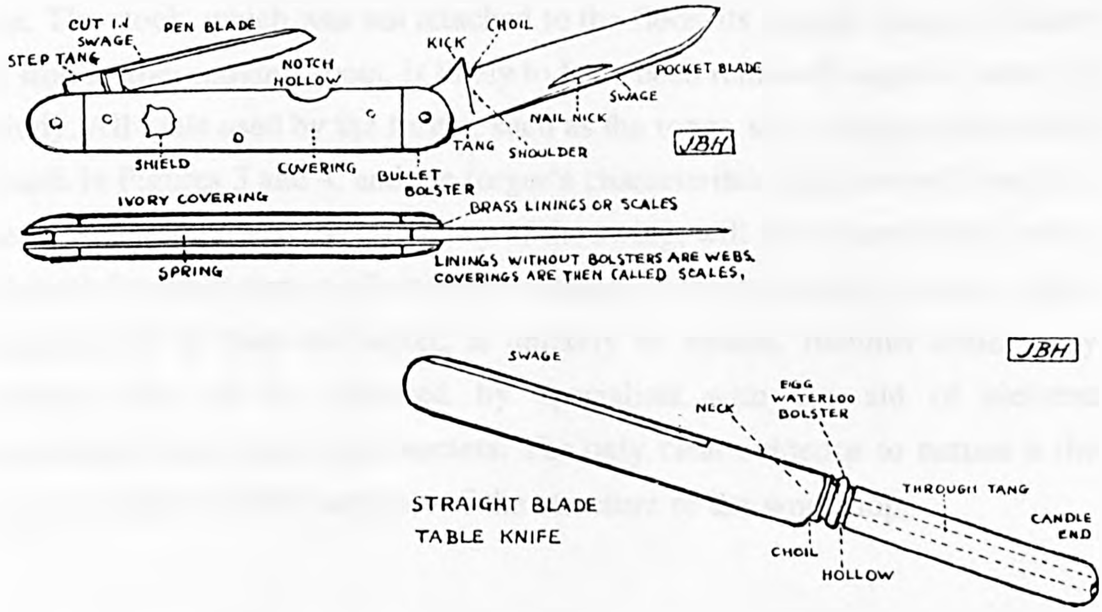

Figure 1: Diagrams showing the different parts of a pen knife and table knife (from Dyson R 1979 (reprint) p11 and 41)

[8] Lloyd, G.I.H. 1968 op cit. p38

By heating the blade a third time it can be finished, and if a pen or pocket knife, the nail nick inserted,[9] and the maker's mark struck before the blade is hardened and tempered. The blade however is still brittle and has to be reheated again slowly to a lower temperature, tempering the blade.

The needs of the forger were few, 'a small reheating hearth, hand bellows, fuel and anvil (stiddy), and hammers.'[10] The forger's workshop usually has an internal area of 10 yards square (9.14m^2). In the centre of the shop was placed the stock (a block of stone or wood) and the stiddy. There were differently shaped anvils for the various branches of the trades as shown in the Sheffield Illustrated List (Figure 2). Figures 3 and 4 show butcher blade and file forging respectively. The different types of anvils are clearly visible. In these figures the 'agon' or upturned chisel for cutting off the 'mood' can be seen. Today forging is rarely carried out by hand; the blades being stamped or 'flied out'. For hardening, in addition to the equipment mentioned above, the forger or hardener would require tongs for holding the blades and a vat for water or oil for cooling or quenching the blade.[11]

In the archaeological record little evidence survives for the processes carried out. The stock, which was not attached to the floor, its weight being sufficient to stop it from moving about, is likely to have been removed together with the stiddy. All tools used by the forger, such as the tongs seen hanging above the hearth in Figures 3 and 4, and the forger's characteristic hammer with the bent head, which improved the efficiency of the swing, will have been taken away. The vat for the water or oil used for cooling in the hardening process, often only an old oil drum or bucket, is unlikely to remain. Hammer scale[12] may survive and can be analysed by specialists with the aid of electron microscopes and mass spectrometers. The only clear evidence to remain is the forgers hearths which form part of the structure of the workshop.

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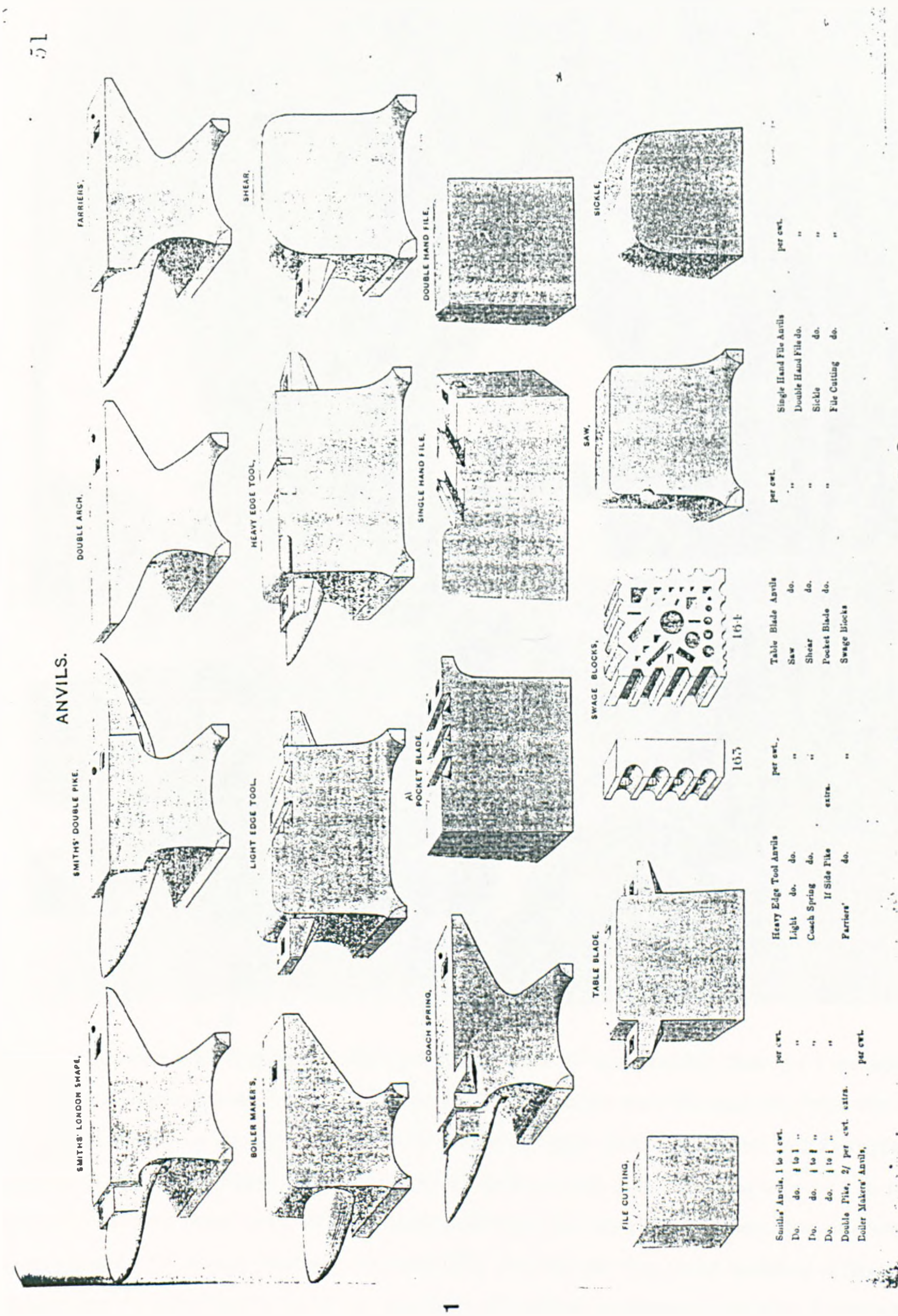
[9] Note today this is usually punched at the time of assembly.
[10] Turner, C.A. 1986 op cit. p 9
[11] Turner, C.A. 1986 p 16 Oil is better as it reduces the risk of cracking the blade
[12] Tiny pieces of metal which are detached during the forging process from the heated rod.

Figure 2: Sheffield Illustrated List for 1864 illustrating the various types of anvils available for the different branches of the trade. Note the gates (A1,B1,C1) used for shaping the different sizes of blades and files.



1
2

A B

Figure 3: Double handed forging of Butcher's Blades at Thomas Turner's c1901. Note at A1 the 'agon' or upturned chisel used for cutting off the 'mood'. The spike at B2 is used to guide the forger when placing the blade over the agon. To the right of the photograph is the forger's hearth with its stepped chimney breast and the forger's tongs hang from it. The forgers hammers, weighing between four and twelve pounds have characteristically bent heads which made the swing more efficient. The same shape is also used for file cutters' hammers (see figure 28b). Note that the floor of the workshop is flagged. (Photograph from the Hawley Collection, University of Sheffield. Originally produced in *Handicrafts that survive* p20)

1

A

Figure 4:File Forging, Thomas Turner's 1902. Note the agon (A1) and the difference in the shape of the anvil when compared to the blade forger's anvil (figure 3). Note the stepped breast of the forger's hearth and the shape of the hammer and the handle of the hammer worn after years of use thus marking clearly where the hammer was held. (*Handicrafts that Survive p55*)

Hearths

Forgers' Hearths

The forger's hearth is similar to any blacksmith's hearth and would be found in most of the workshops termed as smithies. Hearths of this type remain in forgers' workshops, for example in the courtyard of 52 Garden Street. Other examples can be found in scissor forgers' workshops and file cutters' workshops, where they were used for making file blanks and the file cutters' chisels (Figure 5a&b).

1

A

Figure 5a: Scissor forger's workshop, Bingley Cottage, Stannington. This hearth has a stone breast and lintel. Note the hole for the tuyere at A1. The space on the right-hand side of the hearth may have been used for tempering the blades.

2

1

B A

Figure 5b: File Forger's Hearth, Stepping Lane, Grenoside. Note that the chimney breast is stepped and constructed of brick, whilst the base is of stone. It is also possible to see the ash hole (A1) and hole for tuyere (B2) indicating that the bellows were situated to the left of the hearth. On the right is a bowl under which a fire could be lit. This may have been used for melting lead used to make the beds on which the files were cut (see section on file cutting, this chapter).

Within the town, hearths are usually constructed of refractory brick. Stone or a stone lintel is used in rural areas. The chimney breast is usually stepped. The hearth is positioned at waist height with a depth of between 80-100 cm (31.5-

39.4 inches). The width of the hearths at Nook Lane (Figure 6),[13] and Bingley cottage were between 1.25m and 1.5m (1.37-1.64 yds).

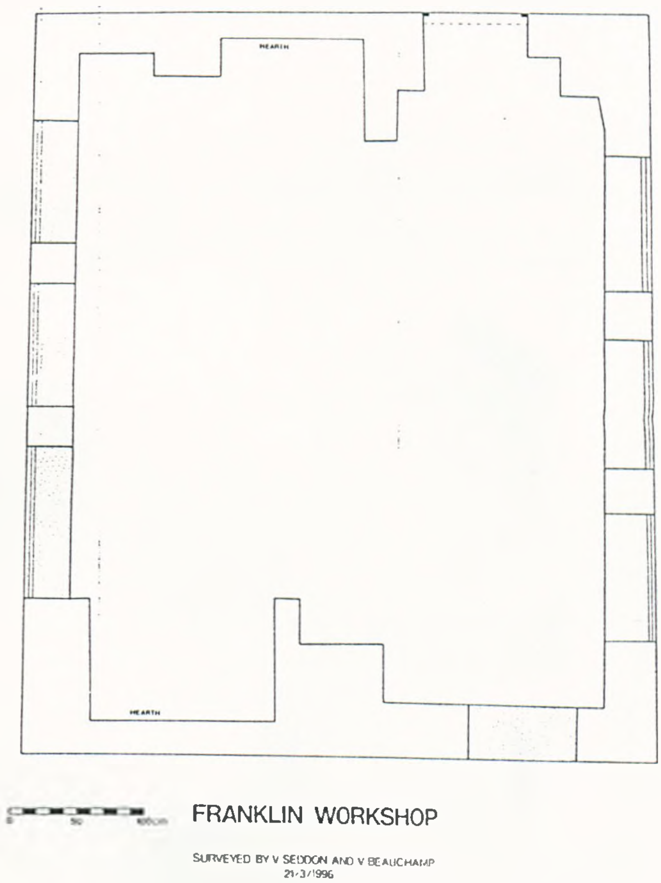


Figure 6: Plan of Nook Lane Works, Franklin Cottage, Stannington.

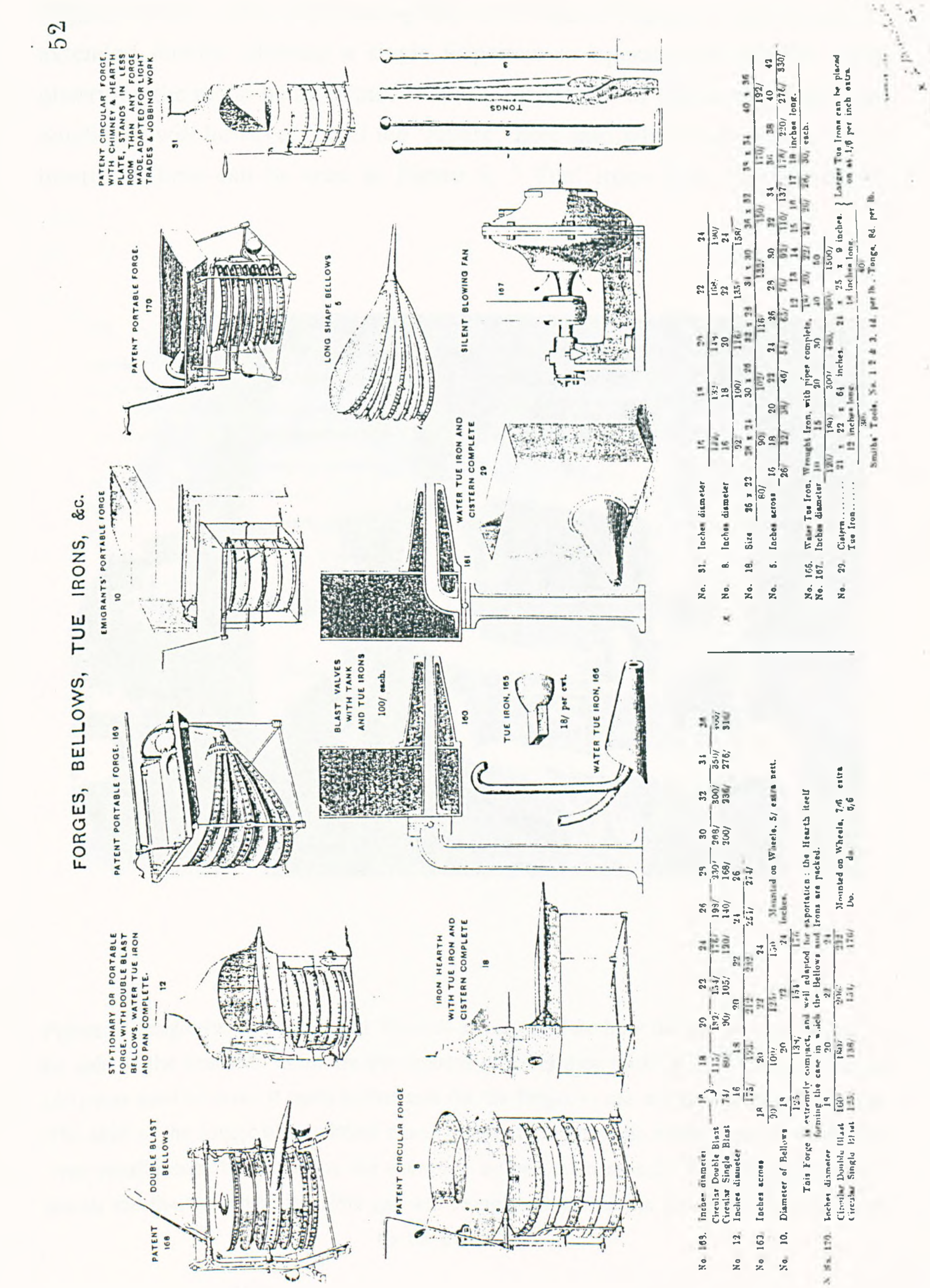
Below the main hearth is a second smaller hole or 'ass hoil or nook'[14] where the ashes and clinker could be raked out. In the urban workshops the hearths that survive have been whitewashed while in the rural workshops the brick and stone work retains its natural state. This possibly reflects the greater influence of the 1878 Factory Acts in urban areas.

In order to increase heat within the hearth, bellows would be required. The Sheffield Illustrated List in 1864 (Figure 7) shows the types of bellows and forges available. The most commonly used were the Double Blast Bellows

[13] The author wishes to thank V. Seddon for assisting with fieldwork and drawing up the plans to the workshop in Nook Lane belonging to Franklin Cottage.

[14] Dyson, R. 1979 reprint **A Glossary of Words and Dialect formerly used in the Sheffield Trades** STHS, University of Sheffield p 10

Figure 7: Sheffield Illustrated List 1864: The various types of bellows, tuyeres and forges available. The most common forms of bellows used by the cutlery industry were the Double Blast Bellows and the Long Shaped Bellows. Portable forges were rarely used.



costing between £5-15-0 and £20. In size these ranged from 16 to 36 inches (40.6-91.4cm) in diameter and stood about four feet high (122cm).

As the hearth extended into the room the bellows could be placed at the side (Figure 8) thus not compromising the work space. Figure 8 also shows an extended handle allowing a single forgeman to operate the bellows while observing the metal being heated. Careful inspection of the hearth, if in good condition, will however reveal the 'tuyere' hole into which tuyere irons were inserted. These can be seen in Figure 5. ' Tue' irons were 'metal nozzles

Figure 8: Single-handed forging at Thomas Turner's. Note how the bellows are placed at the side of the hearth to minimise the amount of room they took up. The extended handle (A1) was used to make it more convenient for the forger to use whilst watching the metal. The skill of the forger was to know exactly when to remove the metal from the heat. The was usually done by observing the change in colour. Also seen in the photograph is the hearth and the water vat. By 1901 gas was being used to fuel the hearths as demonstrated by the pipes at C3.

protecting the pipe of the bellows where it enters the forger's hearth'[15] (Figure 7). The major manufacturers of bellows in Sheffield were Absalom, Harrop and Pearson who were located at Fitzroy Bellows Works on Ecclesall Road in 1883.

Forging hearths are very characteristic but to avoid confusion the two other types of hearth identified will be considered, the cutler's hearth and the fireplace.

Cutlers' Hearths

The cutler's hearth (Figure 9) was rectangular in plan with stepped sides and containing two to three openings.

Figure 9: Cutler's Hearth, Kelham Island. Note the three openings for hardening (A1), the ash hole (B2) and the fireplace (C3). The 'long shaped bellows' are mounted on a wooden frame to which an extended handle is attached so that the cutler could observe the heat in the hearth and the metal.

[15] ibid. p40

One opening, usually the largest, served the purpose of heating the room by means of an open grate. Adjacent to this was a small opening placed at about waist height which was used in a similar way to a forger's hearth for hardening and tempering blades once they had been finished. A comparison of the openings shows that the aperture used for hardening is much smaller than the others. An example of this type of hearth can be seen at Kelham Island Museum. These hearths were approximately one and a half metres wide and 80 cm deep. 'Long shape bellows' (Figure 7) would have been used to operate these types of hearths as shown at Kelham Island. These would have been mounted in a home-made wooden stand. They could be compressed by means of a wooden handle in a similar way to the forgers bellows. The 1864 Sheffield List priced these bellows at between £1-6-0 and £16-10-0 depending on size. Once again they would have been placed at the side of the hearth to minimise the space they took up and a 'tuyere' used to maximise their efficiency.

Fireplaces

Those hearths used for heating the workshops have single fire places and usually a cast iron grate; the most decorative survivals are those to be found in the workshops at Kendal Works (Figure 10). Occasionally 'tortoise' or 'pot belly' stoves can be found as in Basil Walker's former workshop in Nursery Street (Figure 11a) and Kirkanson's works in Garden Street (Figure 11b). These stoves had the advantage of being able to burn anything and were therefore cheap to run. The stoves and hearths illustrated were no different from those found in domestic premises or in other small industrial buildings during the period. In the 1970s a Yorkshire Range was found in Halls Horn Works in Broom Close (Figure 12)[16] and one remains in use at Shepherd's Wheel. Ranges are also known to have existed in the boot and shoe workshops in Leicestershire (Figure 13). Some may have been made in Sheffield by firms such as Steel and Garland at Wharncliffe works or Hoole and Co. at Green Lane Works (Figure 14 a & b). The majority of stove grate and kitchen range manufacturers were however located at Rotherham.

[16] This was removed and is now at Wortley Top Forge

Figure 10: Fireplace at Kendal Works. Note the decoration on either side of the grate.

Figure 11 **A:** Tortoise Stove at Basil Walker's, Nursery Street and **B:** Pot Bellied Stove at Kirkanson's, Garden Street. These stoves would burn anything, including coke, and were therefore cheap to run.

A

B

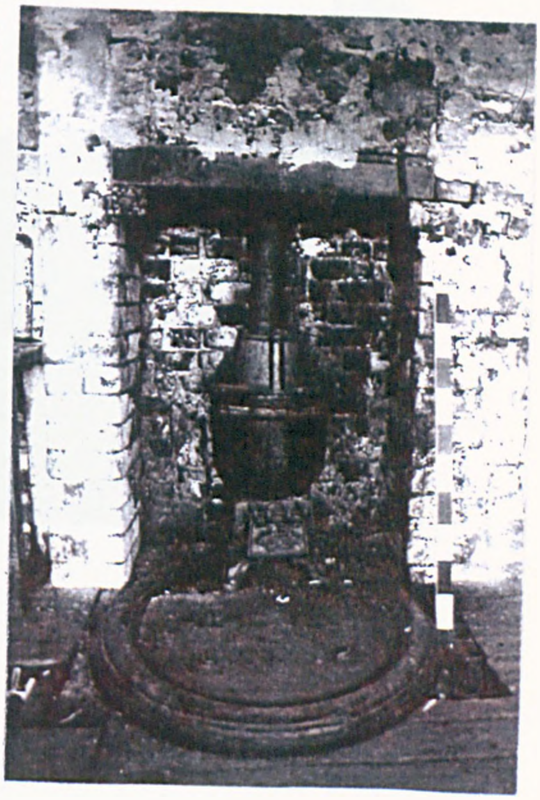


Figure 12: Yorkshire Range at Hall's Horn Works, Broom Close (now removed to Wortley Top Forge; photograph taken c1970, Hawley Collection).

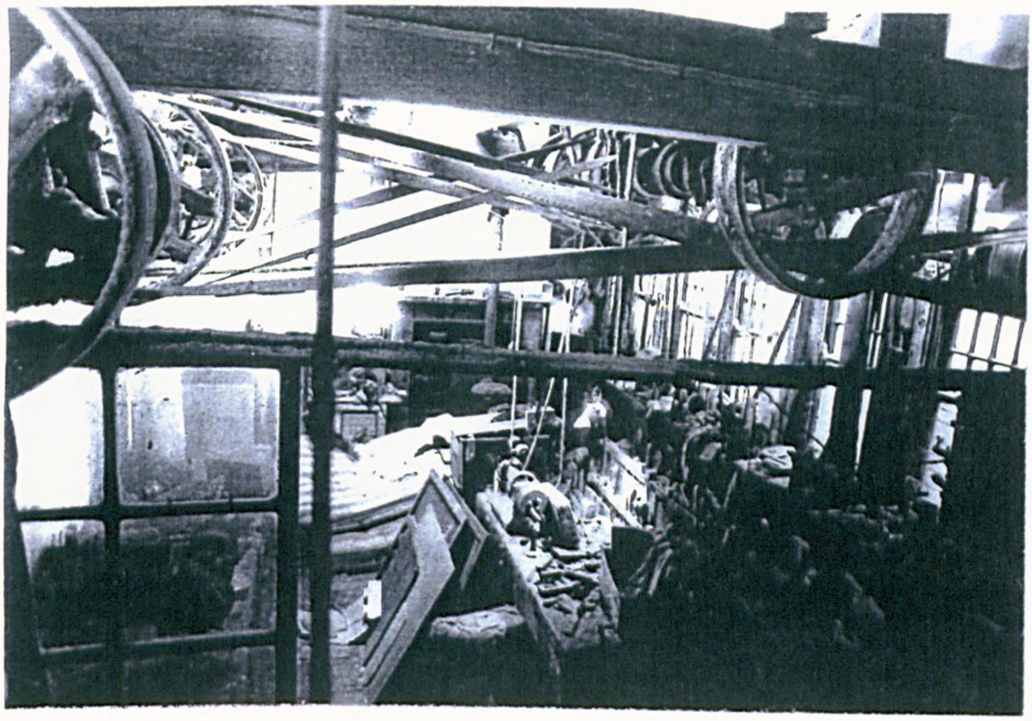


Figure 13: Range found in boot and shoe workshop at Earl Shilton, Leicestershire and now being used in a domestic setting by the owners (Sept 1992).

Figure 14a: Wharncliffe Works, Green Lane, Sheffield. Works of Steel and Garland, stove grate manufacturers. The workrooms are much larger than those found in the cutlery trades.

Figure 14b: Green Lane Works of Hoole and Co, stove grate manufacturers.

In some cases as at Nook Lane the hearth and the fireplace shared the same flue. In other small workshops the hearth provided enough, if not too much warmth, and a fireplace was not required.

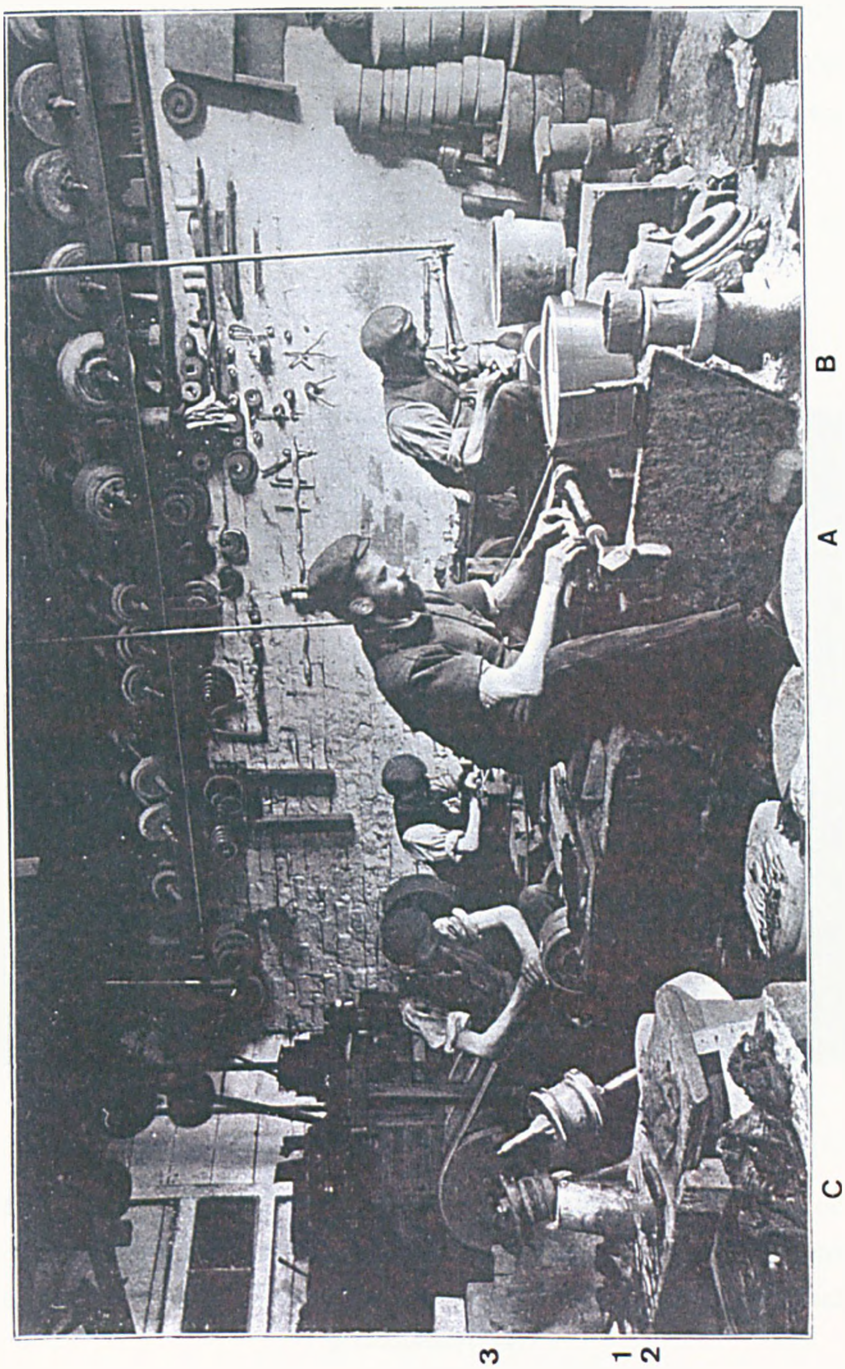
Grinding.

After forging the blade of a knife is sent to the grinder to give it an edge. The grinding wheel, for wet grinding, is mounted in a trough made of wood, stone or concrete (as at Butcher's Wheel) or iron as described in the 'Workshops of England'[17] at Mappin Brothers. The water in the trough covers a two inch segment of the wheel. Wet grinding was used for all 'heavy' work and from at least the 1840s for pen and pocket knives.[18] For a table knife grinder the wheel was usually 4 ft to 4ft 6in (122-145cm) in diameter which would be worn down to about 21 inches (53cm) and then be passed on to a pocket knife grinder who could use it until it measured fifteen inches in diameter.[19] The smallest types of grinding stone, as small as one or two inches in diameter (2.5-5cm), were used for hollow-grinding open razors (Figure 15). At the end of the century, sandstone wheels were replaced by artificial or emery wheels. These were regarded as being safer as they did not contain flaws and 'there would be no grit flying around'.[20] The wheels were fixed on to the axles using wooden wedges, although in some instances iron plates were noticed by the Children's Employment Commission. The latter method was considered to be much safer as it added strength to the centre of the stone and reduced the risk of breakage.[21] As a result of the variation in sizes of grindstones the troughs also varied. The German Wilson papers give the size of a 'Blade grinders Trow':

> Wood ...sides 3in thick bottom 4in thick ends $2^1/_2$ in thick 2'2 deep inside, 5 feet long at top 5 feet long at bottom inside width 14" at bottom, 15" at top with one end 21" deep with three bolts through one end and 4 at other.[22]

[17] Strass, G.L.M. et al 1864 Workshops of England Groombridge and Sons, London p112
[18] Lloyd, G.I.H. 1968 p46
[19] Turner, C.A. op cit.. P 19.
[20] Bill Hukin in On the Knife Edge 1989 p64
[21] White, J.E. 1865 Appendix to the Fourth Report op cit.. P 9 para 92.
[22] PhC 530/1 p15 Sheffield Archives

Figure 15: Hollow razor grinding at John Clark's Mowbray Street c1921 (Photo from Hawley Collection). Note the size of the grindstone (A1). Also seen in the photograph is the grinders' kit (B2). Behind the grinder the blades are being polished. The glazing wheels, covered in glue and emery, can be seen hanging on the wall in a wooden rack. The wooden drums from which power is transmitted from the main shaft can be seen at the back of the workshop (C3).



A Pocket Knife grinders trough was stated as being:

> '42 inches long by 12" wide by 1'6" deep. Axle trees for razor grinders when new 32 inches long to make three deep framing not less than 9 feet long.'[23]

The cost of installing troughs is also mentioned in an estimate for Henry Payne of Wadsley. To install twelve table blade troughs and 36 razor troughs, including all the shafting, pedestals, drum boards and trough framing would have cost £312-0-0 in 1865. The drums were to be three feet in diameter with metal ends and red deal coverings, and the trough frames and drum boards were to be of 'good red deal with metal gains'.[24]

The grinder sits on his horsing, a wooden saddle which is attached to the floor by means of large chains (Figure 16 a & b).

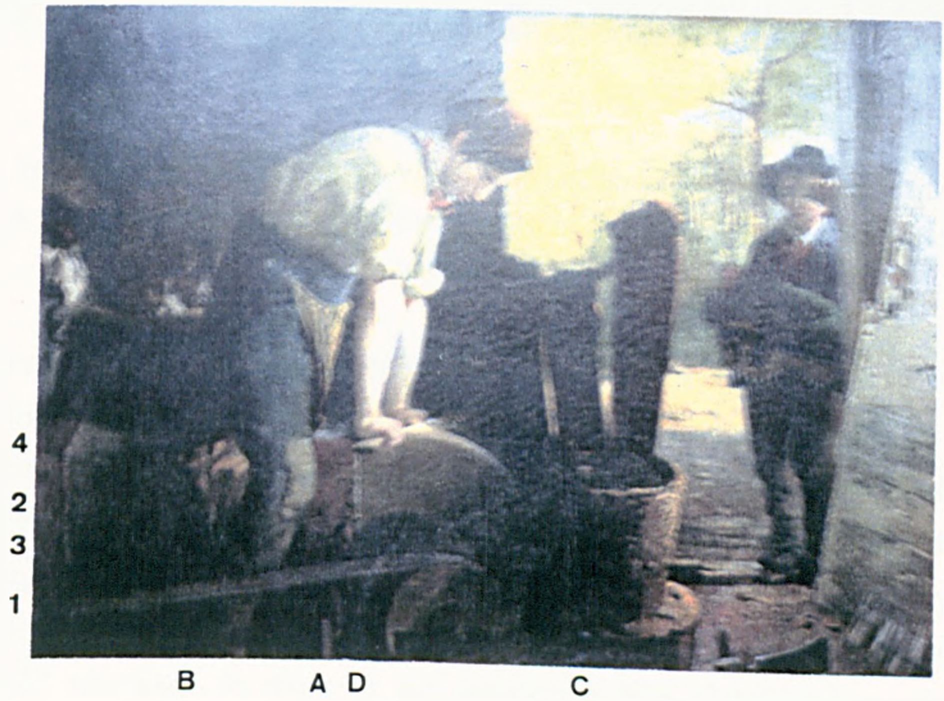


Figure 16a: 'The Two Grinders' c1890 by G Sykes (Kelham Island Museum; K1923.3). Note the heavy chains (A1) used for holding down the horsing (B2). The grinder's kit can be seen (C3). Note the 'flatstick' used by the grinder to apply large blades to the grindstone (D4)

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[23] PhC530/1 p21

[24] PhC 530/2

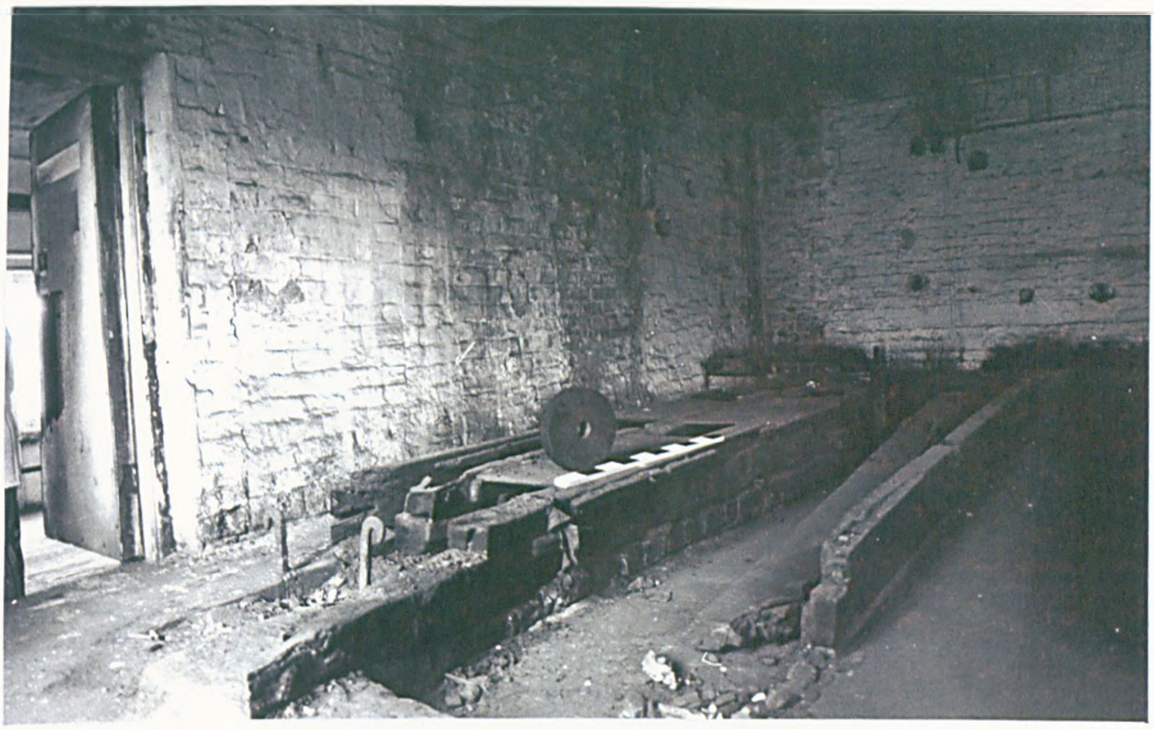

Figure 16b: Grinding Hull, Butcher's Wheel, Arundel Street. Note the wooden troughs on brick bases set three deep and the hooks which once held the chains attached to the horsing (A1).

On average the horsing is fourteen inches wide[25] and may be raised or lowered by adding or removing wooden packs so that it is always level with the top of the wheel. Bricks, stones, or blocks of wood were placed under the feet so that the elbows could be rested on the knees. This produced the effect of ensuring that every blade was placed on the wheel in the same way thus introducing an element of consistency. To apply a large blade to the wheel a 'flatstick' was used. In front of the grindstone was placed the swarf board which caught all the swarf (or muck) off the blade and wheel as it is ground. The grinder's 'kit' consisted of a bucket of water in which blades were cooled after grinding[26] and which could be used to keep the water in the trough at the right level.

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[25] White, J.E. 1865 op cit.. para 48 p 5.

[26] Present day grinders also add a wetting agent

Grinding wheels may be set individually or up to three deep. This can be clearly seen in the second floor hull at Butcher's Wheel, in the Pawson and Brailsford illustration, (Figure 17a)[27] and at Birley Meadows (Figure 17b) as painted by Stevenson where saw grinding took place. This illustration shows that for saw grinding the grinder stood up so that his whole weight could be used to hold the blade against the wheel.

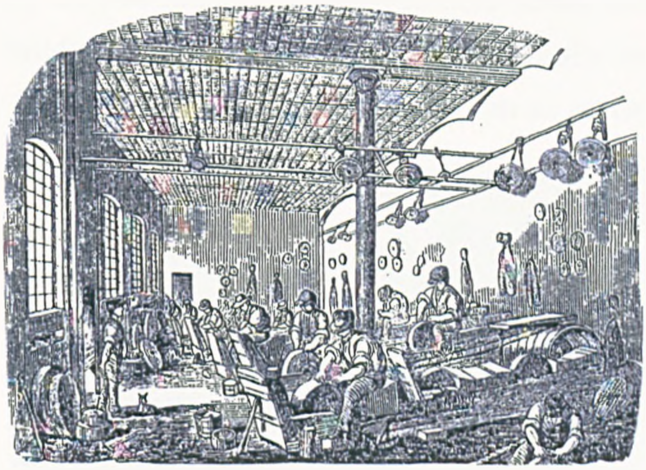

Figure 17a: Illustration from Pawson and Brailsford of a grinder's hull. Here the setting of wheels three deep is clearly seen. Note also the swarf board (A1). Blocks were often placed under the grinder's feet to support the arms (B2). It is common in grinding hulls to see glazing wheels suspended on racks on the wall and ceiling. In this illustration the use of brick jack arches and cast iron columns can be clearly seen and the presence of the overseer (C3) suggests that this is an integrated works.

Figure 17b: Saw grinding at Birley Meadows by Stevenson 1876 (K1971.463). Note that for heavy grinding the grinders stood to apply pressure to the blade with the aid of a 'flatstick'.

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[27] Taylor, J. 1879 **The Illustrated Guide to Sheffield and the Surrounding District** Pawson and Brailsford, Sheffield. p136

The evidence that remains for grinding varies according to the condition of the building. The horsing, like the blocks on which the feet were placed, has in most cases been removed, however the hooks for the chains may still exist as at Butcher's Wheel. The swarf board was usually made of wood and once again will not survive once the building has gone out of use. The grinder's 'kit' will have disappeared. Occasionally grinding wheels and the mounting blocks (Figure 18) may be found, especially in rural areas, scattered around the remains of the building but in the towns they have usually been disposed of. If they did remain they are likely to have been sold on as garden ornaments.

1

A

Figure 18: Remains of a water-powered 'wheel' at Upper Cut (Rivelin). Note the mounting blocks used for the grindstones (A1) (1996).

Other artefacts that sometimes remain include the tool used to true the grindstones called a 'racing iron'[28] (Figure 19), and evidence for the products that were either not finished or were not good enough to be sold if the building has remained undisturbed since the firm left.

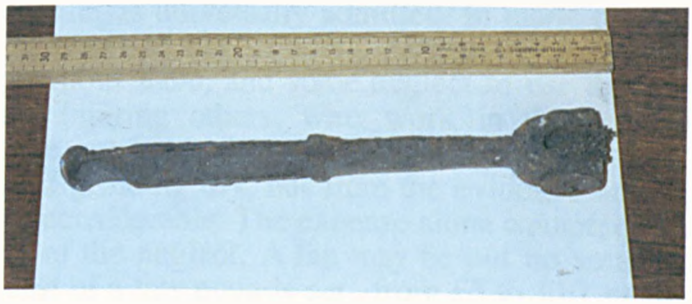

Figure 19: Racing iron, used to true up irregularities on a grindstone. Found at Butcher's Wheel (Sept 1995)

Swarf is evidence for wet grinding but its presence in a building is not necessarily proof of grinding at that particular site. In the last chapter it was shown that swarf could be incorporated into plaster for ceilings and Alan Day recalls fetching swarf from Swann's, saw grinders, to clean the emery and glue from glazing wheels.[29]

Fans

The use of extractor fans was not widespread within the industry although it had been demonstrated that they helped to improve the air quality within the workshops.[30] Thomas Roebuck for example, when giving evidence to White for the Fourth Children's' Employment Commission in 1865 said that he had found 'great benefit from it'[31] and James Bingham, manager of razor grinders at Messrs. Wostenholm's, reported that 'When I was first in the trade the average age of razor grinders at death was 34. Now it is much raised by the fan, and we have some men of good age'.[32] However in White's report there are many more interviews which give details of the absence of fans in the

[28] Dyson, R. 1979 op cit. p34
[29] Interview with Alan Day 16/4/1995
[30] See the evidence produced in White's report to the Children's' Employment Commission 1865 Appendix to the Fourth Report. Evidence.
[31] Evidence 15 from Whites report 1865 op cit.. p16.
[32] Evidence 37 White's report 1865 op cit.. P 19.

grinding hulls and workshops and the reasons why. In his introduction to the report White states in paragraph 43:[33]

> 'The great benefit of fans in protecting the workers from dust in dry grinding of every kind, indeed the absolute necessity of them for the preservation of health, is universally admitted. In many places fans are put up and used, but numbers of dry grinders, particularly fork grinders, who need them most, are without them, and some neglect to use them even where they are out up, thus injuring others, who work in the same hull, as well as themselves. I have not been able to ascertain the proportion of workers who do not use them at grinding dry, but from the evidence and from what I have myself seen, it is considerable. The expense alone cannot, or at any rate should not, be the cause of the neglect. A fan may be put up so as to protect several workers at the cost of a few pounds e.g., from £5 to £10, or for much less, e.g., from 30s to £3, for only one. Where there are fans they are sometimes used by glaziers and polishers as well as grinders.'

The reasons quoted by the men and women interviewed by White for not installing fans, or if they were installed prohibiting them from using them, ranged from too much noise to 'the trade was bad enough as it was; and if the men lived longer it would be so over full there would be no such thing as getting a living'.[34] In the case of Patrick Stavin's evidence[35] the fan was not used because the pipe was choked. William Dyson believed that not one wheel in three had a fan installed. 'What do I want with a fanny, a short life and a merry one is their rule.'[36] Another reason for not using a fan in the polishing processes was given at Joseph Rodgers and Son, Norfolk Street as 'the draught cools the metal and prevents it from polishing so easily'.[37]

From the documentation above it is not surprising that very little evidence survives for the use of extractor fans within the workshops and grinding hulls of the cutlery trades. In the grinding hulls, such as Butcher's Wheel, there was no evidence for their use but this was probably because wet grinding was taking place here and the dust would be kept down to some extent by the water. Grinders' dust can still be sensed in many of the buildings visited today.

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[33] White, J.E. 1865 op cit.. p 4 para 43.
[34] From J.C. Hall's treatise on the Sheffield Grinders Disease, quoted by White in his report op cit.. p13-14 For failure to install fan due to noise see also no26 op cit. p 18 the evidence of Edward Sotheran.
[35] Number 18 in list of those giving evidence to White in 1865 op cit.. p16
[36] Number 40, William Dyson, scissors grinder 1865 op cit.. p 21.
[37] Paragraph 31 White's Report 1865 op cit. p19.

In rural areas fans were not used because the grinding hull windows were not glazed and therefore the dust could escape easily. In other shops, used for cutlery, found in rural areas there is also no evidence for fans being used. The hours of work were not regulated in the villages as in the town and if the workshop became filled with dust it was possible to escape outside. It was commented upon by John Mason at Beardshaw's Wheel that:

'There is one of the most extraordinary ideas here that ever was. The windows, which had all been put in lately, are made so that they will not open. If you came in when we are hanging or racing a stone[38], neither you nor any man living could see us for the dust. It hangs about for an hour afterwards.' [39]

The only archaeological evidence for the use of fans is connected not with grinding but with the polishing and glazing of goods. For example at Kirkanson's, 50 Garden Street, at the present working firms of A Wright and Son on Sidney Street and at Stan Shaw's workshop at 52 Garden Street.

The extractor fan has a hood which is positioned on the workbench over the grinding and polishing machinery (Figure 20 a and b). From here pipe work would take the dust to the outside. The fans would be powered from a line shaft, creating a vacuum which sucked the dust into the pipes. At Kirkanson's it was said that huge clouds of dust could be seen emerging from the flue into which all the pipes fed (Figure 21) and the courtyard was full of it. Hence the problem was shifted from inside the workshops to outside. The dust would be collected, so the evidence in White's Report suggests, and used in lime mortar. In some cases, where the work bench survives, the evidence for a fan being fitted would be a piece cut out of the front of the workbench; this was about twenty centimetres by five centimetres; alternatively there might be a hole in the centre of the bench twenty centimetres by fifteen centimetres. Some pipe work may survive under the bench.

[38] These processes are carried out to make the stone run true.
[39] Evidence no 27 White's Report 1865 op cit.. p18

Figure 20 **A:** Extractor fans used with polishing machinery in display at Kelham Island set into the front of the bench and **B:** at A Wright and Son where they are set in the middle of the bench.

A

B

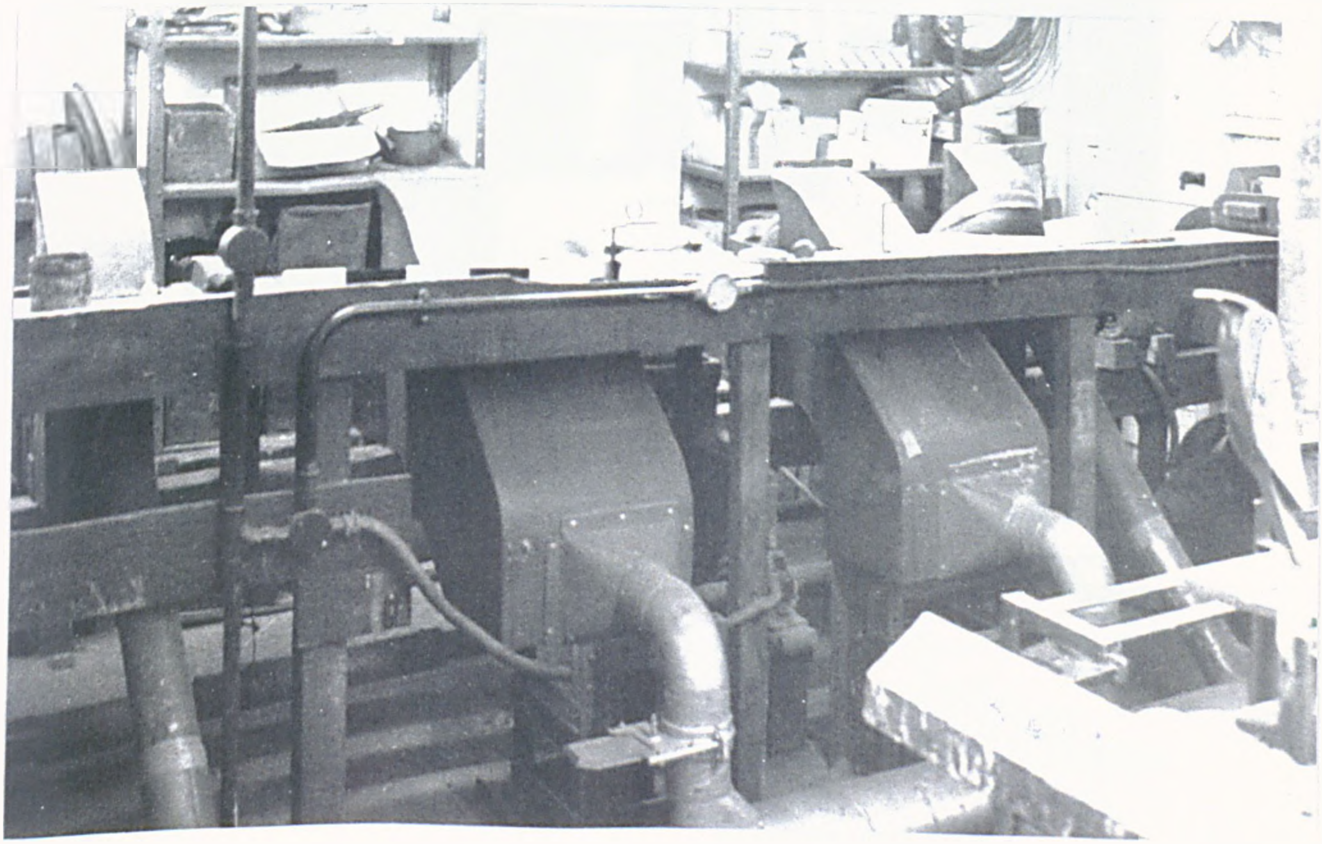

Figure 21: The external evidence for extractor fans at Kirkanson's, 50 Garden Street. The yard used to be covered in dust which was extracted by the fans from the workshops. This was collected and sold to be incorporated into mortar.

The Cutler

From the grinder the blade would be passed on to the cutler who assembled the knife and put the handle on. Traditionally the handles or outer scales of the knife would be pearl, tortoise shell, abalone[40], stag, ivory, bone, or buffalo horn. From the 1860s new materials were introduced such as celluloid and from the 1880s products with handles made from vulcanite, xylonite and ebonite became available.[41] Evidence of these materials can often be found in the workshops either in their raw state or partially worked. The inner scales of pocket knives were made of iron, brass or steel.

In 1843 *The Penny Magazine* described the cutler as working at:

'A small bench near a window, and is provided with a number of tools to facilitate his operations - such as a vice, a small anvil, several files, steel burnishers, a drill-bow and drills for boring holes, a glazer coated with emery, a polisher coated with oil and rotten-stone, steel plates to act as gauges in making holes through the various parts of the knife, and numerous other appliances which we cannot enumerate. With the aid of these he shapes and adjusts his various pieces, fastens them with pins or rivets, files down these pins to give them a neat and level appearance, polishers every part after it is fixed; and, in short, he does to a pen knife what every watchmaker does to a watch- he makes very few of the parts, but he adjusts them all.' [42]

The most important part of any cutler's workshop was the workbench. This was usually made up of two or three lengths of timber (Figures 22a). Other examples can be seen at Kendal Works (Figure 22b) and Kirkanson's. Any workbench found less than one inch thick was probably not used for cutlery and may have been a warehouse bench, such as can be seen in Butcher's Wheel and Kendal Works (Figures 23 a+b).

The cutler would keep his tools on the work bench. These included as the quote in the Penny Post illustrates, a vice, a small stiddy or anvil, files and a bow-drill or parser. Hammers were also used and their weight depended on the type of hafting materials being used. Sometimes files and hammers were kept

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[40] Any mollusc of the genus *Haliotis*, with a shallow ear-shaped shell having repertory holes, and lined with mother of pearl. (O.E.D. 1990)

[41] Pollard, S. 1959 **A History of Labour in Sheffield** Liverpool University Press p 129

[42] Quoted in Tweedale, G. 1993 **Stan Shaw, Master Cutler: The Story of a Sheffield Craftsman.** Hallamshire Press p62.

Figure 22a: Cutler's Workbench, Kelham Island. Note the thickness of the timber.

Figure 22b: Workbench at Kendal Works, made up of short lengths of timber. Note line shaft under bench. (Photo: Sanella, 1994)

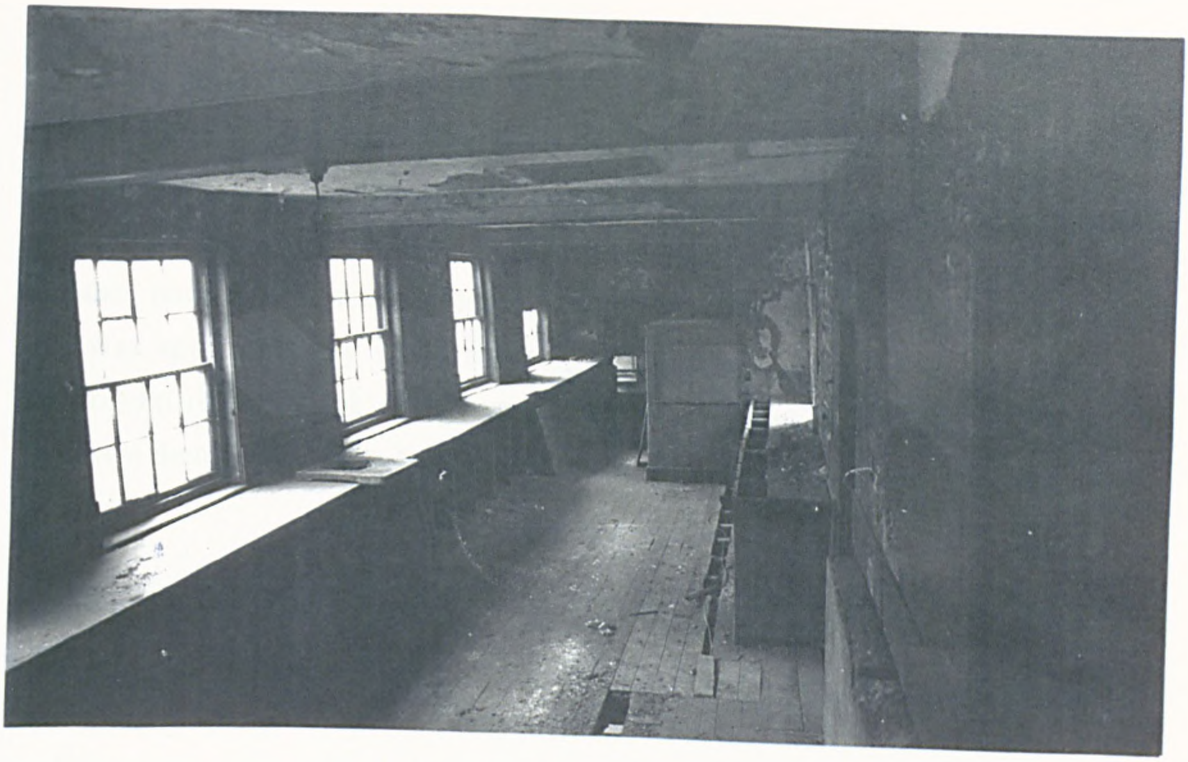


Figure 23a: Packing Shop benches at Butcher's Wheel.

Figure 23b: Packing Shop bench at Kirkanson's, Garden Street.

in wooden racking mounted on the walls above the bench. The various wheels required for finishing the knife were usually made from wood and would be covered in emery for glazing or made from soft calico for polishing. Often the final finishing would be sent to specialists, usually women, for buffing. The vice which the cutler usually had was termed a leg vice. Sometimes they were mounted on wooden blocks to adjust the height to a comfortable working position. They were used in preference to bench vices because, until casting was perfected, they were easier to make.[43] In size the leg vice was approximately 39-41 inches[44] (1m-1.05m) in length from the jaws to the bottom of the shank. They were made of iron, sometimes with steel jaws. The jaws themselves were $4^1/_4$ (11cm) inches long and half an inch in thickness (1cm).

The tools rarely survive in the workshops. Even the racking on which they were kept, as shown in Baker's "The Cutler's Shop in Uproar" (Figure 24), have usually disappeared. The only evidence for the tools, if the work bench itself survives, is a small square hole where the shank of the stiddy had been fastened or bolt holes for a vice.

Buffing and Polishing

To polish up the knives before the advent of steam power treadle glazers (or leg frames) would be used. These consisted of two uprights supporting a glazing wheel and placed on a small bench. (Figure 25a). Below the bench was a large wheel through which an iron crank shaft was placed and to which a wooden treadle was attached. A leather belt connected the wheel and the spindle of the glazing wheel. By treadling the pedal the glazing wheel was turned and the blades could be polished. Treadle power left the hands entirely free to apply the blade to the wheel. Even young children could use these, as a block of stone could be placed at the side of the treadle to stand on.

Steam power meant that more advanced glazing and buffing machines came into use. In Figure 25b shows the modern machine to which the different heads are attached for glazing or polishing. These machines and wheels could

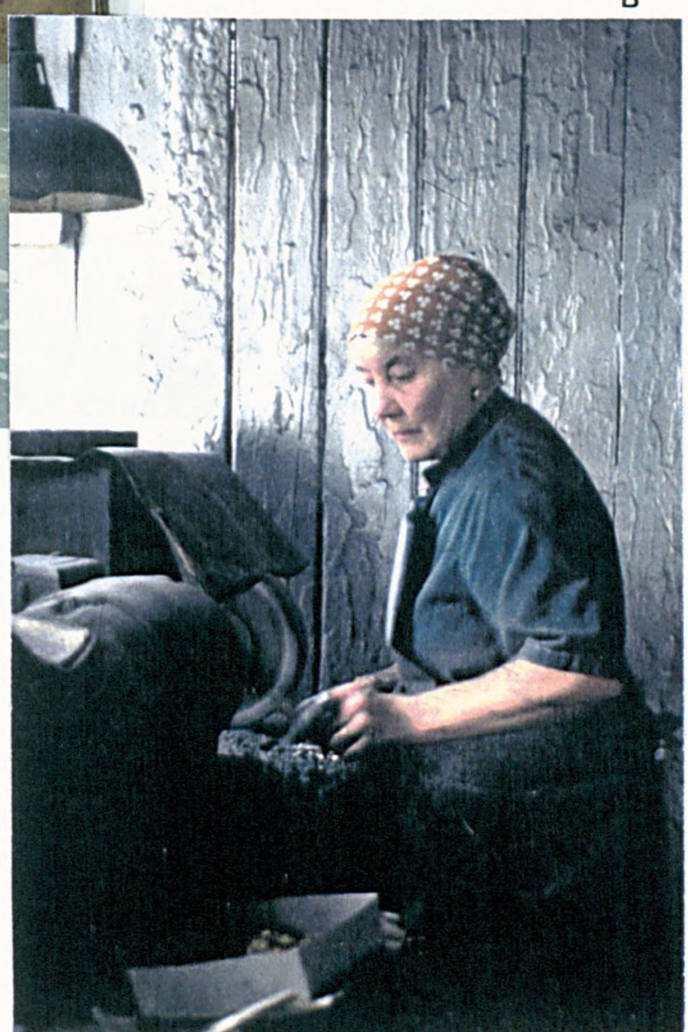
[43] Pers. comm. Ken Hawley May 1996
[44] Vices in the Ken Hawley Collection.

Figure 24: The Cutler's Shop In Uproar (Baker, W.E. Kelham Island K1919.20). Note the racking for the Tools (A1), the Treadle Glazer (B2), the Parser or Bow Drill (C3) and the Leg Vice (D4).

Figure 25 **A**: Buffing and Polishing used to be carried out on a treadle glazer or leg frame. **B**: Today it is carried out on machines to which different heads can be attached and which have integrated electric motors. Polishing machines driven by shafting however are still considered superior by some as they ran at a faster speed giving a higher quality finish (Pers comm. silver worker, Leah's Yard).

A

B



be bought from firms such as Farrer and Son on Division Street (Figure 26). Once again no evidence would be left for this type of machine other than the bolt holes which attached it to the bench. Once the firm had closed the machines could be sold on for use elsewhere or for scrap value. The racking on which the wooden glazing and polishing wheels were suspended will also have disappeared although some wheels may remain.

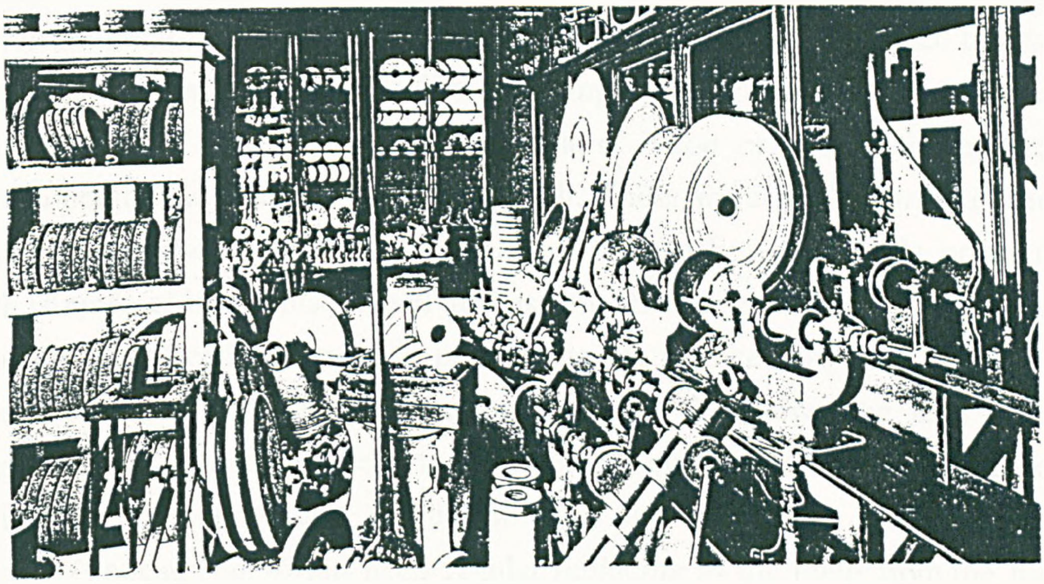
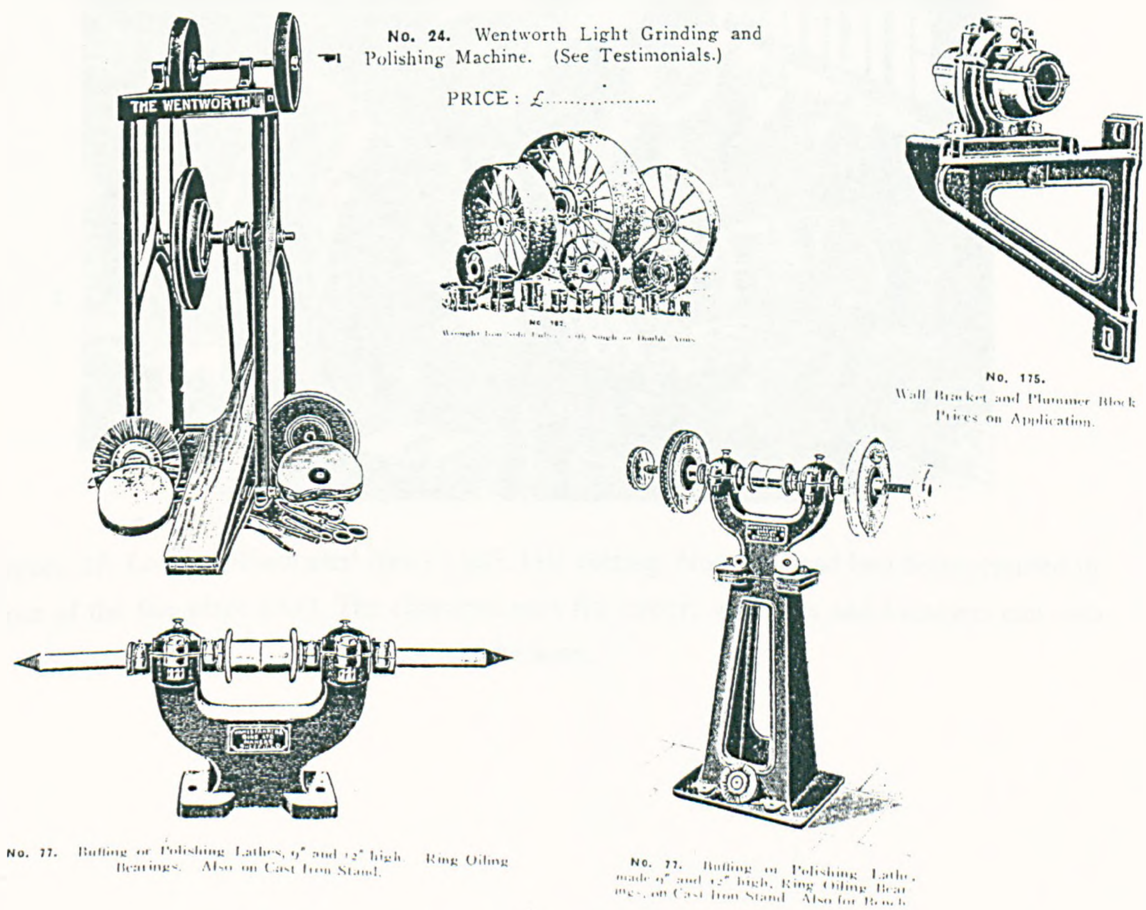


Figure 26: The show room of J Farrer and Son, Division Street. Note the different types of buffing and glazing wheels available. Farrer also supplied grinding, buffing and glazing machines, line shafting and belting (see below).



Some Characteristics of the Premises of Specialised Trades.

File Cutters' Workshops.

The file cutters' workshops within the town have very few characteristics to distinguish them externally from other branches of the cutlery trades but in rural areas and away from the tenement workshops they have a completely different internal layout to the other branches of the cutlery and related trades. Instead of the main piece of equipment being the workbench, a stock and stiddy were used. The stock could be made of wood or stone and about a metre in height and 30cm in width and depth. These were partly buried in the ground to increase stability. In the centre of the stock is the stiddy or anvil which is made of iron. This formed the base on which a lead 'bed' was placed to cut the files. Lead was used to protect the teeth once they had been cut because they had not yet been hardened. Figure 27 shows the lead beds being made or 'teemed' by the man in the background. The bowl adjacent to the hearth in Stepping Lane (Figure 5a) may also have been used for this purpose. The lead bed would need regular replacing as the teeth from the file would cut into it thus making the surface uneven and difficult to work on.

Figure 27: *London Illustrated News* 1866, File cutting. Note the lead bed being teemed in front of the fire place (A1). The characteristics file cutters windows and hammers can also be seen.

It has been alleged that due to the incidence of lead poisoning, file cutting had an equally if not a higher number of deaths than grinding. George Greaves, a file cutter in Ecclesfield, reported that :

> 'Though we do not appear to touch it (the lead), it does reach us. You can see the fine dust always rising from it when the file is struck...Besides, we are constantly handling the lead to shift it, to place it right for the work; and often when are fingers are too dry to hold the chisel we put them in our mouths to wet them; and we often have to brush off the dust from the iron-plate on which the lead rests with our hands, or the lead would not lie firm....With the average kind of file...a piece lasts about a day. We keep moulds in which we 'teem', i.e., cast our own lead, and use up the old thin pieces.'[45]

The files were held down by means of leather straps attached to the feet as seen in Figure 28a. To cut the files small triangular chisels and a file cutter's hammer were used(Figure 28b).

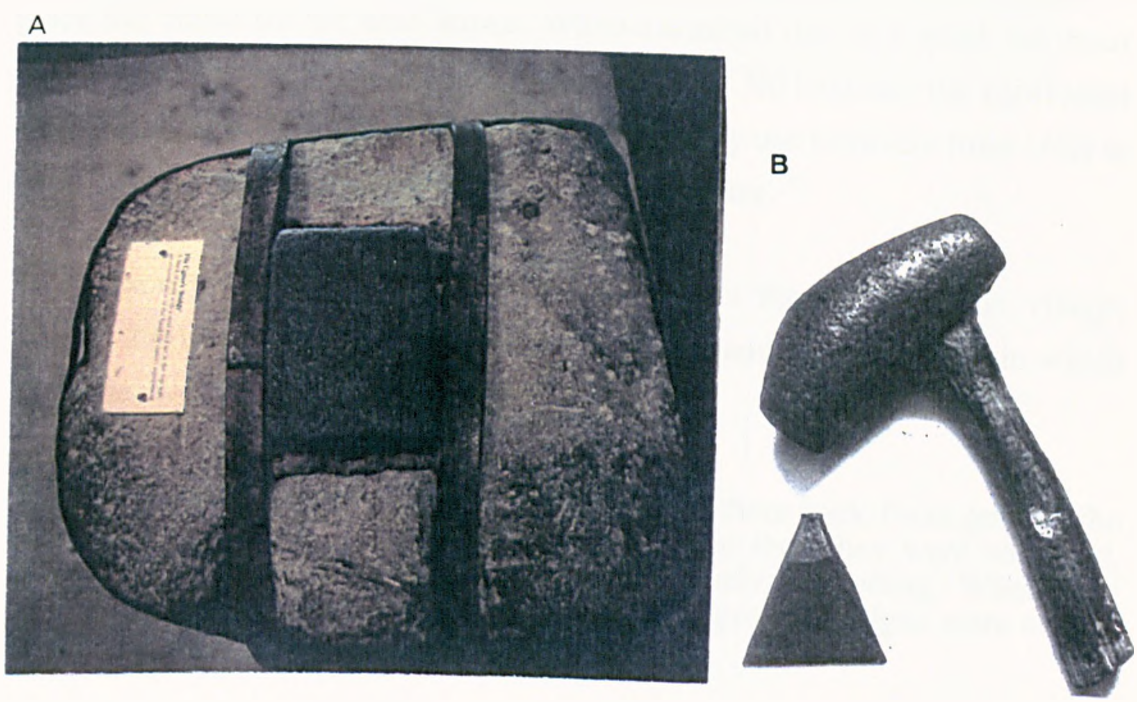


Figure 28a: File cutter's stock and stiddy. In rural areas the stocks are always of stone. The stiddy was made of iron and occasionally steel faced. On top of this was placed the lead bed. The files were held in place by leather straps with stirrups which attached to the feet. b: File cutter's hammers weighed between a quarter and seven pounds. Small triangular chisels were used to cut the files. Those depicted belonged to Mr. Ellision's father at Grenoside.

[45] Evidence no 132 White 1865 op cit. p 36

White in his report to the Fourth Children's Employment Commission used evidence from the two principal centres of file cutting, Ecclesfield and Oughtibridge. He describes the process thus:

'The working position is constrained and uncomfortable, the seat being a sharpened edge form or horse, on which the cutter sits astride, the left foot being raised on a step on one side of a broad block in front to bring the leg up as a support to the chisel arm, the right foot on the other side holding down a strap passed over the file to hold it in its place when struck. The body leans over the block. To keep the under side of the file from being injured by the iron plate on the block while the upper side is being cut, the file is rested on a small piece of lead of the size and shape needed.'[46]

The work was carried out by men, women and children, the women and girls in particular being good at the smaller files. The process was carried out using the sense of touch rather than sight, the expert cutter knowing exactly where to place the chisel for the next stroke. White estimated that in a good ten hour day a file cutter might make 46,000 stokes with a 7.5lb hammer, the equivalent to lifting 142 tons. The boys and girls would usually use hammers from 1/4lb to 3lbs, but the work carried out with these was quicker. [47]

Mr. Ellison, from Grenoside, whose father was a file cutter in the village, (Figure 29a) described the process of file cutting and the workshop in which his father worked:

'Firstly he would have to collect them and bring them back From getting the blanks they had to be greased with an oily rag and then they were whitened, just with ordinary whitening. Then they were ready for cutting. When they had cut them, it was usually my job to file the edges. The edges were always rough.'[48]

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[46] ibid para 131 p 35
[47] ibid para 60 p6.
[48] Interview carried out with Mr. Ellison 21/3/1995

Figure 29a: Mr Ellison's file cutter's workshop, Grenoside (A1) c1920.

In the workshop there was (Figure 29b):

'A wooden barrier to keep the cold off. The stithies and the seats are shown. There was a leather strap fastened at that end, it came over (the stithy) and he put his foot in this end to hold it down and that held the file. A piece of lead four to five inches long [10-12cm] and 2.5 inches [6.3cm]wide and one inch thick [2.5cm]was used. That was to take the bounce and to protect the teeth that had already been cut and that had been put underneath.' [49]

The hearth, bellows and a stithy on which Mr. Ellison's father forged some of his tools and the grindstone on which he sharpened them is also shown. In workshops with no power the grindstone was turned by hand. There was also a fireplace. Under the window was a small workbench c20cm (7.87in)wide where the files not being cut were placed. The grindstone in the workshop came from the quarry in the village. Mr. Ellison's aunt and two other female cutters worked in the shop with his father. They would cut a gross of files (156) a week[50] The evidence given by Mr. Ellison illustrates that from 1865 to 1920 the methods used in the file cutting industry did not change.

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[49] Pers. comm. Mr. Ellision 21/3/1995

[50] This is cutting thirteen files to the dozen. There was a practice in Sheffield that a dozen consisted of thirteen but it could be as much as fourteen or a standard twelve. The practice varied from firm to firm.

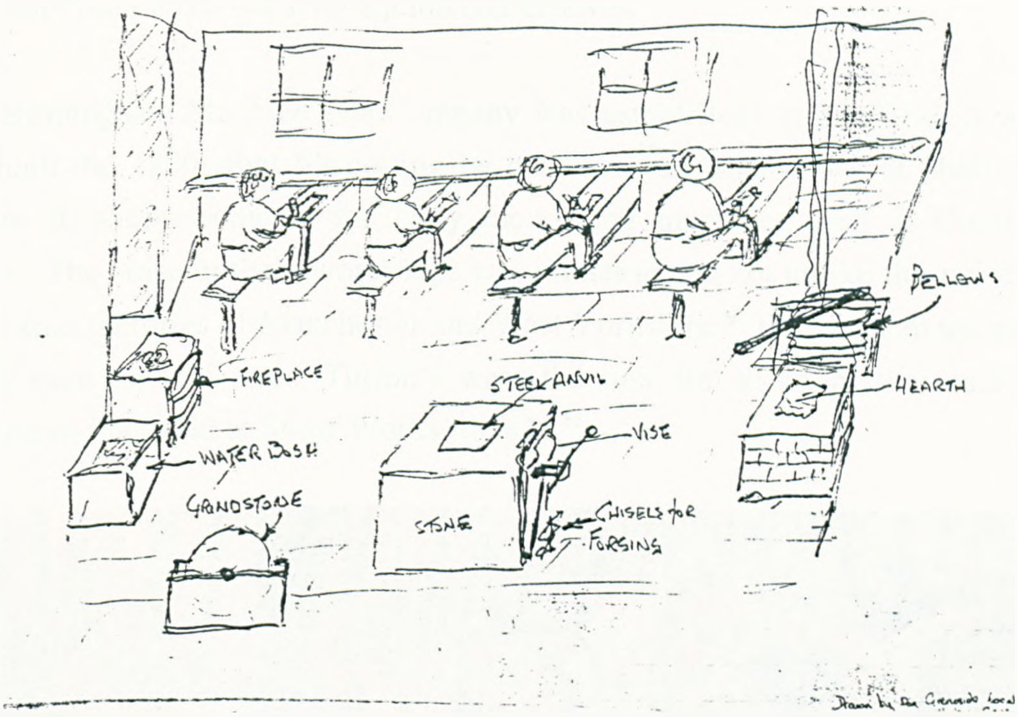

Figure 29b: Interior of file cutter's workshop drawn by Don of the Grenoside Local history Group. Note that file cutters should be women.

Machines were not successfully introduced until the end of the nineteenth century. Attempts had been made in the 1850s to mechanise the process in places such as Leeds and Manchester but these produced inferior goods.[51] The Nicholson File Companies' 'Treatise on Files' published in 1878 stated that the main problem with machine cut files was that they were too evenly cut. 'Such extreme regularity causing, in double cut files,[52] when put to use, the exact counterpart of the equidistant grooves to be found in the file; and in single cut files, a chattering and jarring sensation, at the least not pleasant to operate.'[53] Their answer was to make the "Increment" cut file where the teeth were spaced progressively wider from the point to the middle and smaller again towards the heel. The rows of teeth were also not cut exactly parallel

[51] Pollard, S. 1959 **A History of Labour in Sheffield** Liverpool University Press p127.
[52] This is where the file is first cut one way and then the other to produce a hatched effect.
[53] Nicholson File Co 1878 **A Treatise on Files and Rasps** Providence U.S.A p 56.

but at slight angles to each other thus enabling the file to cut more rapidly and smoothly than a file cut with equidistant grooves.[54]

The Birmingham Machine File Company was established in 1863 but it was not until the 1880s that file cutting by machine was carried out in Sheffield. Figure 30 shows some of the early file cutting machines used at Cammell Lairds. The noise in these workshops was immense and not unlike the noise in the textile factories of Manchester and West Yorkshire.[55] These machines were never used in rural areas. Turton's were the first firm to adopt the machine method in Sheffield at Sheaf Works in 1875.[56]

Figure 30: Machine File Cutting at Cammell Laird's.

The evidence remaining inside a file cutter's workshop is usually minimal. Occasionally the stocks and stiddies/stithies[57] survive as at 9, Woodside Lane (Figure 31a), Grenoside and at Crown Works, Ecclesfield. Crown Works was a small scale works. The complex, seen in Figure 31b, consisted of the file cutting shop; a warehouse and packing shop; the hardening shop, where the

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[54] ibid. p 57.
[55] Pers. comm. Ken Hawley 20/3/96
[56] Turner C.A. 1986 op cit. P 48.
[57] This word means the same i.e. an anvil but local variations account for the two different spellings.

files were hardened and then dropped into salt water to cool; the tanging shop; and stable where the horse and cart were kept to take the goods to market.[58] In the hardening and tanging shops two forgers' hearths could be seen[59] and Turner reported that the warehouse still retained the oiled paper for wrapping goods in the 1970s.[60]

Figure 31a: 9, Woodside Lane, Grenoside. One of the few remaining file cutter's workshops were the stock and stiddies remain in situ.

58 Pers. comm. owner Feb. 1995.
59 Turner, C.A. 1986 op cit. p 45.
60 ibid.

Figure 31b: Crown Works, Ecclesfield. This complex consisted of the file cutting shop (A1), a warehouse and packing shop (B1), a hardening shop (C1), a tanging shop (D1) and the stable where the horse and cart were kept (E1).

Unfortunately, in the other file cutters' workshops identified during fieldwork, all that survives, as at Cross Hill, Ecclesfield (Figures 32), are the remains of the hearth and the stiddy which had been moved into the garden.

Figure 32: Cross Hill Ecclesfield. The stock has been removed from the workshop into the garden and the stiddy has been removed.

At Topside, Grenoside, the workshop has been converted to goats' pens and once again the stiddy has been placed outside (Figure 33 a+b). Topside, Grenoside is rather unusual in that, although it was a file cutter's workshop at some point in its life, it had the windows which were more characteristic of the cutlery trades. Even these have been moved from the 'shop' to the garage.

Figure 33a: The stock and stiddy have been removed to the yard (Topside, Grenoside).

Figure 33b: Topside, Grenoside. The file cutter's workshop has been converted to goats pens.

The internal characteristics identified above are representative of file cutting anywhere in the country as the basic process did not change, although machines were introduced earlier elsewhere. Similarities can therefore be seen in Prescot where the file makers were mainly supplying the watch trade. It is unfortunate that no pictures survive of Peter Stubs' workshops at Warrington. All the pictures in Surrey Dane's biography of Peter Stubs are illustrations of Sheffield file cutters.[61]

Scissor Making

Once scissors had been ground they were sent to the 'scissor putter-togetherer' or 'putter' on scissor sticks. These were long metal rods with an 'eye' in one end on which the scissor handles were threaded. Figure 34 shows a putter at work at Thomas Turner's c1901. In addition to the leg vice

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[61] Surrey Dane, E. 1973 **Peter Stubs and the Lancashire Hand Tool Industry** Sherratt and Son Ltd. Altincham

Figure 34: Scissor 'Putter.' Note the leg vice that would have been used to hold the scissors whilst filing out the 'fash'. Also note the small anvil or stiddy used for riveting the blades together and the shape of the hammer being used. At A1 the rivet board can be seen. The finished scissors are hung up on pegs by the window (B2). Note also the racking used to store the scissor 'putter's' tools (C3).

Figure 35: Wilkinson Scissors. Here the stiddy used for riveting is clearly seen (A1). Note also the 'swage' block (B2) which is used for straightening the blades and bows of the scissors. The greasy rags are also important for holding the blades when straightening them. At C3 scissor sticks can be seen which were used to transport the scissors to and from the forger. Note also the variety of hammers used.

used for truing the blades,[62] a small anvil was also required on which the scissors could be riveted. The rivets were stored on a rivet board. Also essential were greasy rags to protect the hand when straightening the blades[63] Files were used for removing the fash or excess metal inside the handles (Figure 35). As in the other processes connected with the cutlery industry all of the characteristic features are likely to have been removed from the building, leaving only the workbench and possibly any shelving that may have been used for storing finished goods or tools.

Silver Working

When silver was worked, the cutler was very careful not to lose any of the silver between the floor boards. Stan Shaw laid newspaper on the floor to catch the silver. Billy Thornton, saw piercer, had two metal hoops through which were pushed two metal rods holding a piece of cloth which covered his lap to catch the majority of the silver. On the floor, metal sheets had been placed to catch silver which slipped through the cloth. In the case of saw piercing, the silver was weighed out of the factory and back in together with the waste when the products were returned. If any was missing it had to be paid for.

However the evidence for floor coverings is likely to be minimal, especially if newspaper was used, as this will be picked up when collecting the waste silver. The metal sheets will also disappear if the building is unattended for a long time as they have scrap value. If the workbench survives the metal hoops may be in evidence, but the rods and cloth or hide will have disappeared. This type of evidence has not been seen in any of the redundant workshops visited.

Hollow-ware

Although this is not technically connected to cutlery production it is included as many of the buildings used have the same exterior characteristics as those occupied by the cutlery trades (Figure 36).

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[62] This ensured the blade cut its entire length

[63] Pers. comm. Wilkinson Scissors Feb 1996

Figure 36: The exterior of I Gibson's, Mary Street. Note how the windows are very similar to those used by the cutlery industry.

Where spinning of silver and Britannia metal to produce 'hollow-ware' took place moulds may be found as at Cornish Place or Gibson's (Figure 37 a & b). The tools used for the manufacture of hollow-ware in silver, Britannia metal and pewter trades were different from those used in the cutlery trades. As demonstrated at I Gibson and Son, St Mary's Road, tools used for spinning have much longer handles so that force can be applied to the silver without the hand slipping. Where silver, Britannia metal or pewter goods are produced a flat stove for heating the metal in a ladle and several moulds of wood, metal and rubber may be found (Figure 38). Once the contents of the building had been removed there would be little to distinguish a flatware/hollow-ware workshop from a cutlery workshop.

Figure 37a: Moulds used for spinning hollow/flat ware at Cornish Place and I Gibson's.

Lighting Within Workshops

Although the workshops were naturally lit by the window types examined in the previous chapter, the cutlers would have used candles and oil lamps to enhance the light and prolong their working hours. By the 1820s gas was available as a source of light in the town and by the end of the century electricity was available.

Figure 38 **A:** Spinning pewter at I Gibson's. Note that the tools have long handles so that pressure can be applied to the metal safely. **B:** The heating of metal to be poured into moulds is done on a flat heated surface in ladles. **C:** Some of the wooden moulds used for producing decoration and handles for Britannia metal or pewter goods.

A

B

C

The first Sheffield Gas Company was established by an Act of Parliament in 1818 and produced its first gas in 1819 from its premises in Commercial Street.[64] Initially the service only covered the central part of the town, the first pipes being laid to Queen Street, East Parade and Campo Lane, Market Street and Sands Paviors to the bottom of Broad Lane.[65] Within a year of the first gas production, grinders were having problems caused not by the gas itself but by its production. Lime water, used in the purification of the gas, was reported on the 11th May 1820, to be a nuisance to grinders at Blonk's Wheel and others residing near the Sheaf. Unfortunately details of meetings with the grinders are not given. A similar complaint was made by Messrs Booth and Co., knife manufacturers, in 1839 when they complained that coal tar, a by-product of gas production was flowing down their goit to their works and affecting the quality of their work. Once again the results of the investigation made are not reported.

The cutlers saw the Gas Company as a good investment with 28 subscribing for company shares. However the second minute book of the Gas Company shows that of 74 customers paying rent for gas there were only seven firms associated with the Sheffield Trades: Charles Mills, razor manufacturer and dealer in cutlery, Benjamin Parkin, Pocket Knife manufacturer, Martin Marshall, merchant, factor, steel and cut file manufacturer, John Hall, Pen and pocket knife manufacturer, John Smith and Sons, manufacturers of saws, files, edge tools and general merchants, John Milner, penknife manufacturer, and George Smith, file manufacturer.

A new Gas company was formed in 1835. The necessary Act of Parliament for its formation led to a report on the provision of gas in the town and this provides some interesting information about users and uses of gas within the Sheffield Trades.

Problems had arisen with the supply of gas by the Sheffield Gas Company, with reports of its supply being irregular and brown in colour.[66] The investigation which followed showed that it was principally silver workers

[64] Gas Company Records (GCR) 1 Minute Book, Sheffield Archives

[65] GCR1 10/6/1819 and 14/12/1819 Sheffield Archives.

[66] Evidence from Enoch Eaton of Messrs Kitchen, Walker and Curr, to the House of Lords Committee on the bill for "An Act for better lighting with Gas, the Borough of Sheffield in the West Riding of the County of York" printed 10/7/1835 p17.

who used the gas supply as it could be used for soldering as well as for lighting, so long as it was of good quality. Mr Dixon, of Cornish Place gave evidence that although he had 385 gas lights on the premises in the years leading up to the Committee's report he had only been able to light about 300, due to the state of the gas supply, and that the gas could not be used for soldering as 'it has been so pernicious that if we had attempted to have it in the rooms where we solder Britannia Metal it would have injured their health'.[67] He went on to state that had the Act not been proposed he would have attempted to make his own gas on land which he had purchased close to the works.[68] Dixon was not the only one to consider producing his own gas. At Turton's File Steel Manufactory, Mr Thomas Burdett stated in his evidence that they had always used gas of their own making in the workshops and had never used town gas.[69] Smith, Tate and Co. had also produced their own gas for a time. William Shatford, silversmith at the Company, said that they had manufactured their own gas since 1824, Mr Colquhan erecting the gas works, but had stopped as they 'had found it too trouble making and impure'.[70]

The Act was passed and the new company formed, but the minute books give few details beyond the extension of the number of streets covered as to who used the gas, the exception being the complaint of Booth and Co. quoted above in 1839. Details are given on prices, which fell steadily from 1835 onwards. In 1842 the price was 8 shillings and 4 pence per thousand cubic feet, with discounts of 10% if the gross half yearly account amounted to between £10 and £20; 15% was given for bills over £20 and 20% if over £40. In 1843 the price fell to 7 shillings and 6 pence per 1000 cubic feet and in 1844 it was 6 shillings and 8 pence. By 1853 the price was down to three shillings per 1000 cubic feet under the auspices of the United Gas Light Company which was formed in 1844.

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67 James Dixon, employer of 400 on the premises. Evidence to House of Lords Committee 1835 op cit. p10

68 James Dixon 1835 op cit. p 10

69 Mr Thomas Burdett, Turton Steel manufactory. Evidence to Lords Committee 1835 p 30

70 William Shatford of Smith, Tate and Co, Evidence to Lords Committee 1835 p 128

The surveyor of Sheffield in 1835, John Taylor, gave details of the 236 streets covered by gas supply a total of 27 miles, 3 furlongs and 154.5 yards of pipe.[71] By the 1870s nearly the whole town was supplied with gas lighting.[72]

Sheffield received its first public supply of electricity in 1886. The first electrical generating plant was installed by John Tasker at an engineering and repair shop at 29 Sheaf Street. It comprised three horizontal compound condensing engines driving three British Thompson Houson 2000 volt, 50 lamp series arc lighting machines and it is thought that his first customer was William Brown the jeweller.[73] In 1889 a 35 kW 2000 volt single phase Mordey Alternator was installed to provide electricity for incandescent lamps. This however only supplied twenty people and in 1892 the company obtained a provisional order to supply electricity to the whole of Sheffield. A new electricity generating station was built in 1894 in Sheaf Street containing one 35kW, one 50kW and two 100 kW Mordey Alternators manufactured by the Brush Electrical Company.[74] The company's revenue grew from £300 in 1892 to £5000 in 1894. New offices and a generating station were built in Commercial Street in 1895. The generating plant and 2000 volt switch gear was installed by Ferranti Ltd.[75] In 1898 Sheffield Corporation bought the Sheffield Electric Light Company and built a further extension to the generating station in 1900 as demand was outstripping supply.[76]
Electricity however did not necessarily mean improved lighting conditions in the workshop. As late as 1934 *The Electrician* reported on a paper by Mr R.W. Danile on electric lighting. Of the 475 factories and workshops that he visited in Sheffield he estimated that only 27 possessed up-to-date installations for lighting. In one workshop he found three file cutters working by the light of a single candle clipped to an ancient bracket, even though the gas main went past the door. In another there were five workbenches in a room 425 sq. feet in area, illuminated by fifteen 'totally unscreened 150W clear lamps. Lighting was immeasurably improved by the efficient use of only

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[71] Taylor John, Evidence to Lord Committee 1835 p315
[72] The growth of the gas companies and the provision of gas can be following in the Gas Company Records Minute Books GCR1-24
[73] **100 years of Electricity** Yorkshire Electricity Board p5
[74] *ibid. p6*
[75] ibid. p7
[76] ibid. p8

22% of this original consumption.'[77] Where gas was used, bats wing burners or open ended pipe flares were still utilised; even if the landlord had provided a burner these were found to be removed. In conclusion to his findings Danile stated that 'well lit tenement workshops exist but infrequently'[78] and perhaps offered some explanation for the loss of supremacy of the Sheffield cutlery trades in the world.[79]

Alan Day recalled that in the 1930s his father's workshop was lit by unshaded electric lights attached to cables which could be moved to where they were required.[80]

In the archaeological record evidence for previous light sources has frequently been destroyed by the installation of electricity. In rural workshops however no source of light apart from the windows can be seen and in these areas it is likely that the candle and oil lamp continued until the workshop was no longer used.

Moving Raw Materials and Goods Within Buildings

The previous chapter indicated that taking-in doors were rare in Sheffield and that external staircases were the most likely way of moving goods around in larger buildings. Some remains have been found for the use of internal cranes and pulley systems and oral evidence also points to their use. At Butcher's Wheel for example in the southern building a hand-driven crane and one way trap doors (Figure 39a) were installed for lifting grinding wheels to the upper storeys. The directional nature of the trap doors meant that the crane could not have been used for taking goods out of the building. Plans of George Butler's Trinity Works also show the use of internal trap doors to the packing rooms on the first floor but not to the workrooms.[81] Mr. Day records at Sheffield Shears in the 1930s they installed a 'block and tackle' with a pulley wheel in the roof and a rope on which one or two men pulled so that goods

[77] Danile, R.W. 1934 *A reproach to Sheffield: Deplorable Conditions in Factories and Workshops- Dimness, Glare and Inefficiency* **The Electrician Nov. 23 1934** p65

[78] Danile, R.W. 1934 op cit. p 65

[79] Introduction to article **The Electrician Nov. 23 1934** p64

[80] Interview with Alan Day 16/4/1996

[81] 134/19/4 Plan of George Butlers 1904, Sheffield Archives by Hadfield and Hadfield.

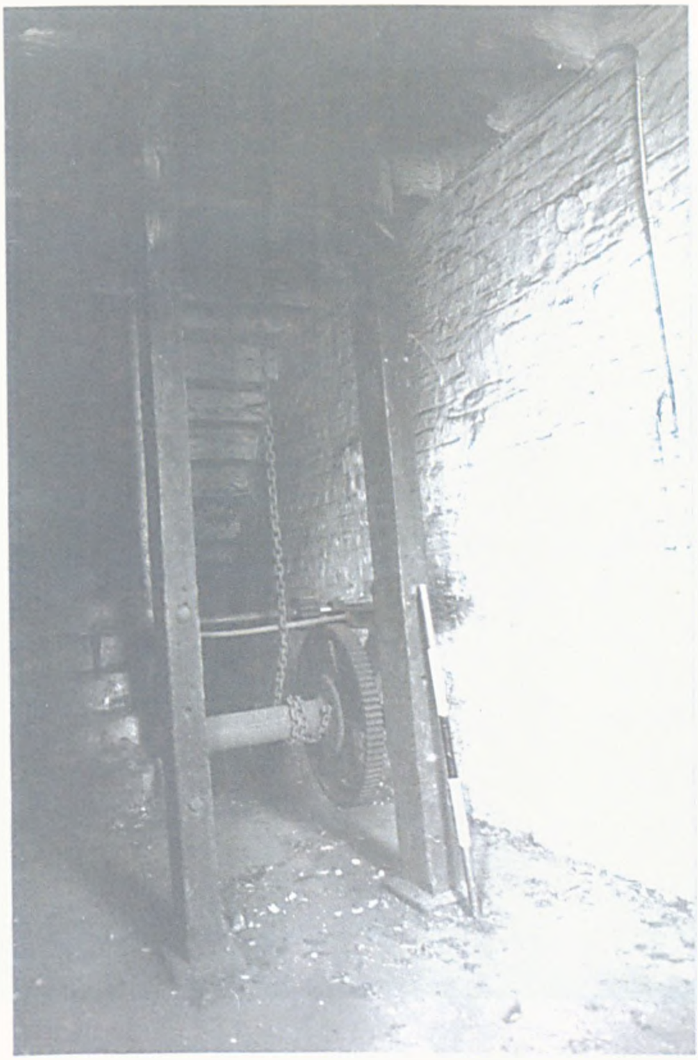

Figure 39a: Internal Crane at Butcher's Wheel.

could be lifted to the packing shop.[82] However, the narrow staircase remained in most workshops, the only option for the movement of goods (Figure 39 b-c).

[82] Alan Day 16/4/96. Taking about works in Gibraltar/Copper Street.

B

C

Figure 39 b&c: Narrow Staircases at Stan Shaw's Workshop Garden Street and Basil Walker's Workshop, Nursery Street.

Spatial Analysis of the Cutlery Workshops.

The present-day evidence that survives in workshops, once used by the cutlery industry, reveals that little detail about the processes of manufacture will survive in the archaeological record. Only where permanent features still exist, such as hearths, will any firm conclusions about the use of the building be reached. To determine how a building functioned, spatial analysis can assist in the interpretation of the inter-relationship of the workspaces.

Rapoport remarked, while commenting on the cultural determinants of form, that vernacular architecture was 'accepted and adjusted to specific requirements...[making] it very specific to its context and place.'[83] He went on to state that 'buildings....are ways of ordering behaviour by placing it into discrete and distinguishable places and settings, each with known and expected roles, behaviours and the like. The more roles, the more behaviours and the more distinct settings.'[84]

The work of Hillier and Hanson in their 'Social Logic of Space'[85] was fundamental in taking Rapoport's ideas and creating an easily understood mapping system to document the internal organisation of structures both buried and standing. Like Rapoport they stated that buildings could be analysed as organisers of space rather than just objects:

'Buildings may be comparable to other artefacts in that they assemble elements into a physical object with a certain form; but they are incomparable in that they also create and order the empty volumes of space resulting from that object into a pattern. It is this ordering of space that is the purpose of the building, the physical object itself......In so far as they are purposeful, buildings are not just objects, but transformations of space through objects.'[86]

Workshop Size

Information relating to size has been derived from the field and building books of the Fairbank Collection, from architects' plans drawn for the planning office since 1864, from maps and from the author's own surveys.[87]

Small-Scale Buildings

The single-roomed workshops found in these buildings usually had a working space of between 10 to 40 square yards (8 - 30 m^2). They would have been occupied by between one and five or six men or women who either owned but more commonly rented the workspace. In some cases the workbenches were sub-let.

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[83] Rapoport, A. 1980 *Cultural Determinants of form* in King, A.D. eds Buildings and Society Routledge and Kegan London p285.
[84] ibid. p 300
[85] Hillier, B. and Hanson, J. 1984 The Social Logic of Space Cambridge
[86] ibid. p1.
[87] The definitions are based on those used in chapters two, three and six

Medium-Scale Buildings

Included in this category are small-scale 'works' such as Kendal Works (a tenement works), A Wright and Son, Sidney Street and Victoria Works, Gell Street containing a number of rooms varying in size from seven square yards ($6m^2$) to 63 square yards ($53m^2$). They could be occupied by a single firm or let out as separate workshops. This type of building, if occupied by a single firm, may also include some office space which is not seen in the small workshop building.

Water-powered sites, although externally the same size, would have had one workroom or 'hull', or have been divided into two parts called 'ends' which were then sub-let, as at Shepherd's Wheel. These would have been between $100yds^2$ and $200yds^2$ (91.44-$182.8m^2$) in size. These would be occupied by between nine and twenty grinders. Water-powered sites did not contain offices within the hull. At larger works such as Abbeydale, a manager's office was often housed in a separate building.

Large-Scale Buildings

Large-scale works such as Dixon's Cornish Place, Butcher's Works and Soho Works, like medium scale premises, had a variety of workroom sizes. In the integrated works office space, large warehouses and packing rooms up to 300 square yards ($250m^2$) in size can be found. The variety of room sizes reflected the number of processes carried out.

Changes in room sizes, for example the increasing floor space of packing shops in large scale works, however, do not reflect a general change in working conditions. These reflected changes in the marketing rather than the production of goods. It is therefore hypothesised that 'cells'[88] of production did not increase in size from 1750-1900.

Workspace Size

Tables 1 to 3 show a selection of workroom areas throughout the period covered by this thesis. The average area in the early field books (1750s) was 42.36 square yards ($35.42m^2$). In the later building books covering the turn of

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[88] A 'cell' is a room. The term is used by Hillier and Hanson when describing gamma maps and by the author later in this chapter.

the nineteenth century the average was 42.76 square yards ($35.75m^2$). The Fairbank evidence therefore supports the hypothesis that the areas of workspace did not change in the period 1750-1800.

Reference	Type	Unit	length[89]	width	Square	Height[90]
1757 Fb11/37	Smithy	yds.	5.75	3.57	20.52	3.57
1756 FB9/109	Smithy (roof)	yds.	5.70	3.75	21.38	-
1754 FB5/2	Smithy (floor)	yds.	4.50	4.90	22.05	-
1757 FB12/90	Smithy (floor)	yds.	5.10	4.90	24.99	2 floors
1754 FB5/1	Smithy	yds.	5.50	4.58	25.19	2 floors
1756 FB9/108	Smithy (floor)	yds.	5.40	5.05	27.27	-
1753 FB3/43	Smithy	yds.	6.25	4.40	27.5	7.00
1753 FB2/01	Smithy	yds.	5.64	4.90	27.63	5.15
1755 Fb9/59	Smithy	yds.	5.65	5.25	29.66	5.65
1757 FB11/37	Smithy	yds.	5.87	5.40	31.70	3.00
1755 FB9/12	Smithy	yds.	7.78	4.50	35.01	5.50
1753 FB2/01	Smithy	yds.	7.80	4.60	35.88	2.40
1756 FB10/29	Smithy	yds.	5.37	7.03	37.75	7.00[91]
1754 FB6/42	Smithies	yds.	8.70	4.45	38.72	7.60
1755 FB9/53	Smithy	yds.	8.75	5.25	45.93	6.44
1757 FB12/80	Smithy	yds.	9.75	5.30	51.68	7.17
1755 FB9/54	Smithy	yds.	10.40	5.05	52.52	7.06
1755 FB8/64	Smithy and Barn	yds.	9.75	5.55	54.11	7.75
1754 Fb3/56	stamping shop	yds.	6.80	8.20	55.76	-
1753 FB3/38	Smithy (roof)	yds.	9.60	6.50	62.4	-
1753 FB3/40	Smithy	yds.	10.00	6.90	69	-
1754 FB3/56	casting shop	yds.	6.80	9.50	71.40	-

Table 1: Examples of the sizes of Smithies from the first 12 Field books. (1753-57).

Reference	Type	Unit	length[92]	width	Area yds²	Height
1791 BB76/88	Smithies (floor)	yds.	3.38	3.50	11.83	-
1796 BB81/2	Workshop	yds.	5.38	4.88	26.25	7.97
1783 BB67/170	Workshop	yds.	4.72	6.22	29.35	3.55
1791 BB76/88	Walls	yds.	8.18	4.02	32.88	5.63[93]
1800 BB84/157	Workshop (floor)	yds.	8.20	5.08	41.66	-
1784 BB69/46	Smithy	yds.	8.55	5.55	47.45	7.50
1787 BB71/84	(Front rooms in GW[94])	yds.	8.05	6.65	53.53	-
1800 BB82/157	Workshop (floor)	yds.	12.44	5.08	63.19	-
1797 BB71/34	Workshop	yds.	14.85	4.60	68.31	8.50
1786 BB70/164	Smithies	yds.	19.75	4.86	95.98	9.72[95]

Table 2: Sizes of workshops as shown in the Fairbank Building Books 1783-1800

[89] These are maxima and do not take into account the variation in sizes that may occur for example where the room is not a perfect rectangle.
[90] To the top of the wall and not including the gable which is usually +2.10-2.50 yds.
[91] Gable end is +3.25 yds.
[92] These are maxima and do not take into account the variation in sizes that may occur.
[93] Gable = +1.20 yds
[94] GW = Grinding Wheel (in this instance Castle Orchard Grinding Wheel)
[95] Gable = +1.45 yds

Reference	Type	Unit	length	width	Area yds²	Height
Stannington	Razor Scale	m	4.25	3.35	17.03	-
Stannington	Razor Scale	m	4.06	3.80	18.45	-
1874	File cutters	ft	9'	23'	23.00	9'18
2284	Cutlers	ft	17'	15'5	29.12	9'
2284	Grinding	ft	15'5	23	39.40	11'
2284	Cutlers	ft	19'	25'4'	53.49	9'
2284	Grinding	ft	25'4'	23'	67.74	11'
Kendal Wks.	Workshop	m	7	4.25	35.60	-
Kendal Works	Workshop	m	4.25	2.00	10.66	-
Kendal Works	Workshop	m	3.25	3.75	14.58	-
Kendal Works	Workshop	m	3.75	4.25	19.06	-
Kendal Works	Workshop	m	4.25	3.75	19.06	-
Butcher's Wheel	Packing	ft	94	25	261.11	-
Butcher's Wheel	Grinding	ft	20	10	22.22	-
Butcher's Wheel	Grinding	ft	18	14	28.00	-
Butcher's Wheel	Grinding	ft	24	21	56.00	-
Trinity Works	Workshop	ft	8	10	8.89	-
Trinity Works	Workshop	ft	11	11	13.44	-
Trinity Works	Workshop	ft	11	20	24.44	-
Trinity Works	Workshop	ft	30	11	36.67	-
Trinity Works	Grinding	ft	24	18	48.00	-
Trinity Works	Grinding	ft	15	32	53.33	-
Trinity Works	Warehouse	ft	13	16	23.11	-
7400	Workshop	ft	34'8'	17'7'	67.72	11'6
7400	Warehouse	ft	46'9'	17'7'	91.34	11'6
7400[96]	Workshop	ft	81'5'	18'	162.83	9'9'

Table 3: Sizes of workshops in the 19th Century from Architects plans and Surveys.

The average 'cell'[97] in the later 19th century is 39.33 square yards (32.9m²). Only the packing shop at Butcher's Wheel can be regarded as exceptionally large. The hypothesis holds true therefore that whilst structures in which the workshops are arranged become larger over the period, the individual 'cell' of production does not increase.

Room size indicates that the independence of the craftsman continued in the larger works and that larger rooms were likely to have been used as warehouses and for packing rather than for manufacturing goods within the cutlery industry.

[96] Four figure numbers from CA206 Building Registers

[97] Workshop or grinding hull

Organization of Rooms in the Workshops of the Cutlery Industry

By assessing the organization of cells of production it is possible to determine if a building was designed as an integrated or tenement works. The simplest way of evaluating the layout of a building is to use Hillier and Hanson's model which created a systems diagram clearly showing the inter-relationship of 'cells' within a structure by the use of the 'gamma analysis.' These diagrams were called 'justified gamma maps'[98] and they provide a form by which hypotheses can be created about the internal and external relations of each cell 'as part of the general theory of the social logic of space.[99] They consist of circles which represented cells within a structure and lines representing the route ways to other cells. Thus the number of entrances and exits of the cells are shown (Figure 40).

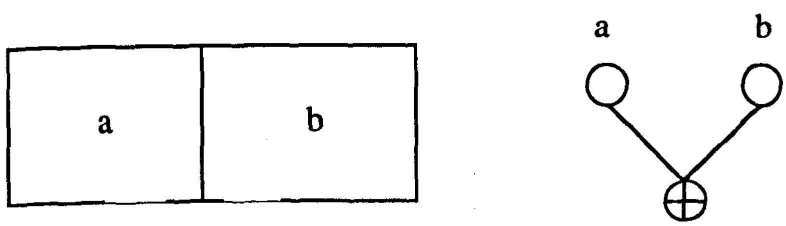

Figure 40: An example of a simple Hillier and Hanson gamma map.

The 'carrier' represented by a cross within a circle represents the outside world, i.e. the point of entry into the building from, for example, the street. In order to give a sense of proportion, all those 'cells' at the same depth from the carrier are lined up on a horizontal plane.[100] These maps, while attempting to show the three dimensions of a building in two, can appear confusing and it is for this reason that in this thesis the pathways between cells have been marked on the floor plans drawn in isometric in addition to Hillier and Hanson's version.

For small-scale buildings such as those seen at Stannington at 643, Stannington Road, Nook Lane, and Mr. Ward's file cutting shop (Figure 41), gamma maps are superfluous as there is usually only one entrance and only one workroom and would not pick up the more complex organisation of

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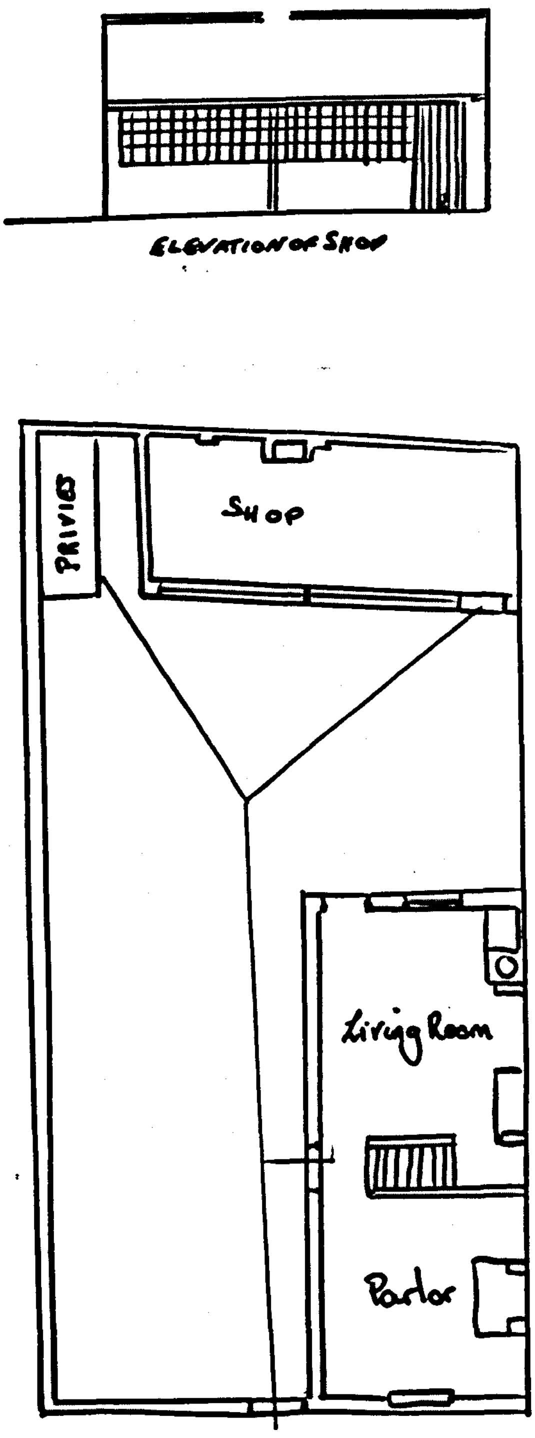
[98] ibid. p 143
[99] ibid. p 143.
[100] ibid. p149

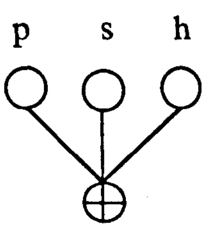
working space within buildings where workbenches were sub-let to other independent 'little mesters' as at Nook Lane.

Figure 41 **A:** Mr. Ward's house and file cutting shop showing that spatial analysis reveals little more than is already shown, **B:** Hillier and Hanson gamma map.

A



B



With medium and large scale buildings the gamma maps can help to determine whether or not a building was designed to be a tenement or integrated works. A proposed three storey grinding wheel in Cambridge Street for example, from the outside may appear to have been designed for one firm. Analysis of the floor plan however shows that (Figure 42) each of the workshops is independent of the others and can only be accessed from the outside.

A building of similar scale to Mr. Gaunt's Grinding Wheel is that occupied by A Wright and Son at 16 Sidney Street (Figure 43). The floor plan shown on Goad's Fire Plans of 1893[101] and the present layout indicate that the building was never designed to be used by more than one firm. The gamma maps however do not indicate the sub-letting of the ground floor to Wilkinson Scissors which now takes place. The relationship between the two firms is complex, for while remaining an independent firm, all of Wilkinson's scissors are sold through A Wright and Son.

Gamma maps are most useful when analysing large and complex buildings. Union wheel for example, 280ft long, would in other parts of the country such as Manchester[102] or Leicestershire[103] be considered as an integrated site. However on consideration of the floor plan (Figure 44) it is obvious that all the workshops are individual cells of production. Each storey is only accessible from the outside and the workshops have single entrances off a main corridor running through the centre of the building. The evidence for the individual firms comes from documentary evidence which details 24 firms on the first floor alone in the 1920s.[104] Firms also have workshops distributed throughout the building as in the case of Franklin's file cutting firm, Rutherford's cutlery manufactory, and J W Ward's tool manufactory (Figure 45). The variety of trades which were carried out within the building is also significant as it indicates, as suggested above, that there were very few distinguishing characteristics between the trades. Those features which were distinguishable were often portable such as stocks and stiddies, tools and

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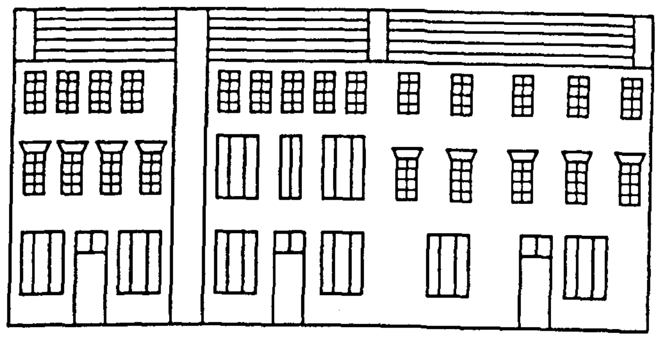
[101] 674/B1/24 Sheffield Archives
[102] Textile industry
[103] Footwear industry
[104] Insurance Plans UGW plan 27 Sheffield Archives

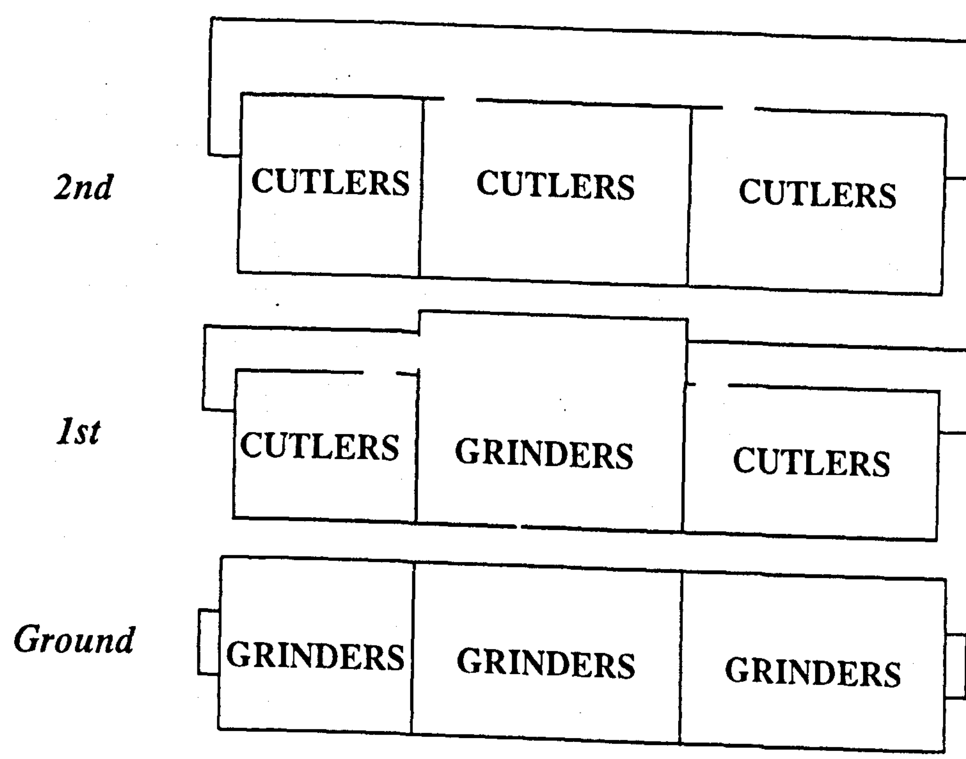
Figure 42 **A:** Plan and elevation of Mr. Gaunt's Grinding Wheel. At first sight this appears to be an integrated works but closer inspection reveals that each workshop has a separate entrance. **B:** This is more clearly shown with the aid of a flow diagram. **C:** A gamma map emphasises the point.

A

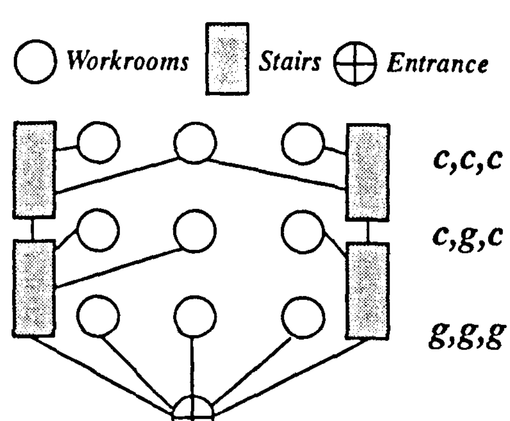


Mr Gaunt's Grinding Wheel

B

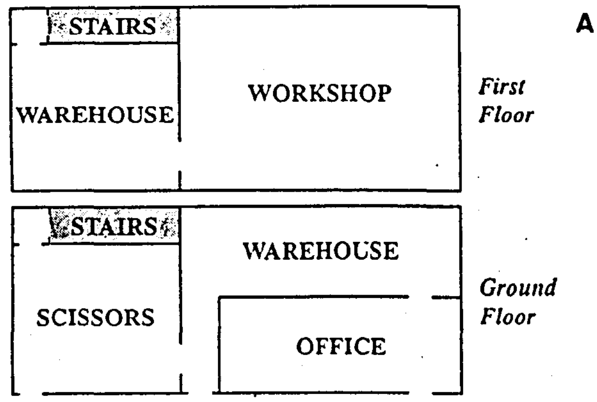


C

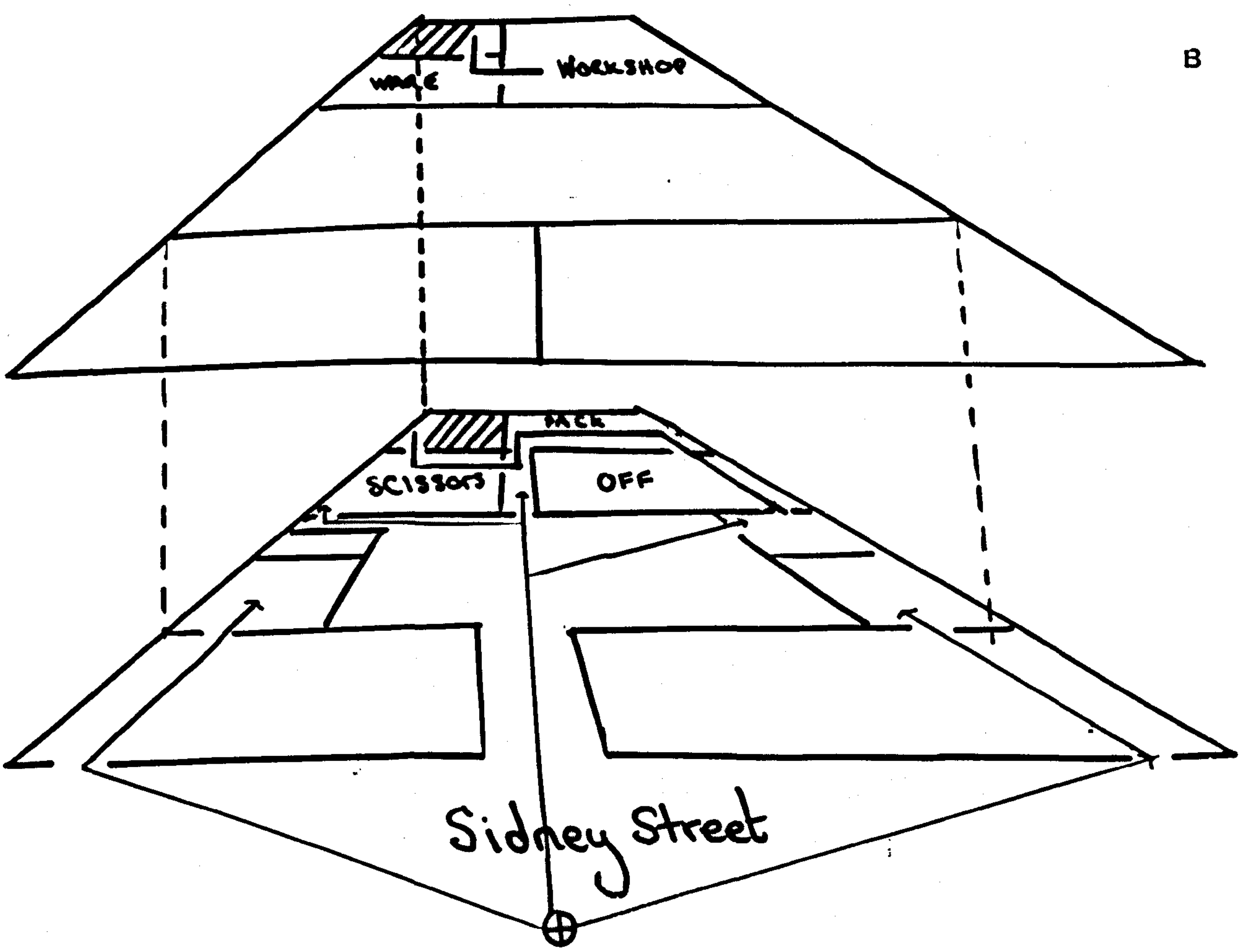


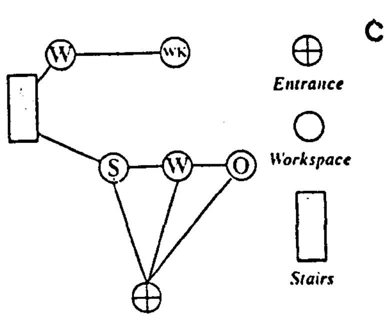
Justified Gamma Map of
Mr Gaunt's Grinding Wheel

Figure 43 **A:** A Wright and Son, an integrated works now containing two firms. **B:** The flow diagram shows the possible movement of goods through the building. **C:** The gamma map shows clearly that this is an integrated works.



A Wright and Son and Wilkinson Scissors





Justified Gamma Map of
A Wright and Son

Figure 44: The floor plan of Union Wheel shows that there was no link between rooms, except those used by the same firm.

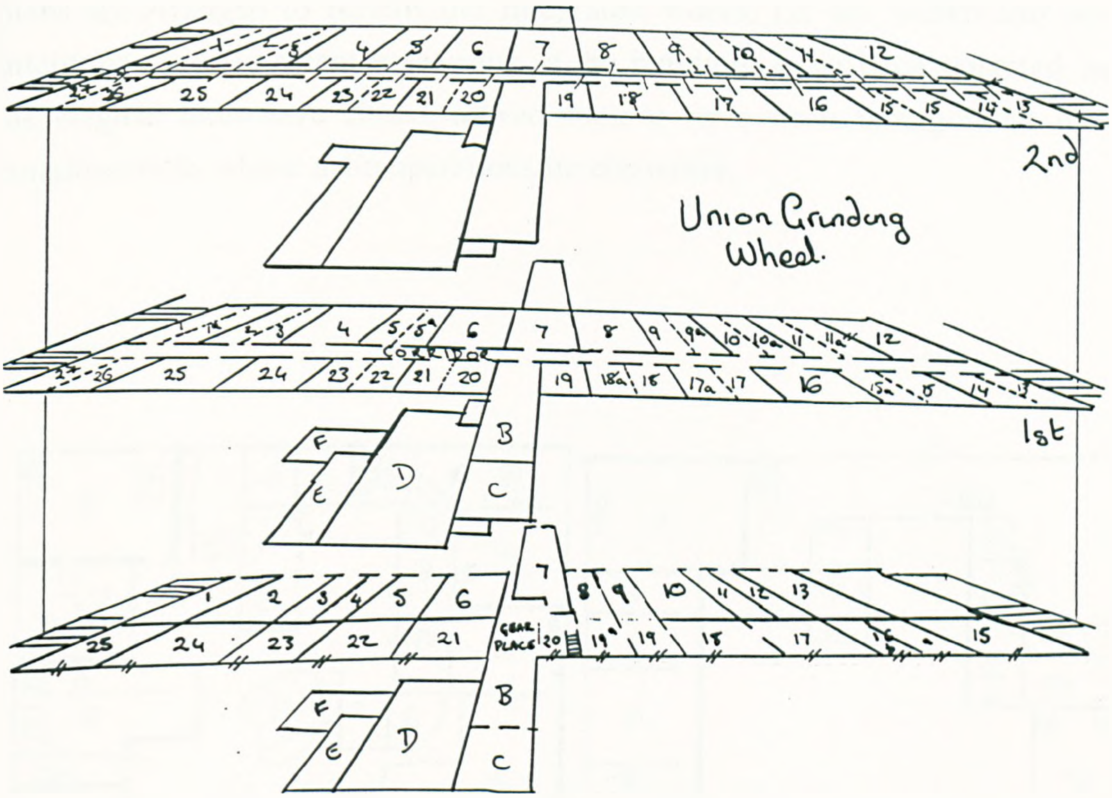
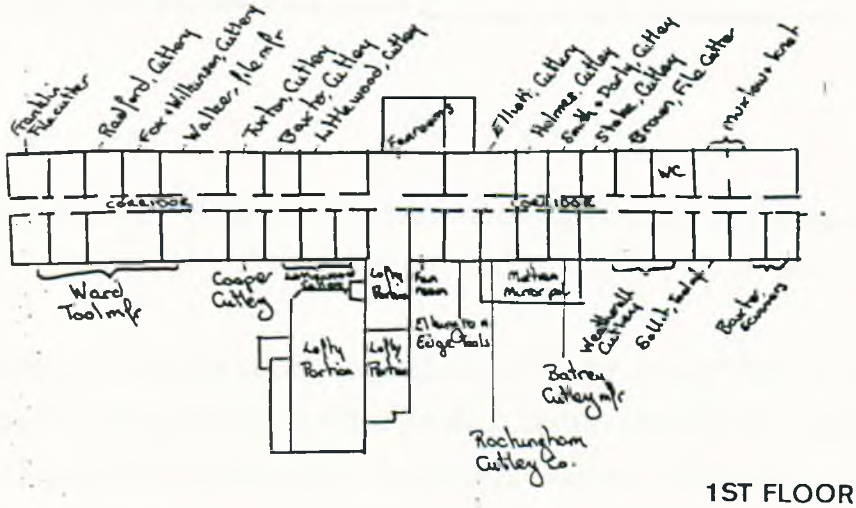


Figure 45: The tenement nature of this building is emphasised by the number of firms recorded in the 1920s.



machinery. Unfortunately this building was demolished in the 1970s.

At works such as Cornish Place, and Butcher's Wheel (Figure 46a) the floor plans are arranged to benefit the integrated works, i.e. the workrooms are interconnected. In recent times parts of the buildings have been tenanted as the original firms have closed, moved sites or have been incorporated into conglomerates whose main operations lie elsewhere.

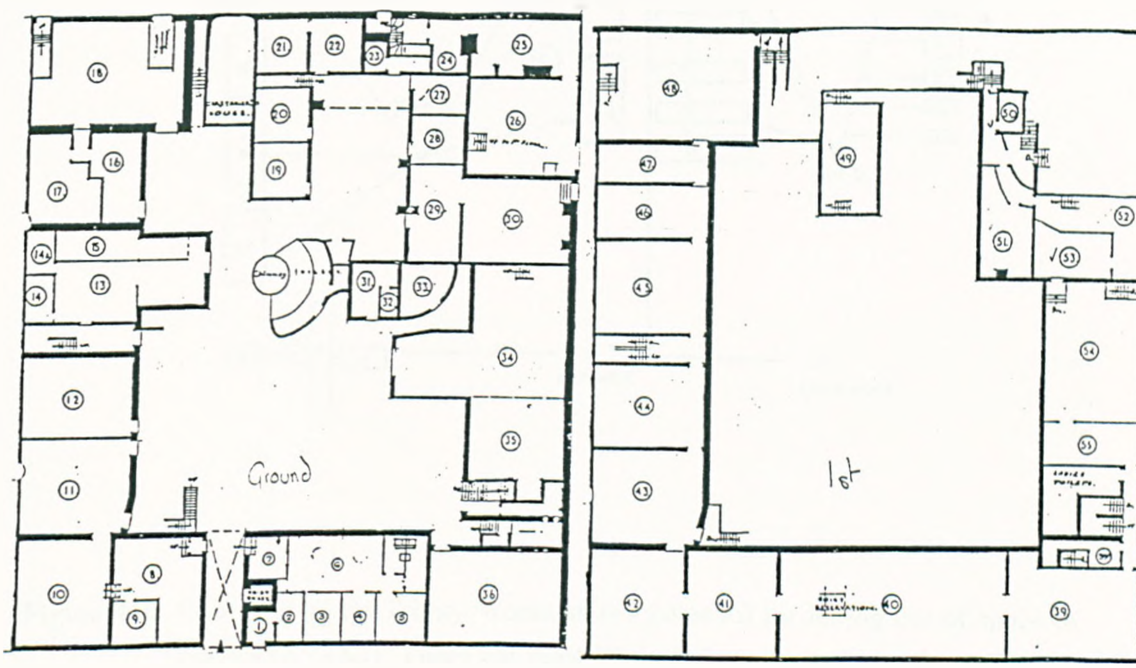


Figure 46a: The floor plan of Butcher's Wheel shows that it was designed as an integrated works as the workshops are linked to one another.

In some works of a similar scale the practice of hiring outworkers to perform specialist work while providing them with accommodation can perhaps be seen in the layout of the floor plan. At George Butler's Trinity Works which once stood on Eyre Lane, for example, many of the workshops were part of the integrated firm as indicated by their links to other 'cells' (Figure 46b). However, in one part of the yard a group of seven workshops stand alone each with their own access. It has been suggested that these could be hand forgers' shops[105] which in larger firms could often stand apart. Equally they could have provided accommodation for outworkers but without further documentary evidence their use cannot be proved either way.

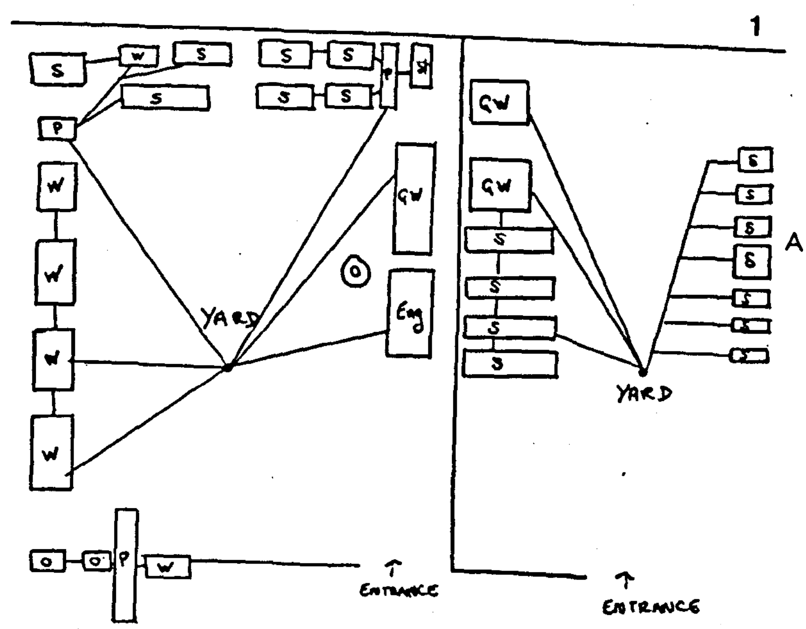


Figure 46b: George Butler's Trinity Works shows potential for letting out of space to outworkers (A1). These are most likely to have been forges.

Working Conditions

Finally working conditions should be considered. To some extent these have already been summarised by looking at the processes and the evidence which they leave behind in the archaeological record. However to understand them, if not to empathise with them, the combination of the archaeological with the documentary evidence is essential.

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105 Pers. comm. Ken Hawley 20/3/1996

The image that one gains from the documentary sources available is that the workshops were dirty, ill-lit and cold. In section five of the Second Report of the Commissioners on the Employment of Children, which describes the state of the place of work in 1843, paragraph 225 suggests that the

'workshops require a through draft to carry off the dust, and much of the increased unhealthy nature of grinding [is] owing to the more crowded state of the rooms at the town wheels. Cleanliness is of course out of the question; and nearly equally so in all the Sheffield Trades. The hafting or cutlers shops are in general tolerably airy and healthy, and as coals are cheap, well enough protected from damp.'[106]

In 1865 the Appendix to the Fourth Report written by J.E. White concluded that little had changed since 1841 when the research had been conducted by Mr. Symons for the 1843 report. He concluded that there had been an increase in the number of wheels within the town in which the workshops were built back to back, thus making the

' rooms or hulls ill-lighted and gloomy; some which I have seen are quite unfit for use. In some the plaster is falling from the ceiling, in others wet is dripping from the floor above, and is sometimes caught by sheets of metal placed to protect the workers beneath. The glass is generally broken out of the windows, and purposely by the grinders to allow the dust to escape and to admit light, which the glass covered by the dirty spray from the grinding, keeps out. This subjects the workers to draughts, and in the winter to severe cold.... The dust is also blown back upon them......The floor are often sloppy with wet.'[107]

White's portrayal of the other workshops used by the industry is equally damming, referring to them as, 'cramped and ill-arranged...by all appearances the cleaning and whitewashing etc. are in general much neglected.'[108] Even in 1887 the Annual Report of Her Majesty's Chief Inspector reported that many of the workshops were 'dirty and discreditable' as 'what is every man's business is no man's business,'[109] referring to multi-tenanted workshops where no one took it upon themselves to clean up.

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[106] 2nd report of the Commissioners on the Employment of Children Sessions 1843-5 Vol. XIII IUP reprints. p34

[107] Appendix to the Fourth Report - Reports and Evidence of Assistant Commissioners: Report upon the metal manufactures of the Sheffield District by J.E. White. 1865 para 42 p4 IUP reprint.

[108] ibid para 45 p4

[109] British Parliamentary Papers Industrial Revolution, **Factories**, Report 31/10/1887 p36.

Conditions have not much changed over the past 140 years, for 'little mesters' and 'outworkers'. In Jenkins and McClarence's work those interviewed said that the workshops were 'death traps, with walls, floors, benches and tools thick with grime.'[110] Doris Walsh, who had worked as an acid etcher at Butcher's Wheel, reported that it was 'cold',[111] noisy and dirty[112] and Billy Hukin, an open razor grinder, said that 'the usual workshops you couldn't keep clean. They were draughty and not properly heated. A real muck heap, a lot of places. Oh, I've no time to clean it up, they used to say...You couldn't keep a place like that clean because there was so much muck flying around, dust and grease. And the whitewashed walls would get filthy'.[113]

When on field visits to redundant buildings such as the upper storeys of Butcher's Wheel, Cornish Place, and Kendal Works and the workshops at 50 Garden Street, the smell of metal, grease and dust still lingers. This feature of the workshops is impossible to record.

Conclusion

This chapter has identified the main characteristics seen in the buildings associated with the cutlery industry and allied trades. It has sought by means of examples, found in the field and in the documentary evidence, to give detailed descriptions of these features and how they fitted in to the processes involved in the various branches of the trades. Analysis of spatial organisation, using gamma maps, has revealed little new evidence relating to the process of cutlery manufacture. However it can be used to determine whether larger workshops were designed as integrated or tenement works.

The archaeologist in the future will have to use this combination of the documentary and archaeological records to interpret the silent remains and how individual workshops functioned.

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[110] Jenkins, C. and McClarence, S. 1989 On a Knife Edge Sheffield Libraries and Information Services, SCL Publishing Sheffield pxii.

[111] ibid. p 27

[112] ibid. p 32

[113] ibid. p 62

Power Sources and Power Transmission

'It is not generally appreciated that in 1800 steam power was still in its infancy, that in the vast majority of manufactures there had been little or no power driven mechanisation, and that where mechanisation had occurred water power was still much more widespread and important than steam. After 1800, the 'triumph of the factory system' took place more slowly than has generally been realised; water-wheels long continued to be built and used, while most manufacturing operations remained largely unmechanised until 1870.' [1]

The history of the Industrial Revolution is traditionally characterised by developing power sources that were regular and indefatigable, a dramatic increase in the quantity of goods produced[2] and production being carried on under one roof. However in the cutlery and related trades in Sheffield there was still little mechanisation in 1800 other than in the branches of forging and grinding which had utilised water power from the 15th century[3] and no dramatic increase in the use of power in the 19th century. Water power continued to be used by wheels situated in the Don, Porter, Rivelin, Loxley and Sheaf valleys into the 20th century. Steam power was only gradually introduced to the larger works and between 1880 and 1900 gas engines were installed into some of the more moderate sized works. Only with the introduction of electricity at the end of the century was power more widely adopted in the small scale workshops.

This chapter assesses the evidence for the use of power in the workshops of the cutlery trades and identifies the archaeological remains for each source of power and its transmission and asks if 'reductions in capital costs ....were common to technological changes involving power machinery'.[4]

Manpower

Documentary sources and observation of current working practices in small cutlery firms demonstrate the continuity of hand and foot power to the

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[1] Musson, A.E. 1976 *Industrial Motive Power in the UK 1800-70* **Economic History Review 2nd Series** XXIX p416

[2] Mantoux, P. 1929 **The Industrial Revolution in the 18th century** translated by Majorie Vernon, J Cape London 2nd edition p26

[3] Crossley, D. et al 1989 **Water Power on Sheffield Rivers** STHS and Div. Of Adult Continuing Education, University of Sheffield pvii, Reference to a lease of 1496 which gives details of water powered metal grinding probably at Moscar Wheel.

[4] DuBoff, R. 1967 *The Introduction of Electric Power in American Manufactory* **Economic History Review** 20 p 512

present day. This continuity of 'muscle' power within many trades, not just the cutlery industry, has now been recognised by many historians and archaeologists. For example, hand power in the textile industry continued well into the nineteeth century[5] whereas the boot and shoe industry[6], like the cutlery industry, maintained its use into this century. Pollard argues that for grinding however, by the 1850s treadle-driven stones 'had virtually gone out of use, and water-power or a steam engine supplied the central motive power to the 'wheel'.[7]

The evidence for muscle power which survives is usually only in the absence of evidence of other types of power sources. Treadle wheels, used in the finishing processes, for example buffing (Figure 1a)[8], where they survived, have been removed from the workshops to museums and collections. The majority of the cutlers' tools (Figure 1b) used such as the parse drill, hammers and saws, as demonstrated in the last chapter, will have been removed when the firm left the building. Muscle power was the only form of power used until the end of the 19th century in the rural workshops surveyed.

Why did Manpower Power Continue?

Its continued use in urban areas was a result of the diversity of the products produced. 'The benefits of substituting mechanical methods were limited in a manufacturing system in which goods such as pocket knives were made in such a wide variety of types even by single firms'[9] and because a skilled workforce was available. It was also considered to be cheaper to employ outworkers to make up special patterns than to buy expensive machinery.[10] Population figures show that between 1750 and 1821 the town had expanded

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[5] Giles, C. and Goodall, I. 1992 op cit. p 125 also see Palmer, M. 1994 *Rolt Memorial Lecture 1993, Industrial Archaeology: Continuity and Change* **Industrial Archaeology Review** Vol. XVI no 2 Spring pp135-157

[6] Perry, V.A. 1993 **The Archaeology of the Domestic Workshops of the Boot and Shoe Industry in Leicester and its Satellite Villages** Unpublished Dissertation University of Leicester Dept. Of Archaeology.

[7] Pollard, S. 1959 **A History of Labour in Sheffield** Liverpool University Press p51

[8] Treadle Wheel in the Ken Hawley Collection, Pitt Street, Sheffield.

[9] Rule, J. 1992 **The Vital Century** Longman London p123.

[10] Taylor, S.A. 1988 **Tradition and Change-the Sheffield Cutlery Trades 1870-1914** Unpublished PhD Thesis University of Sheffield p 131

Figure 1a: Treadle glazer or leg frame used for finishing knives (Hawley Collection, University of Sheffield).

Figure 1b: A selection of cutler's tools (Hawley Collection, University of Sheffield).
Top: Forging aid.
From left to right: Hammer, drill for use with a parser, forging aid, parser.
Below: Stiddy and file. (Scale in centimetres)

fourfold.[11] An anonymous letter written around that time attributed the increase to the growth of the industry; 'so great a connection has the encreased [sic] of mankind with industry'.[12]

The evidence from the Cutlers' Company records shows that apprenticeships increased until 1800 when the system began to decline (Table 1).

Period	Apprentices
1741-1750	1211
1751-1760	1089
1761-1770	2042
1771-1780	2510
1781-1790	2559
1791-1800	3588
1801-1810	2734
1811-1820	748

Table 1: Number of Apprentices registered at the Cutlers' Company 1750-1820[13]

The number of small scale firms also emphasises the use of workers' skills rather than machinery for specialised tasks. By 1850 there were 'perhaps half a dozen firms which could count the number of their workmen by the hundred.'[14] 'This small scale industrial system had the advantage of flexibility in regard to new patterns, products, materials or fashions, without the loss of technical efficiency.'[15] In 1870 the Factory returns record 6334 males and 769 females connected with the cutlery trades alone but only in those factories where power was used. This gives an average of thirteen people per works based on the 539 entries for workshops in the ratebooks for that year although the majority probably employed less than ten. By 1891 22,106 males and 3,637 females were occupied by cutlery, file, saw, and tool making within Sheffield. [16]

Labour was therefore available to be used. With cheap labour which could be laid off when times were hard, many employers saw no reason to invest in expensive power plants. Using the out-work system a wider range of products

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[11] Favell, N. 1996 **The Economic Development of Sheffield and the Growth of the Town 1740-c1820** Unpublished PhD University of Sheffield p22

[12] ibid p21

[13] Database created by Unwin, J. et al, based on Leader, R.E. **Records of the Cutlers' Company** and Cutlers' Company Records at the University of Sheffield.

[14] Pollard S 1959 op cit. p 55

[15] ibid p56

[16] Lloyd, .G.I.H. 1968 p442

could also be maintained and those working as 'little mesters' could not afford to install power sources of their own accord. Where it was needed, as in grinding, water and later steam power was used.

Unlike the textile trades, there is little evidence for the use of animal power being utilised in the production of cutlery.[17] In the Sun Fire Office Records Flavell found only one example of a horse mill, used by Messrs. Tudor and Leader in the 1760s.[18]

Water Power (sites mentioned can be found on Map 1)

Water power was used by grinders for goods ranging in size from penknives to scythe blades and by tilters, rollers and forgers of metal. A survey of 1794[19] gives details of 76 water-powered sites on the Rivers Don, Loxley, Rivelin, Sheaf and Porter connected with the grinding and forging of metal. In total there were 1029 troughs for grinding and seventeen forges and tilts.[20] Some of the tilts also contained grinding wheels such as Mr Harrison's 'Storebridge' tilt and wheel and Camm & Co's Nether Slack Wheel and Tilt on the Loxley, and Mr Cadman & Co's Sandbed Wheel and Tilt on the Don. As demonstrated in the last chapter, water-powered sites were generally medium-scale works and employed between nine and twenty grinders. The largest site recorded in the 1794 list was Mr. Blonk's Castle Orchard Wheel on the Sheaf which contained 50 troughs. The history of all the known water powered sites on Sheffield's Rivers has been covered by Crossley et al. [21]

Advances in water power technology in the 18th century by Smeaton, Rennie and Hewes, especially in the control of water by sluices, gearing mechanisms, the use of buckets and the replacement of parts of the waterwheel with iron, meant that water power could compete successfully with steam power, at least until the middle of the 19th century.

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[17] Giles, C. and Goodall, I. 1992 op cit. p 123.
[18] Flavell, N. 1996 op cit
[19] CP26(90)90 Fairbank Collection, Sheffield Archives
[20] Tilt = were tilt hammers are used, ie a heavy pivoted hammer used in forging
[21] Histories of all the waterpowered sites are given in Waterpower on the Sheffield Rivers edited by Crossley, D. et al 1989.

KEY
River
Water Supply
Boundary of workshops in town
For other sites not shown by map
see Figure 1 Chapter 1 p26
SHEFFIELD
NETHER HALLAM
ECCLESALL BIERLOW
Scale Six Inches to One Statute Mile

The cost of water-power

Water-power was not free. Water courses had to be constructed, the wheel had to be built and maintained, in addition to the principal building which housed the machinery it was to drive, and ground rents had to be paid, usually to the Norfolk or Wentworth estates in Sheffield's case.

Some of the annual rents charged can be found in the Fairbank Collection. For example wheels on the Rivelin c1812 were charged rents from £17-6-3 to £38-0-0. The rent was calculated on the basis of half the annual value of the troughs after deductions for expenses (Table 2).[22]

Wheel	**Tenant**	**Head of fall Ft**	**in**	**No. of troughs**	**Ann Value**	**Description of troughs**	**Rent due**
Swallow	Hallam	16	4	10 + 4	£6+£4	Cutlers' & razor troughs worth each rather above one 1/2 of cutlers trough	£38-0-0
Wolfe	Windle	16	6	12	£5-15-6	Cutlers' troughs	£34-13-0
4th Coppice	Townsend	18	10	13	£5-0-0	Cutlers' troughs	£32-10-0
3rd Coppice	Ibbotson	18	4	-	£5	Now a paper mill at will, equal to 14 cutlers troughs + £7 for new erections	£35-0-0
2nd Coppice	Darwin	15	4	1+2		Scythe trough let for £20, saw troughs, the whole let for £46 p.a.	£23-0-0
Upper Coppice	Law & Co	12	0	8+1	£4	Cutlers' and razor troughs £32-0-0+2-12-6p.a.	£17-6-3

Table 2 Rentals of some water powered sites on the Rivelin as valued by Fairbank c1812.[23]

The cost of erecting and maintaining water courses as well as the wheel itself is more difficult to ascertain.

In Sheffield, almost all the wheels were operated on a bypass system of water management, ie the wheels were situated to one side of the main river. The key to such a system was the weir, constructed at an angle across the river, which

[22] CP25 (34) Fairbank Collection, Sheffield Archives

[23] Fairbank's note at the bottom of the estimates reads: 'To ascertain the annual rental of each wheel, all assessments of the rate charged to the tenants, the average yearly expenses of repairs and then divide the residue into 2 equal parts such as to vary with circumstances.'

diverted water into a channel locally called a goit.[24] Water was then stored in a dam[25] before passing through a pentrough, over or under the wheel and exiting through the tail goit. 'But as the Sheffield rivers became overcrowded, compromises appeared. There are a number of cases particularly on the Don, where it was difficult to build adequate weirs because of insufficient fall. Hence one shared weir would serve more than one mill-site, the dams and wheel being placed in tandem without any immediate return of water to the river, the tail goit of one mill forming the head goit of the next.'[26] The most detail about the construction of the water-powered sites comes from the Fairbank collection.

Weirs

Weirs consisted of slopes of stone set into clay with kerb stones top and bottom, occasionally making use of the natural bed rock as at Third Coppice on the Rivelin (Figure 2).

Figure 2: Third Coppice (Rivelin), the weir here is constructed from the natural bedrock. Note however that the kerb stones at the top of the weir are held together by iron staples.

The top kerb stones were regular in shape and linked by iron staples set in mortises and secured with lead. This added strength to the weir and was

[24] In other parts of the country is can be known as a leat or race
[25] Locally used to refer to the pond as well as the retaining bank
[26] Crossley, D. et al 1989 op cit p x

designed to catch water borne debris. However lack of maintenance has meant that sometimes these kerb stones have disappeared. The lower kerbs were often made of timber as they were less subject to damage but there are few survivors; today those that do remain are made of stone (Figure 3).

Figure 3: Example of a weir at Frank Wheel (Rivelin) were the top kerb remains but the bottom one has begun to erode with lack of maintenance. The head goit can be seen at A1 and note the height of the head race above the river (B2).

The cost of setting out part of S Broadbent's weir in 1764 came to £6-18-11$^{3}/_{4}$. It consisted of 6 panes[27]:

1st pane	5.00 yds. by 3.9 yds.
2nd pane	4.73 yds. by 3.6 yds.
3rd pane	3.89 yds. by 4.18 yds.
4th pane	3.89 yds. by 3.89 yds.
5th pane	3.89 yds. by 4.49 yds.
6th pane	2.30 yds. by 4.80 yds.

Total 97.29 yds. or 13.898 rods at 10/- per rod = £6-18-11$^{3}/_{4}$.[28]

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[27] These have been referred to by Crossley, D. et al 1989 as "bays" to define the sections of the weir.
[28] FB 27 p 53 Fairbank Collection, Sheffield Archives

In the 19th century weirs on the Don and Loxley and Rivelin were divided into bays to give them added strength, especially after the 1864 flood. The bays were divided by sloping ashlar blocks (Figure 4).[29]

Figure 4: Example of weirs constructed in bays on the Rivelin. Above Wolf Wheel, below a weir built in the vernacular style at Mousehole Forge.

Ponding up water behind a weir had the effect of diverting it into the head goit. In order to maintain a sufficient flow into the dam, weirs could sometimes

[29] Crossley, D. et al 1989 op cit. pxi.

be raised by fitting wash-boards, however in doing so the flow of the river was impeded and 'backing up' occurred which impeded the egress of water from the wheels above.[30] The Fairbank correspondence papers of c1840 describe a dispute concerning the raising of the weir at Mousehole Forge causing water to back up at Walkley Bank Tilt.[31] The outcome of the dispute was that Mr Armitage had to lower the weir to its previous level thus allowing the Walkley Bank Tilt wheel to operate efficiently again.

Head Goits

The head goit carried the water from the river to the dam. Water entering the head race was regulated by means of a shuttle or sluice (Figure 5a). By the 19th century a ratchet system was sometimes used (Figure 5b). In some cases the tail goit from the mill above formed part of the supply to the dam as in Figure 6 at Second Coppice where a bypass channel from Upper Coppice feeds into the head race, or at Plonk Wheel where the tail goit from Swallow feeds directly into the dam.

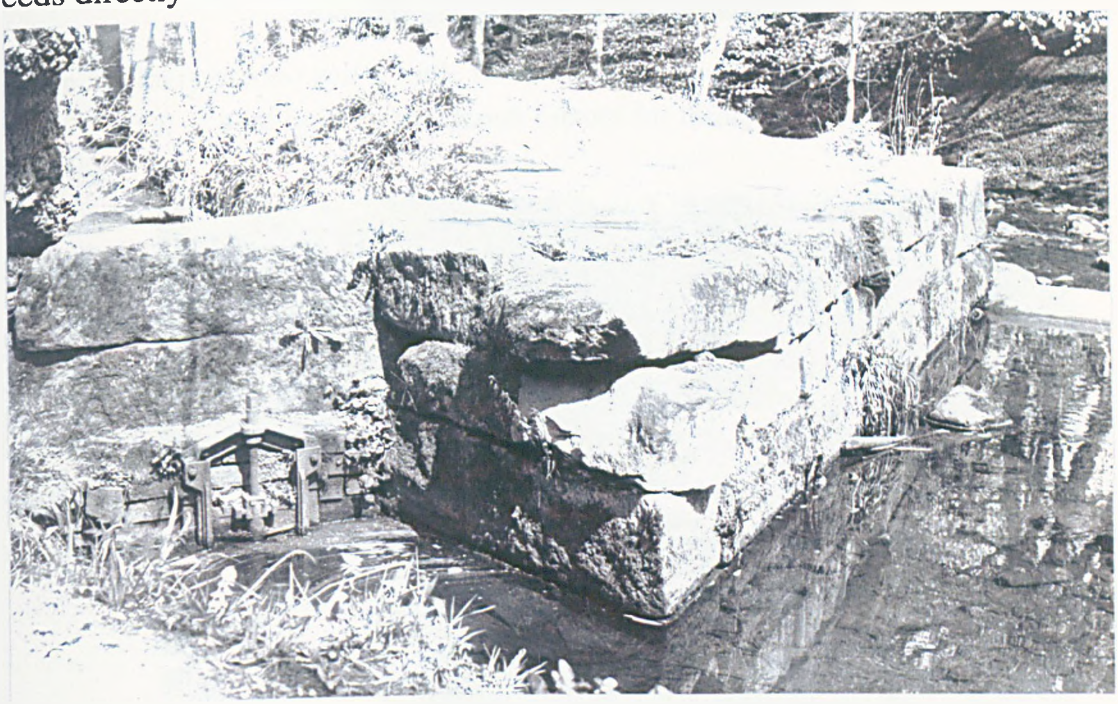

Figure 5a: Entry to head race at Frank Wheel showing sluice shuttle.

[30] Crossley, D. et al 1989 op cit p x

[31] CP37 (132-146) Fairbank Collection, Sheffield Archives

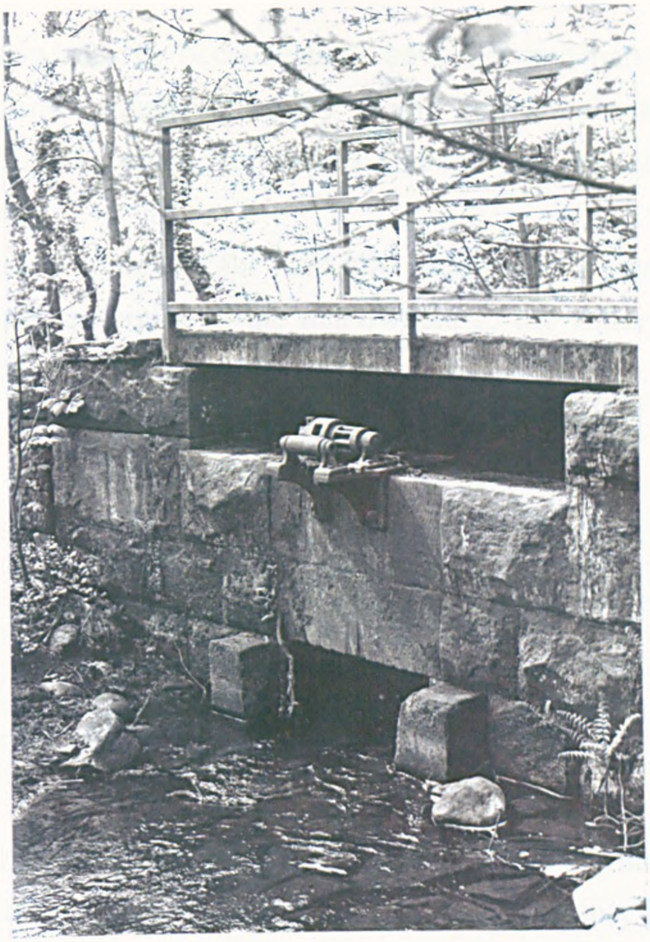

Figure 5b: Entry to head goit at Little London Wheel (Rivelin) showing the ratchet system used from the nineteenth century for lifting the sluice.

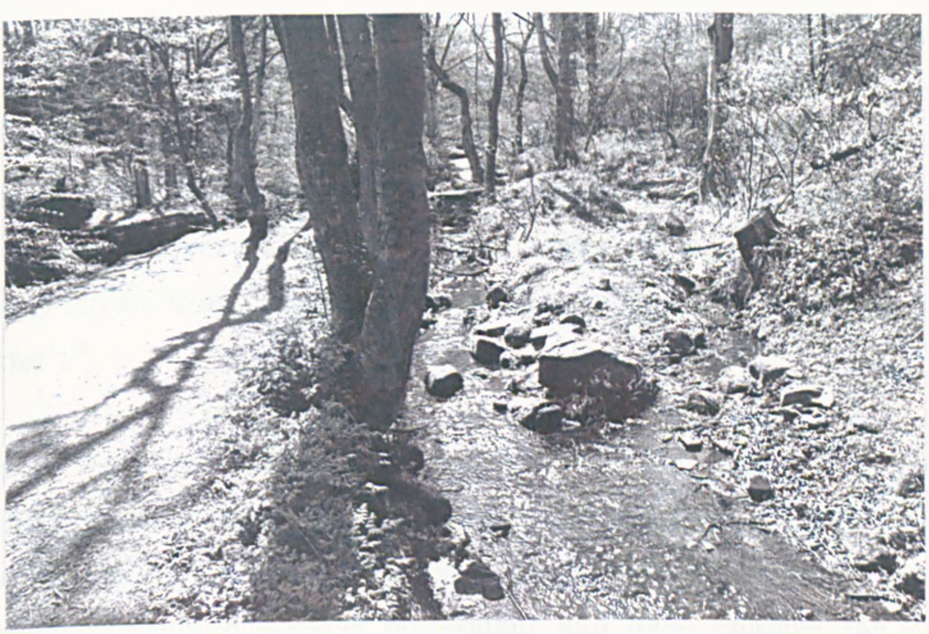

Figure 6: Tail goit of Third Coppice feeding into head goit of Frank Wheel (Rivelin)

'Head goits frequently survive because they have become part of the local pattern of drainage and because the entry to the goit was built of durable ashlar masonry.'[32] The shuttle or the staples and rack by which they were operated also survive.

Where water had been diverted off the land into head goits, the enclosure acts were careful to protect the rights of the mill owners to the water. The Act of Enclosure for Ecclesall in 1789 stated that Commissioners were:

'impowered to divert and alter, or to order and award all or any streams of water, springs or water courses, within the said manor and township of Ecclesfield........; provided such streams of water, springs or watercourses, be not diverted or turned so as to prejudice the person or persons now entitled to the use of the same; and provided no water be diverted or turned out of the Mill Dams, Wheel Dams, goyts, or mill or wheel streams, belonging to any mills or wheels within the said township.'[33]

Concern was also voiced about the supply of water to the mills when the Water Works Company wished to establish reservoirs to supply water to the town. A report by Fairbank in 1833 referring to intended reservoirs in the Porter Valley reported that in 1831 there was 'no more water at some of the works on the River Porter that served them nine or ten hours a week' and issued a warning to the mill owners that any 'diminution of the present supply must be attended with serious loss to the parties who hold the mills'. Josiah advised the mill owners committee that 'I know of no claim so likely to protect the mill owners from injury as one to exclude the Water Works Company from taking any water whatever for the use of their works which now runs into it or to divert any stream from its natural course so as to impede it from running into the Porter'.[34]

At the start of his report however he had outlined that the mill owners themselves had proposed reservoirs at the summit of the Porter Valley as 'a store for the surplus supply to be collected in flood times which might have been a great advantage in seasons of drought and have enabled the mill

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32 Crossley, D. et al 1989 op cit p xi

33 Act of Enclosure for Ecclesall 1779 p13

34 CP26 (59) Fairbank Collection

owners to perform their business perhaps at less expense than erecting steam engines which have been found necessary in several cases to make up for the deficiency in the supply of water'.[35] This referred to the ideas suggested by William Jessop, engineer, in 1785 after his enquiry 'into the practicality of forming reservoirs of water with other expedients tending to produce a regular supply for the works in the Town and environs of Sheffield in dry seasons.'[36] The results of his survey concluded a supply of ten cubic feet per second would be the required flow on the River Don in the driest seasons and thus a reservoir of 30 acres and three yards deep at Deadman's Ford and a twelve acre reservoir four yards deep at Denaby Common in addition to a further 24 acres, two yards deep at six other sites along the Don would hold sufficient water for 56 days. Similarly on the Porter a reservoir at White Moss, 65 acres and a yard deep, would produce a sufficient flow of five cubic feet per second. The total cost of the reservoirs on the Don and Porter including catch water drains was estimated at £4600. There is no evidence for the reservoirs being created and by 1830 when Fairbank raised the issue again, water power was in decline. The rivers Porter and Sheaf were straightened however to improve the flow of water in their lower reaches and a number of goits were improved as detailed by Fairbank.[37]

The length of the head goit varied from wheel to wheel. At some sites it is no more than a few metres; in others it is hundreds. Crossley suggests that in narrow valleys following the contour gains a greater fall of water[38] and this increases the potential power of the wheel. This occurs noticeably at Upper Cut Wheel on the Rivelin. The complexity of surveying for goits is shown in the Fairbank field books (Figure 7).

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[35] ibid.
[36] Survey carried out August and September 1785 CP26(8) Fairbank Collection
[37] Flavell, N. 1996 op cit p150
[38] Crossley, D. 1990 Post Medieval Archaeology in Britain Leicester University Press, Leicester pp140

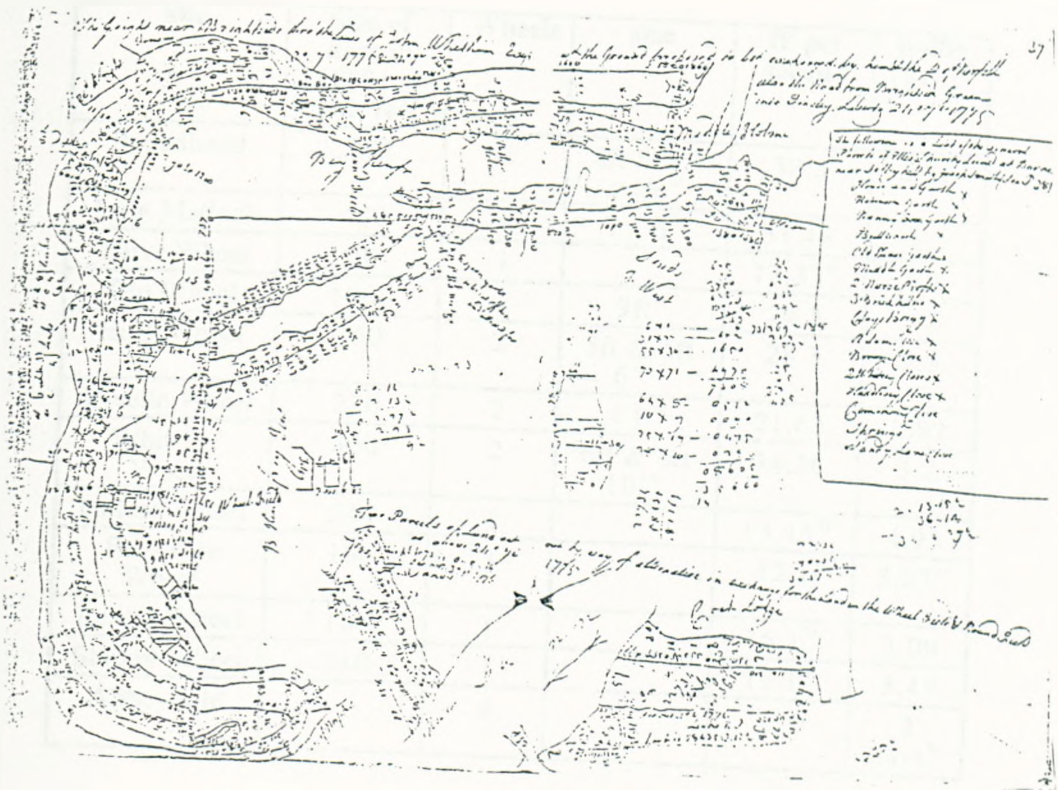

Figure 7: The surveying of goits was complex as details from Fairbank Fieldbooks show. This example near Brightside is from 1777, FB47 p37 (Sheffield Archives)

Dams

Locally the term dam refers to the pond as well as the retaining bank. Those supplying the wheels of Sheffield vary considerably in size from little more than an extended head race, as at Upper Slack Wheel or Birley Meadow Wheel on the Loxley, to dams of up to four acres, as at Abbeydale. In the majority of cases however these ponds can be regarded as little more than a buffer against short term variations in flow rather than as storage reservoirs providing enough water for a day's work.[39] At Old Park Rolling Mill Fairbank estimated that when both wheels were running, one 12ft diameter undershot and another 18ft, the dam would be drained in quarter of an hour if no water ran into the dam.[40]

Table 3 shows the sizes of some of the dams on the Sheffield Rivers and how long a buffer they would provide should no more water enter the dam.

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[39] Crossley, D. et al 1989 op cit. pxi

[40] CP40 (90) Fairbank Collection, Sheffield Archives.

Site	Size of dam in 1000s of cubic feet[41]	Wheels	size	ft^3 per second	Buffer (hrs)[42]
Broadhead	240	2	8ft & 6ft wide[43]	38.8	1.76
Low Matlock	480	1	11'6[44]	31.48	4.2
Olive Wheel	36	1		12.33[45]	8.1
Old Wheel	1050	1	9ft[46]	24.3	12
Hind Wheel	360	2	5ft & 5ft 6' [47]	28.3	3.5
Rivelin Wheel	220	2	4 ft[48]	21.63	2.82
Whiteley Wood	400	2	6ft & 6ft 10'[49]	34.56	3.2
Holme Wheel	240	1		13.45[50]	4.95
Endcliffe Wheel	160	1		12.1	3.67[51]
Lescar Wheel	180	1		16.1[52]	3.09
Stalker Wheel	240	1		12.1[53]	5.49
Abbeydale		4			2 days[54]

Table 3: Buffer provided where the sizes of dam and wheel are known.

The data shows that of the wheels sampled, only at Abbeydale and Olive wheel would there be enough water in the dam to provide for a full day's work. It would therefore be necessary to take a constant supply of water from the rivers while the wheel was running. At Abbeydale it has been estimated to

[41] This is based on measurements taken from the 1st edition 6" OS map and a constant depth of 2 feet based on figures given by Tunzelman, G.N. von 1978 **Steam power and British Industrialisation** Oxford p131

[42]Assuming $Q=a\sqrt{2gh}$ $m = a \times 5.4$ a pentrough height of 4 ft an aperture of 3" Q= units of volume discharged per second, a= are of aperture in $feet^2$ g = acceleration due to gravity (32ft/$second^2$) h height of pentrough in feet and m= coefficient of efflux through submerged pentrough aperture (0.67) (Crossley et al 1989 op cit. p117) also see CP 19 (1) Fairbanks notes from Robinson's Mechanical Philosophy Vol II the theory of Rivers.

[43] Crossley, D. et al 1989 op cit p39

[44] ibid p36

[45] Crossley, D. et al 1989 op cit. Appendix p118

[46] ibid p 29

[47] ibid p 58

[48] ibid p52

[49] ibid p 72

[50] ibid

[51] CP25 (32) Fairbank Collection Sheffield Archives

[52] CP25 (33) Fairbank Collection, Sheffield Archives

[53] ibid.

[54] Pers. comm. warden at Abbeydale Industrial Hamlet 6/9/1996.

take two days to refill[55] the dam when empty but on the Sheaf there were fewer problems with water supply than on, for example, the Porter or the Rivelin.

The material quarried out to form the dams was used to create retaining walls, in some cases several metres above the level of the stream as at Shepherd's Wheel and Endcliffe Wheel on the Porter and at Broadhead Wheel on the Rivelin. To prevent the dam from leaking it was lined with puddled clay. Without regular maintenance however this can crack, especially if seeds that become lodged in the banks begin to grow. Therefore in the 1990s many of the dams which survive show signs of seepage, most notably at Ibbotson's Wheel below Shepherd's Wheel on the Porter. The cost of banking at Clough Wheel in 1762 was £61-16-8. Calculations for extending dams can also been found in the Fairbank field books, as those at Simon's Wheel in 1756 and Broomhead Wheel in 1760. The details given for enlarging the dam at Hind Wheel are more specific:

'Bank wall to be 18 inches thick at the top and to latter downwards 12 inches for every yard, to be measured per square rood [rod] face measure only the price to be for getting the stones, leading and building the wall complete with scaffolding .... with sufficient through stones.
Price for building the bottom 18 inches thick with puddle including all leading and labour
Ditto for puddling the bank 12 inches wide at top and to increase 1'9' in 10ft downwards including leading and building per cubic yard
The raising of the bank along the whole of the dam to be 4'6' from the inside of the aforesaid wall at the top and later 11ft 9' in 10 feet with or about 14 inches for every foot min including the materials and labour (part of the materials may be from the bank of the present dam) the price to be fixed per cubic yard to include everything.'[56]

To prevent the dam from silting up and also to stop vegetation embedding itself in the puddling, overflows and deep drains were incorporated into the structure of the dam. When water in the dam needed to be retained (Figure 8 a & b) wash boards were inserted into slots or sluices were used. The first edition OS Map shows several sluices in use by 1850 for the purpose of draining the dams (Map 1).

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[55] ibid.
[56] CP27 (121) Fairbank Collection, Sheffield Archives.

Figure 8a: Deep drain at Holme Head Wheel used when cleaning the dam to stop it from silting up. Note the slots in the masonry for the washboards used to raise the level of the dam and the top of the ratchet system used for raising the sluice.

Figure 8b: Overflow at Rowell Bridge. Note again the slots in the masonry for the washboards. (D Crossley 1989 op cit p31)

In order to filter the water into the pentrough, a fore bay was created, or narrowing of the dam. These were reinforced with stone as at Upper Coppice Wheel (Figure 9).

Figure 9: Forebay at Upper Coppice Wheel. (From Crossley et al 1989;xi)

Today the majority of dams have silted up and become overgrown (Figure 10) and therefore it is difficult to establish their original size. The principal evidence for their existence are head and tail races and any remains that may survive of the forebay and entrance to the pentrough.

Figure 10: Dams, when left, frequently become overgrown, as at Plonk Wheel (Rivelin). Note here the height of the bank (A1) compared to the river (B2).

Pentroughs and Regulation of Water on to the Wheel.

The pentrough was a box made from timber or cast iron and used to regulate the flow of water on to the wheel.The majority have now been removed from sites where protection is not afforded by continued use of the buildings associated with them. Good examples however still survive at Abbeydale, Shepherd's Wheel, Olive Wheel and Low Matlock. A recent copy has been made to replace the pentrough at Rowell Bridge and a collapsed pentrough survives at Holme Head Wheel (Figures 11 a&b).

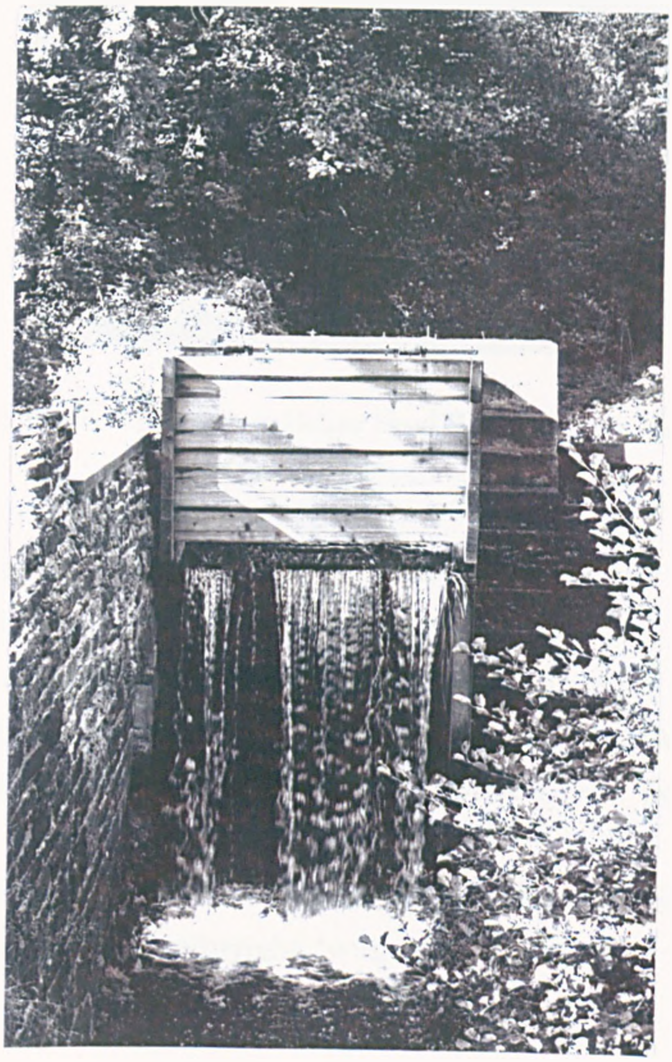

Figure 11a: Pentrough restored at Rowell Bridge (Loxley)

Figure 11b: Collapsed Pentrough at Holme Head Wheel looking towards the dam. (Rivelin)

In size the ones that remain are approximately six feet high by six or seven feet long and four to six feet wide (c1.8m x c1.8m x c1.2m). The size of the pentrough was calculated to create the correct head of water required to turn the size of wheel installed, although it has been estimated at Abbeydale that a pentrough that is 75% full will turn the wheels but not at maximum efficiency.[57]

The decision to use wood or metal for the pentrough was based on cost. In the papers of German Wilson, millwright, 'with considerable trade in repairing and

[57] ibid and see calculations in Crossley, D. et al 1989 op cit. P 117-118. The head of water was an essential figure used when calculating horse power.

building water-mills and forges,'[58] the cost of replacing a pentrough at Rowell Bridge was estimated at £38 for pitched pine and £63 for a metal one.[59]

Water was let on to the wheel through a sluice or shuttle operated from within the building by means of an iron shaft with a long wooden handle; the system is found at Shepherd's Wheel. It was essential that the water flow could be regulated so that the grinding wheels did not run too fast, thus increasing the risk of a stone exploding. Equally it was necessary to be able to increase the speed of the grinding wheels when 'racing' them[60]. At Abbeydale and at Shepherd's Wheel the optimum speed of the wheel was six revolutions per minute.[61]

Although little survives of the pentroughs their location is clearly identified by the masonry at the exit of the fore-bay as at Upper Cut and Second Coppice Wheel on the Rivelin (Figure 12 a & b).

Figure 12a: When the structure of the pentrough does not survive the location can be established from the surviving masonry as at Second Coppice Wheel.

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[58] Miller, W.T. 1949 (4th edition) **The Watermills of Sheffield** Pawson and Brailsford, Sheffield, p 89

[59] PhC 530/1 (21,49,53,68) Sheffield Archives

[60] This is the act of truing the grinding wheel

[61] Peatman, J. **Abbeydale Industrial Hamlet** Sheffield City Museums 1981 p 14 and **Shepherd Wheel** Sheffield City Museums 1984 p10

Figure 12b: The location of the Pentrough at Upper Cut Wheel (Rivelin) can be seen at A1.

Wheels and Wheelpits

For the most part the water wheels on the Sheffield rivers were overshot or pitch-back wheels (see Figure 13). In some instances breast shot wheels were used and on rare occasions the undershot wheel was employed as at Malin Bridge[62] (Figure 14) and at Old Park Silver Rolling Mill.[63] Crossley has argued that it may be possible to suggest the type of wheel used by the fall of water although this does not provide conclusive proof:

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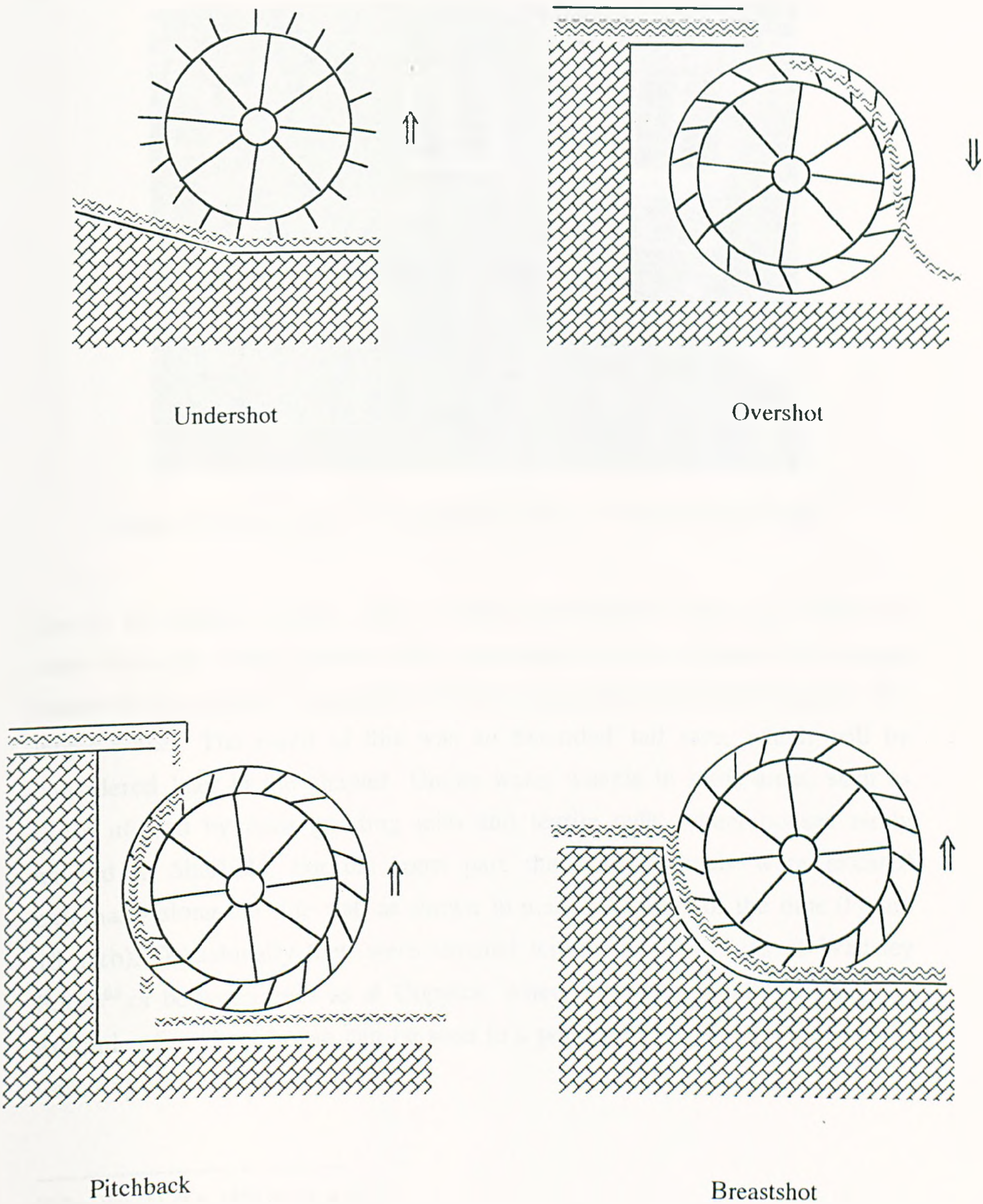
[62] Crossley, D. et al 1989 op cit. p xii and p41-3.
[63] Miller, W.T. 1949 (4th edition) **The Watermills of Sheffield** Pawson and Brailsford, Sheffield, p15

Figure 13: The different types of water wheel found on Sheffield's rivers.



After Giles C and Goodall I, 1995 p 126

'Where the fall was 10 feet or more there is the probability that a wheel would be overshot or pitch back in design. Where the fall of water was lower, the less efficient breast wheel would be used. Low falls, of two or three feet, suggest undershot wheels.'[64]

Figure 14: Rare example of an undershot Wheel at Malin Bridge (Loxley)

Due to the tightly packed nature of the water-powered sites on Sheffield's main rivers the wheel pit was often excavated to a level below the natural course of the river to increase the fall and thus exploit the potential power of a larger wheel. The result of this was an extended tail race, which will be considered later in the chapter. Unlike water wheels in some areas, such as those utilised by corn grinding mills and textile mills, wheel houses rarely existed in Sheffield. For the most part the water wheels were situated externally along the side wall as shown in many paintings of the time (Figure 15 a&b). Occasionally they were situated within the "hull" as at Wadsley Forge[65] or between ends as at Coppice Wheel[66]between buildings. One rare example of a wheel house can be seen in a painting by C.T. Dixon of Lescar Grinding Wheel (Figure 16).[67]

[64] Crossley, D. et al 1989 op cit. p xii
[65] ibid p8
[66] ibid p54
[67] Lescar Grinding Wheel, Sharrow, also known as Wheel at Endcliffe 1868 by CT Dixon Kelham Island Museum K1915-11.

Figure 15a:Water wheels are usually situated on the side wall of the "wheel". This example is of Endcliffe Wheel (Painted by K Siddall (Kelham Island Collection K1953)).

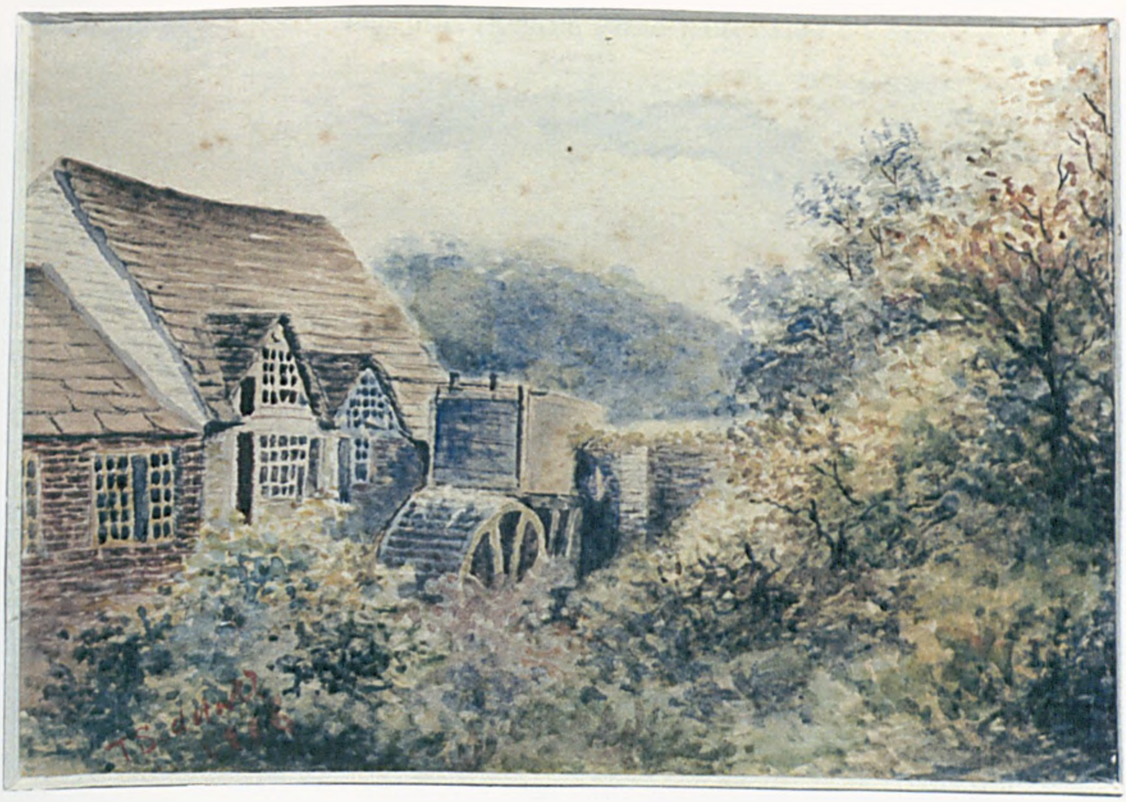


Figure 15b: Another example of the water wheel being located on the side wall (A1) is at Little London Dam, Heeley (Painted by J F Parkin 1868 (Kelham Island Collection 1913.19))

Figure 16: A rare example of a wheel house in this painting by Dixon 1868 of a Wheel at Endcliffe. (Kelham Island K1915.11)

Smeaton advocated that the breastwork of the wheelpit for a breast or pitch back wheel should be 'a true sweep, answerable to the wheel' with a clearance on a 20ft diameter wheel of only quarter of an inch. This minimised losses from the buckets and therefore increased efficiency. Where wheel pits survive Ball argues that this innovation was readily adopted as at Broadhead Wheel on the Loxley,[68] and Frank Wheel on the Rivelin, and where the wheel still exists at Shepherd's Wheel, Olive Wheel and Abbeydale. However, this evidence cannot be conclusive as so few wheelpits remain. On the Rivelin, for example, of the 23 mills that once existed only three wheel pits remain, at Roscoe Wheel, Holme Head and Upper Cut Wheel.

[68] Ball, C. 1992 **Millwrights in Sheffield and South Yorkshire 1550-1900** MA University of Sheffield, Division of Adult Continuing Education p57

In many of the Fairbank papers there are references to the measurement of water wheels and their capacity in terms of horse power. For example a survey of wheels on the Porter in the 1830s showed that those wheels relating to cutlery could produce between six and a half and eleven horse power (Table 4).

Location	Pentrough Depth ft-in	Width of Pentrough ft-in	Opening Inches	Horse Power	Troughs[69]
Ponds Forge	2-4	6-9	3	10.25	-
Broomhall GW	2-7	6-10	3	11	9
Lower Lescar	3-6	5-4	2	6.5	11
Upper Lescar	2-10.5	5-11	2.5	10.5	14
Endcliffe GW	3-6	7-0	1.5	9.25	10
Holme GW	2-7	6-10	3	11	11

Table 4: Fairbank's Calculations for some wheels on the River Porter c 1830s[70] and the number of troughs recorded in 1794.

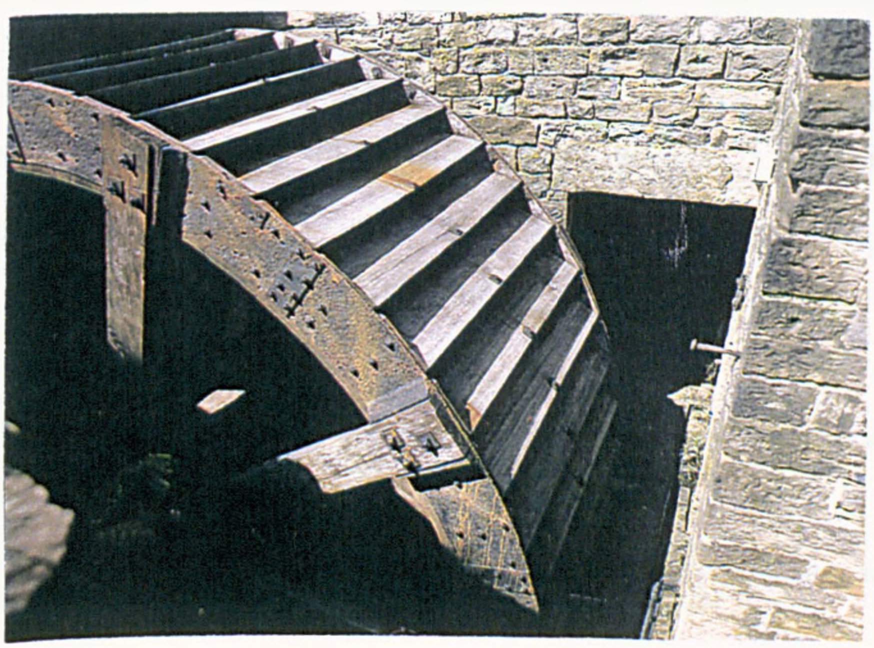
The average power of wheels used in Sheffield was approximately 10 HP[71] although the wheels powering the tilts and grinding wheels at Abbeydale are estimated to generate up to 30 HP.[72] On average one horse-power per trough was required. The effective power produced by each wheel was calculated on a ratio of 3:2 of the maximum theoretical horse power.

It is only possible to guess at the construction materials of the wheels as so few survive, but the majority of the late 18th and early 19th century wheels are likely to have been totally wooden and to have been replaced at a later date by composite wheels, partly made of timber and partly of cast iron, as have survived at Abbeydale Industrial Hamlet (Figure 17). Ball has argued however that new technology was not readily taken up, as the 'push' effect of the textile industry further north was not present. 'Sheffield millwrights

69 From 1794 List
70 CP25 32 Fairbank Collection, Sheffield Archives
71 Crossley, D. et al. 1989 op cit. p 118
72 Peatman, J. 1985 Abbeydale Industrial Hamlet Sheffield City Museum Publication p14

Figure 17: Wheels at Abbeydale. **A:** Tilt Hammer Wheel and **B:** Wheel for driving grinding stones and blowing engine. (From Abbeydale Industrial Hamlet, Sheffield City Museums 1981 pp13-14)

A



B

needed only to adopt such innovations piecemeal, to the extent that they were necessary to overcome a shortfall in power on site.'[73] The mentality of the Sheffield trades seems to have been that if something was not broken there was no point in changing it.

In some cases parts of old wheels were recycled. In 1862 for example a new wheel was installed for Joseph Butler & Co possibly at Upper Cut Wheel.[74] The wood 'for the water wheel patron' was best pine and cost £2-3-5 including springs, glue, sandpaper and labour. This pattern (patron) may have been used for casting some parts in metal.[75] The oak for 'starts' and the cost of repairing what survived of the old wheel cost £2-12-6. Repairing the wheel shaft, fall and shuttle cost £1-14-9 and the wood for the breast shuttle, "red deel", and 14.5 lbs of bolts, hoops etc. cost £0-18-0.[76]

Smeaton[77] was the first to introduce iron parts into waterwheels in the 1750s, beginning with the axle. Oak axles frequently failed and fractured due to natural irregularities in the wood and were less able to resist the torque stresses placed upon them, because they carried the weight of the wheel as well as transmitting the power. Iron did not suffer from these defects to the same extent and could be made stronger (for the same size) or smaller (for the same strength) compared to wooden components.[78] Later, iron was applied to the rim of the water wheel to add strength to the buckets and by 1800 water wheels constructed completely from iron were known.[79] However it was not until the reduction in the price of iron in the second quarter of the 19th century that iron wheels became more widely used. Reynolds' writes 'The greater availability and declining price of iron undoubtedly encouraged the replacement of wood with iron parts in water wheels.'[80] Although Ball

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[73] Ball, C. 1992 op cit. p53-54
[74] Crossley, D. et al 1989 op cit p 59
[75] Ball, C. 1992 op cit p66
[76] Photocopy Collection 530/1 p38 Sheffield Archives
[77] Smeaton had drawn up plans for the Duke of Norfolk's mill at Canklow near Rotherham. His work would therefore have been known in the region. (Ball C 1992 op cit p51
[78] ibid. p287-288
[79] ibid p289
[80] Reynolds, T.S. 1983 (reprinted 1988) **Stronger than a Hundred Men: A History of the Vertical Water Wheel** Johns Hopkins University Press Baltimore US p267

suggests that wood remained cheaper than iron until the 1870s,[81] iron had a number of advantages over wooden wheels in addition to adding strength to the axle. For example the balance of the wheel was easier to maintain, as iron did not suffer from shrinkage and expansion in the same way as wood. Secondly, because of the thickness of wooden components required for strength, water was obstructed from entering the buckets 'therefore significantly reducing the efficiency of the wheel'.[82] Thirdly it was estimated that waterwheels lasted no longer than seven to ten years before repair or replacement was required.[83] There is however little evidence for their adoption in Sheffield, the composite wheel being favoured.

For example in June 1863 a new wheel was to be installed at Rowell Bridge, a grinding 'wheel of two ends'.[84] The entry in the Wilson papers read:

'June 1863: Estimate for one metal water wheel with deal bucket boards and elbows and Oak ribs and stays.
Also one deal pentrough with oak snout plange and pillars and bairers and all the work to be complete in a workman like manner for the sum of £90-0-0.'[85]

Limerick Wheels, where Wilson worked in 1863, was also of composite construction:

'Estimate for one new water wheel for Mr. Peece at Limbrick Works. Metal Wheel 9ft dia. With iron buckets. Plates deal 2inch thick and 2 oak ribs 4in x 3in and oak stays and all complete for the sum of £76-0-0.'[86]

Composite wheels were also found at Mousehole Forge and Smithy Wood Tilt by Miller in the 1930s. Smithy Wood Tilt was largely intact, but only the iron rims remained at Mousehole.[87] Iron wheels are also known to have existed at Wolf Wheel in 1934,[88] and still survives at Low Matlock (Figure 18) and Olive Wheels. By implication Hind Wheel, also known as Iron Wheel, must have had a wheel partly or totally constructed from iron. Unfortunately no documentary

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[81] Ball, C. 1992 op cit p 56
[82] ibid p287
[83] ibid p287
[84] Crossley, D. et al 1989 op cit. p31
[85] PhC 530/1 p49 Sheffield Archives.
[86] PhC 530/1 p49 Sheffield Archives.
[87] Miller, W.T. 1949 op cit p14 & 40
[88] ibid. p66

evidence survives for the types of bearing used for holding the axle which would also have had implications for the efficiency with which it produced power. Of those wheels which survive the axle is held by cast iron open bearings as at Low Matlock, Olive Wheel, or closed bearings as at Abbeydale on stone blocks.

Figure 18: The iron wheel which survives at Low Matlock (Loxley), although it has now been set back off its bearings.

Comparing the prices of the water wheels given above with the cost of an 11 or 12 HP steam engine,[89] water wheels were approximately £100 cheaper. However taking into account the cost of water courses, the maintenance of the dam as well as the wheel, and the irregularity of the power source, there was probably little difference in the amount needed to run a small engine. Flavell quotes from Sun Fire Insurance documents that 'utensils, water wheel at 'going gear' at leather Wheel £10... in 1783' and that Clough Wheels, rebuilt in 1764 were insured for £100 each in 1779 and the 'implications are that the latter were so superior to that at Leather as to be not only bigger, but

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[89] The average size of a water wheel at the time was c10-12 HP

of different quality'.[90] Indeed, as Fairbank noted, steam engines were being installed by the 1840s at water powered sites to operate machinery in times of water shortage.

Power Transmission From Water Wheels.

The principles of power transmission cannot be observed in the field, except where the machinery has been preserved in museums such as Abbeydale and Shepherd's Wheel. There is also a lack of documentary evidence referring to the layout of machinery, one of the few examples being Fairbank's drawing of Moscar Wheel (Figure 19) which shows power being taken from the wheel via a spur gear to the troughs.

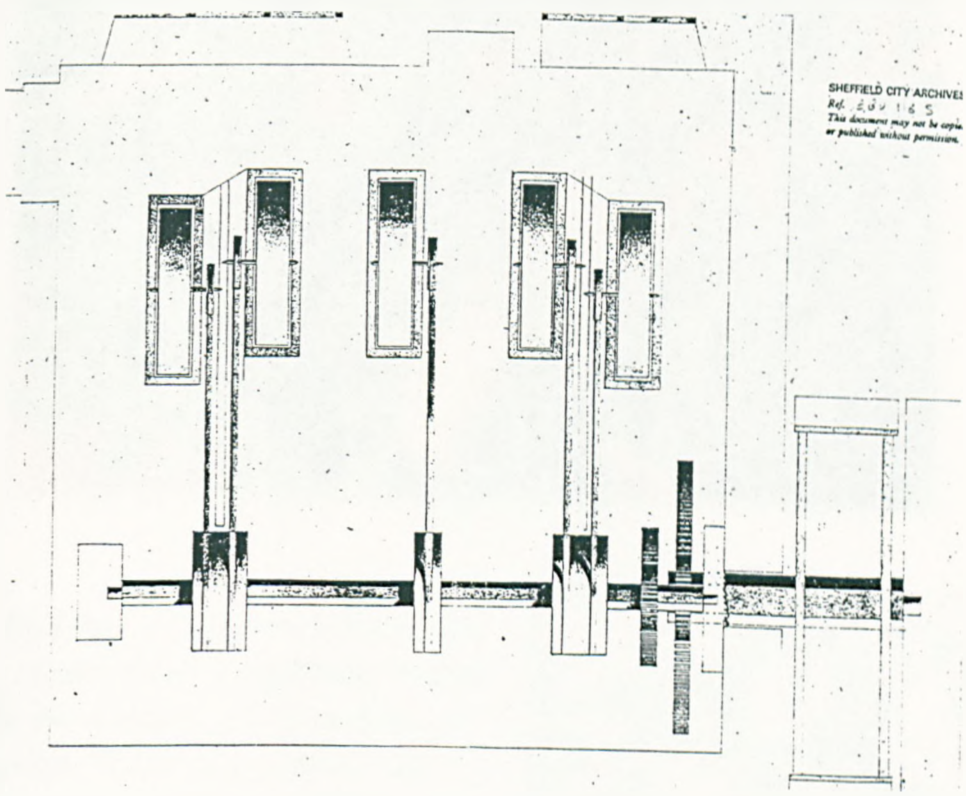


Figure 19: Fairbank Drawing of the system of power transmission from the wheel to the troughs at Moscar Wheel (Sheaf) (Sheffield Archives)

90 Flavell, N. 1996 The Economic Development of Sheffield and the Growth of the Town 1740-c1820 Unpublished PhD University of Sheffield

Another example is a plan of a proposed shop at Wadsley Forge of 1812 found in the Wheat Collection.[91]

At Shepherd's Wheel the water wheel turns a 'crown wheel' (Figure 20) made of cast iron with 80 oak teeth individually set into the face. This meshes with two metal pinions on the stub axles and turns the action through 90° to transfer the power via wooden drums and leather belts to the spindles and pulleys on the grindstone.[92]

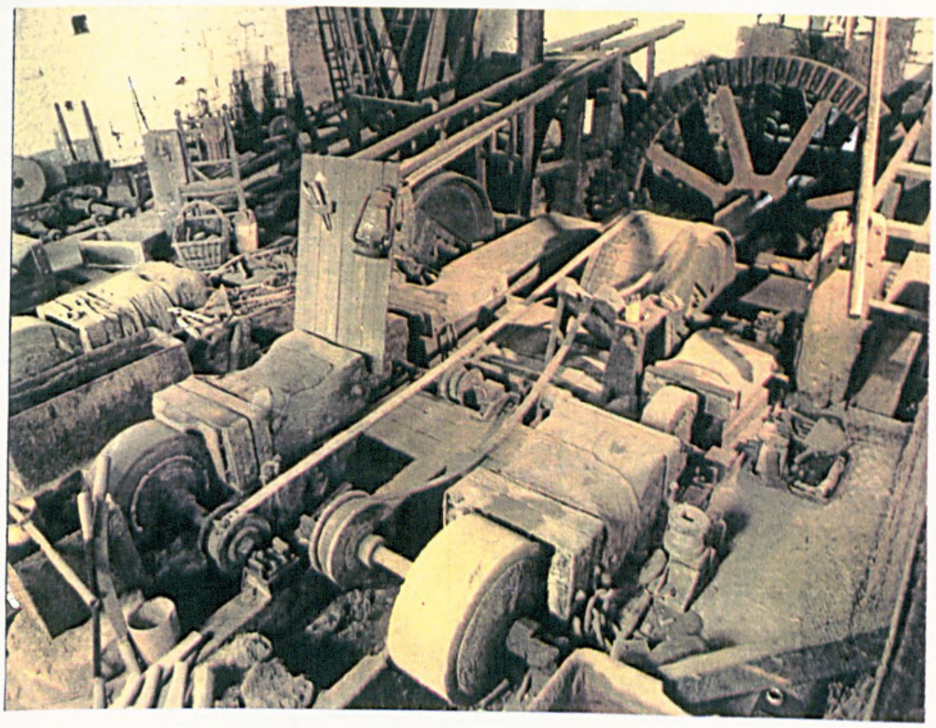
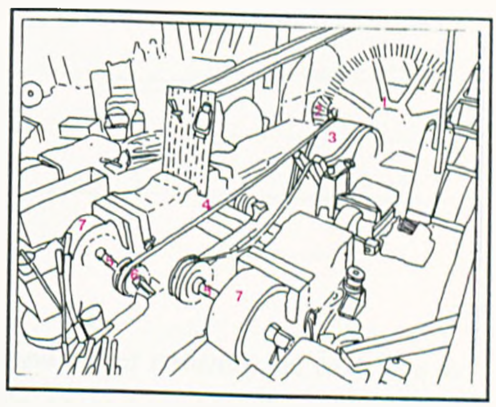


Figure 20: Power Transmission at Shepherd's Wheel. 1. Crown Wheel, 2: Gear Wheel meshes with two metal pinions, 3: Wooden Drum, 4: Leather belt, 5: Spindles, 6: Pulleys and 7: Grindstones (Sheffield Museum Publications 1984)



Work by George Watkins in the 1960s recorded the interior of Abbeydale. The works had four water wheels (Figure 21). The first drove a two piston

[91] Wheat 1806M, Sheffield Archives. See Crossley D. et al 1989 p8
[92] Peatman, J. 1984 op cit. p 9

blower for the forge hearths, the second the hammer shafts by gears and some shears by means of the 'hammer cam shaft or pulley system'[93]. The third and fourth drove the main grinding troughs 'by two stage gears to a main pulley shaft'.[94] The first three wheels were described as 'being of similar construction, having wooden arms, held between double plates that form each side by bolts and bolted to iron side plates of rim. These have wooden axles 1 was twelve inches diameter, 2 & 3 about 30 inches in diameter'.[95] The fourth had cast iron arms and an external spur ring drive. An oscillating horizontal steam engine was later coupled directly to drive the grinding wheel.

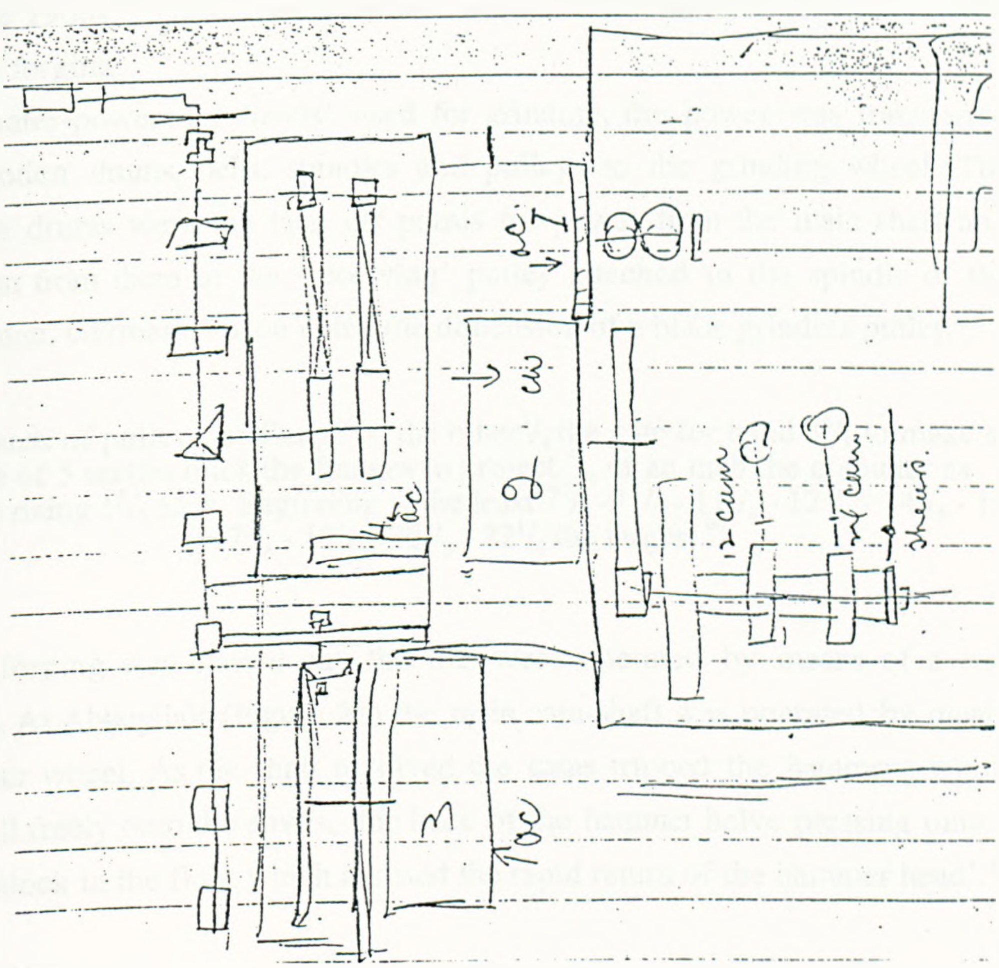


Figure 21: George Watkins' drawing of wheels and power transmission described as 'Wheel at Beauchief' but thought to be Abbeydale. (p256 George Watkins' Collection, NMR)

[93] George Watkin's notebook notes to 256 now housed at the NMR
[94] ibid
[95] ibid

At Rowell Bridge the German Wilson papers give details of a spur wheel 'on water wheel shaft' with 112 teeth, a spur nut with 25 teeth, a 'bevell mortice wheel' with 60 teeth and a bevell nut with 24 teeth, this would allow the drum shafting to make 200 revolutions a minute.[96]

Rim drives, developed by Hewes in the early part of the 19th century, despite the advantages of reduced 'gudgeon friction'[97] were not popular in Sheffield possibly due to the continued use of wooden rather than iron wheels which were unsuitable for such gearing. One example remained at Royd's Wheel until the 1960s.[98] These types of wheel were also not suitable for heavy work such as forging.

In all water-powered 'wheels' used for grinding, the power was transferred via wooden drums, belts, spindles and pulleys to the grinding wheel. The wooden drums were the take off points for power from the main shaft and belts ran from them to the 'receiving' pulley attached to the spindle of the grindstone. German Wilson noted the dimension of a blade grinders pulley:

> Thickness of pulley one flange $^{5}/_{8}$ the other $^{3}/_{4}$ the gate for band $3^{5}/_{8}$ to make a table of 5 inches thick the flanges to project $^{5}/_{8}$ of an inch the diameter as flanges rising $1^{5}/_{8}$ each. Beginning at the least $7^{7}/_{8}$ -9 $^{1}/_{2}$ - $11^{1}/_{8}$ - $12^{3}/_{4}$ - $14^{3}/_{8}$ - 16 - $17^{5}/_{8}$ - $19^{1}/_{4}$ -$20^{7}/_{8}$ - $22^{1}/_{2}$ the largest.[99]

When forging was carried out, the tilts were operated by means of a cam system. At Abbeydale (Figure 22) the main cam-shaft was operated by means of a spur wheel. As the shaft revolved the cams tripped the hammers, which then fell freely onto the anvils, 'the back of the hammer helve pressing onto a recoil block in the floor which assisted the rapid return of the hammer head'.[100]

Tail Goits

The purpose of the tail goit was to remove water as quickly as possible from the wheel and return it to the river; in some cases this was via the headrace

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[96] PhC 530/1 p68 Sheffield Archives.

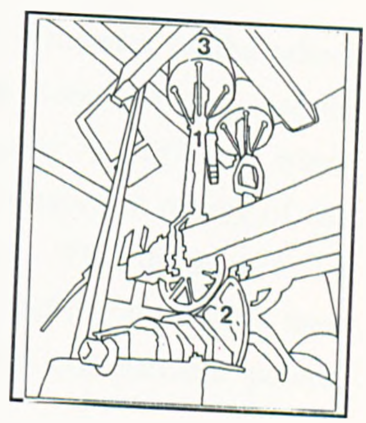
[97] Reynolds, T.S. 1983 op cit p290

[98] Crossley, D. et al 1989 op cit pxiii

[99] PhC 530/1 p14

[100] Peatman, J. 1985 <u>Abbeydale Industrial Hamlet</u> (2nd edition) Sheffield Museum publications p10

Figure 22: The operation of the tilts by a cam system at Abbeydale (Sheffield Museum Publications 1985) 1: ride on triple acting cams, 2: fitted directly to water wheel shaft, 3: cylinders in which pistons are working.



and dam of the next wheel downstream. For example at Frank Wheel the tail race feeds into Wolf Wheel head race. Returning water directly to the river reduced the risk of backing up, although as noted above it did not remove it entirely, especially if the height of the downstream weir was increased. Because of the desire to increase the fall of water, the water leaving the wheel pit was often at a level below that of the stream and for this reason extended tail races can be found at sites such as Holme Head Wheel where the tail goit is separated from the stream by large ashlar blocks joined by wrought iron straps (Figure 23a). Another example is Rowell Bridge Wheel where wooden piles can still be seen which either formed part of the core of a bank or to which planks would have been attached to secure an adequate outflow (Figure 23b).

Figure 23a: Upstream view of extended tail race at Holme Head Wheel where large ashlar blocks separate the tail race (A1) from the Rivelin (B2).

If the water was not removed from the wheel pit the efficiency of the wheel would have been severely compromised. This was noted in the dispute between Mr Newbould and the Rowell Bridge Company in 1837. The water from the tail goit of Old Wheel was impeded by the occasional raising of the dam and pentrough by the Rowell Bridge Company. 'This diminishes the slope or fall of the water flowing down the tail goight and thereby causes their water wheel to be in back water by which they lose considerable power, consequently less work can be done.'[101]

[101] CP27 (46) Fairbank Collection, Sheffield Archives.

Figure 23b: Extended tail race at Rowell Bridge (Loxley) where remains of wooden piles either indicate the further extension of the bank or a system by which washboards were used to extend the length of the tail race.

The cost of digging a tail goit at Walk Mill in 1800 was £5-8-2 (Figure 24a),[102] that at Clough Wheel in 1761 for John Wilson & Co came to £14-15-9 (Figure 24b).[103]

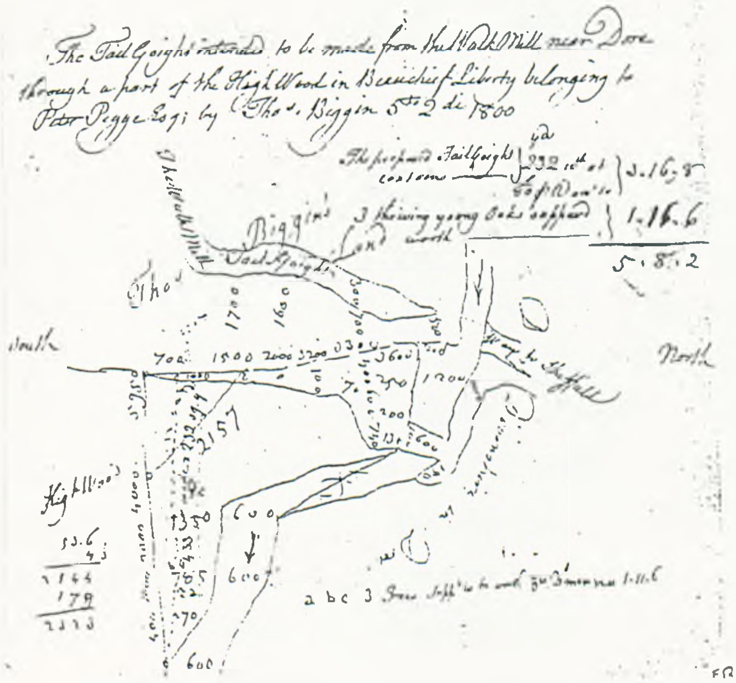


Figure 24a: Digging a Tail goit at Walk Mill (FB87p7)

[102] FB87 p7 ibid
[103] FB19 p99 ibid

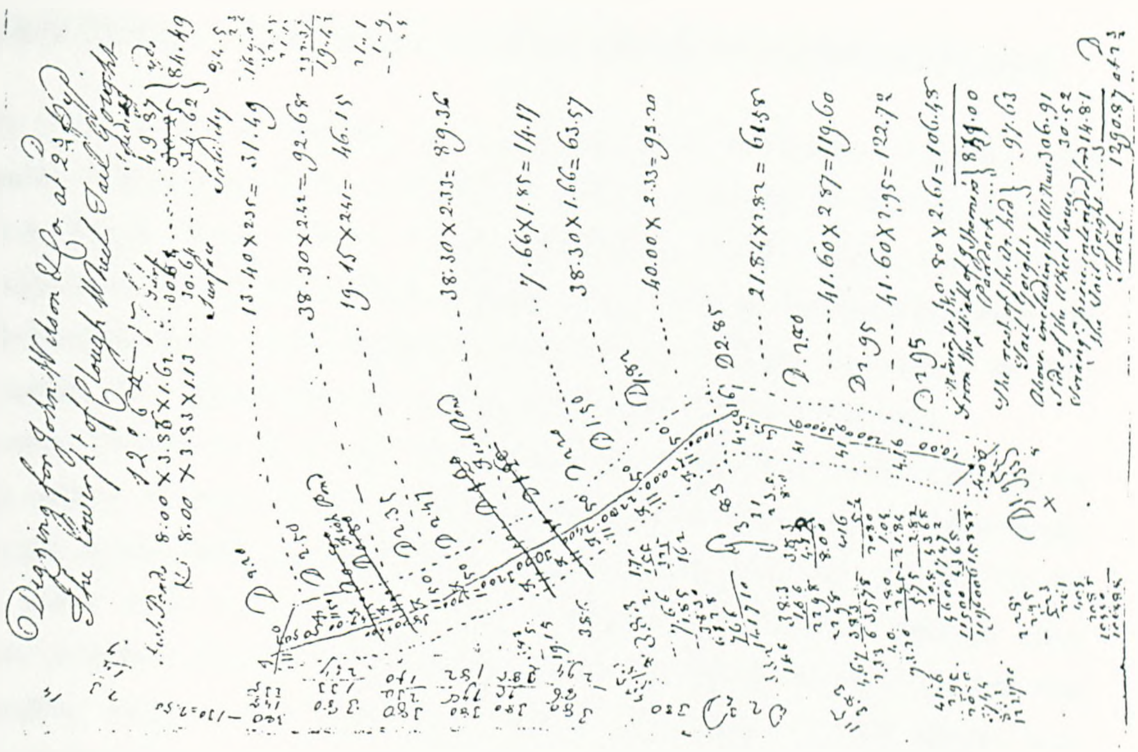


Figure 24b: Example of digging a tail goit from Field Book 9 at Clough Wheel (Fairbank Collection, Sheffield Archives).

Like head goits many tail goits survive as part of the drainage system, although in many cases they have become overgrown and the outfall may not always be obvious.

It can be concluded that although water power was the foundation on which the cutlery industry in Sheffield was based little evidence remains apart from the watercourses created to power the wheels.[104] Water power, it can be argued, must have stayed competitively priced in relation to steam power at least until the middle of the 19th century. Similarly, steam offered little technical or commercial advantage for heavier branches, such as forging, until the 20th century.[105] Those 'wheels' and tilts that survived the longest did so in part because of the removal of some firms to the town centre where they would be nearer their market, thus releasing some of the pressure on water supplies.

[104] Crossley, D. 1989 op cit pv
[105] Ball, C. 1992 op cit p55

Steam Power - To What Extent was it Adopted by the Sheffield Trades?

By 1794 six steam engines were in operation in connection with the metal trades. These included Messrs Kenyon and Co at Ponds, Mr Bailey and Co's Park Steam Wheel, Messrs Ward and Ellis's Steam Wheel and Tilts at Shalesmoor, Mr Parkin's Steam (Rolling) Mill, Gibraltar and Stephen Smith and Christopher Oates, silver plater and cutler, Wicker.[106] These accounted for 300 troughs, just eighteen percent of the total troughs in use in that year.

Despite plentiful local coal sources steam power was only slowly adopted by the cutlery industry in the nineteenth century and then not on a large scale, except by the grinders. Surprisingly, steam engines were not employed to lift the water back to the dams as in the Yorkshire textile mills.[107] Instead, they were attached directly to machinery, as at Abbeydale in 1855, to run the grinding shop, and at Whiteley Wood Forge where a 12HP engine was installed between 1835 and 1838. Other examples include Sylvester Wheel (1830;10HP), Cinderhill Wheel (1830;15HP), Little London Wheel (1901;60HP), and Ponds Forge (1829;83HP). Only after the middle of the century did steam become the principal motive power for turning the grinding wheels as analysis of the ratebooks shows (Table 5).[108]

Year	Number of firms with engines
1820-21	2
1830-31	3
1840-41	6
1850-51	13
1860-61	30
1870-71	21
1880-81	19
1890-91	14

Table 5: The number of cutlery firms with engines recorded in the ratebooks in the 19th century.

[106] Favell, N. op cit p 151

[107] Giles, C. and Goodall, I. 1992 Yorkshire Textile Mills 1770-1930 RCHME, London p 133 and in the Iron Industry at Coalbrookdale.

[108] Pollard, S. 1959 A History of Labour in Sheffield Liverpool University Press p 51.

These figures, however, are not a full reflection of the use of steam power, the ratebooks recording not the existence of engines but of separate engine houses, which were rare in Sheffield. Pollard found that other data showed that within 100 years however their number had equalled those of water power at its zenith.[109] By 1854 for example, the Sheffield Independent reported that there were 109 engines in use by the trades. Water power had however declined over those 100 years from 133 wheels in 1770 to 32 wheels by 1865.[110]

The figures from the Sheffield Independent were broken down between the various trades and branches of the trades as seen in Table 6.

	No of engines	Horse-power
Grinding	40	996
All kinds of cutlery, tools etc.	45	540
Silver and Britannia Metal	19	143
Handle Making etc.	5	33
Total	109	1712

Table 6: Use of steam power in the cutlery and related trades in 1854 summarised from the Sheffield Independent.[111]

One hundred and nine steam engines, allowing one per building, would power just a fifth of all the workshops known to have been in use in the 1850s.[112] By 1870, the factory returns[113] show that there were 168 cutlery firms in Yorkshire using power, twenty of which used water-power, while there were 438 engines. This figures suggests the use of two to three per firm. However the ratebook evidence shows that in 1870 there were 539 firms in total, indicating that two thirds of firms used no power.

[109] ibid
[110] ibid. p53
[111] Sheffield Independent 15/4/1854.
[112] Assessment of the ratebooks collected by the author.
[113] Parliamentary Accounts and Papers, Factories: Returns of the number of manufacturing establishments in which the hours of work are regulated by Act of Parliament 1871 LX11.105

Where was Steam Power Used?

Steam power did not lead to an increase in the scale of operations of many firms, as was stressed in the previous chapters. Unlike its influence on the textile mills of the period there was no large scale development of integrated multi-storeyed factories but power was installed in most of the tenement works from the 1830s. Union Wheel, erected by subscription, had a 40HP engine installed in 1818 and Grimesthorpe Wheel had a 26HP engine installed in 1820.[114] Fairbank in c1830 estimated the cost of installing two engines, machinery and boilers at £3109-0-0 in a tenement works in Thomas Street.[115] These were the equivalent of the 'room and power' mills of the textile industry.[116] Advertisements for such works can be found throughout the 19th century in the Sheffield Independent but they do not emphasise any advantages which the use of steam engines might have over other forms of power source. For example on the 7th April 1855:

> 'Steam power to let Arundel Wks. heavy and light troughs'[117]

Others described the engine as well as the premises, such as that for property in Carver Lane but little description is given as to how the engine would increase production:

> 14/4/1855
>
> 'All that newly erected grinding wheel, containing 7 troughs and range of warehouses and workshops running towards and fronting Carver Lane. And also, all that Steam engine of 12 HP with 2 boilers, engine house and chimney stack and machinery, shafting, gearing and appurtenances connected therewith. The engine is nearly new and made by Messrs Davy Brothers.'[118]

Further evidence for the supply of steam can be found in an agreement made between Leonard Hall and Arthur Smith to supply John Spink, builder with steam to run 18 grinding troughs in 1871 for a term of four years. Evidently they were all speculating in the cutlery trades.[119]

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[114] Flavell, N. 1996 op cit p158
[115] CP3 (132) Fairbank Collection, Sheffield Archives
[116] Giles, C. and Goodall, I. 1992 op cit p 107-10
[117] Sheffield Independent Local Studies Library
[118] Sheffield Independent
[119] MD6443 Sheffield Archives

In 1865 the Royal Commission reported that there had been an increase in the use of steam power but 'the workers even in the factories keep much of the old independence of their masters ...[and]... thus many of the advantages which might be thought likely to result from the supervision of a master and their hours, and the state of the work-place &c. are, unfortunately, often imperfectly realised'.[120] In total, in 1865 White reported that there were probably more than 80 steam grinding wheels but that no survey had been carried out. [121]

Steam power, in addition to its use for grinding, was also used in the forging process but although the process of stamping table blades appeared in 1858, it was not until the 1880s that it became widely used in Sheffield and the 'flying of scissor blades' was not established until 1892.[122]

Evidence for Engines and Boilers.

Archaeological evidence for the steam engine and steam power is scarce. The principal surviving archaeological evidence are the chimneys which have already been discussed in Chapter 4.

Types of Engine

As no steam engines remain in situ it is not possible to identify precisely the types of engines which were used by the cutlery trades. Early rotative engines were essentially beam engine designs, improved upon by Boulton and Watt in the last two decades of the 18th century. These engines however could produce little more that ten horse power and by 1800 Boulton and Watt engines still rarely exceeded twenty.[123] Compounding or 'McNaughting', patented in 1845, allowed engines to work at a higher pressure and therefore produce more power but it was not until the developments of the 1860s that steam engines became available to smaller scale works. Improvements in the horizontal engine allowed it to work at higher speeds while maintaining smooth and economical running. In 1903 William Ripper recommended the horizontal engine but, 'the choice of type depends in some measure on the

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[120] White, J.E. 1865 *Report upon the metal manufactures of the Sheffield District* **Appendix to the Fourth Report Vol. 14 Children's Employment** IUP p2 para 11

[121] ibid. p4 para 38

[122] Taylor, S.A 1988 **Tradition and Change, the Sheffield Cutlery Trades 1870-1914** Unpublished PhD thesis University of Sheffield p34

[123] Giles, C. and Goodall, I. 1992 op cit p 134

space in which the engine is to be fixed, and also on the speed and rotation desired. Where floor space is limited, and height will permit, the vertical type is the only alternative; but where space is not so limited, the question of speed and rotation desired will more probably decide the type, for slow speeds the horizontal being generally preferred'.[124] Advantages of the horizontal engine included ease of maintenance, lack of leakages of water and oil, and less vibration as the weight of the engine was spread over a larger area. However vertical engines were recognised as being lighter for the same power, and their pistons were less likely to wear down.[125] In summary horizontal engines were chosen over vertical engines 'on the grounds of their economy, compactness and lower price'.[126]

From the evidence presented on Goad's fire plans as well as from evidence presented to a House of Lords Committee on the coming of the railways in 1835 we can estimate the average size of the steam engines used. Mr Vickers gave evidence to the House of Lords committee and declared that he had seen three engines working, and that the average of those three was twenty horse power. The average within the town however was, considered to be, eighteen horse power.[127] Table 7 shows works which had steam engines and, where indicated, the engine sizes as identified from Goad's fire plans in 1896.

The data suggests that the average engine was 30 HP. The very largest engines at Wostenholm's and Continental Works had 350 and 300 horse power respectively. Both works had 100 foot (30.48m) chimneys and two wagon-shaped boilers which were probably of the Cornish or Lancashire design, although the map evidence is not specific. Boiler types will be considered in a later section.

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[124] Ripper, W. 1903 (3rd edition) Steam Engine Theory and Practice Longman, Green and Co, New York. W. Ripper was a member of the Institution of civil engineers, mechanical engineers and Professor of Engineering at the University of Sheffield. p320

[125] ibid p320

[126] Ibid p135

[127] Cooper, C. *Sheffield Works: Steam engines in 1835* The Hub volume 10 no 3 pp19-23

Works	HP
26 Eyre Lane, Cutlery	
25 Howard Street, electroplate	
624 Rockingham Street	14
79 Rockingham Street	
A Millward and Son	
Albion and Melbourne Works	
Albert Works	
Aberdeen Works	
Arundel Works	
Argus Works	100
Beehive Works	50
Bone and Horn Works	
Bradbury and Son (silver)	
Burell, Wilson Co	
Cambridge Steam Power Works	
Central Cutlery Works	14
Clarendon Works	
Clintock Works	8
Colver Brothers, Grinding	20
Continental Works	300
Cross Rockingham Lane	20
Ct 3 Sidney Street	45 & 25
Division Lane	
Empire Cutlery Works	
Exchange Works	25
Furnival Works	
G & W Lowe knife factory	
G Travis and Co	25
Globe Cutlery Works, Carver Street	
Hallamshire Works	
J Rodgers and Son	80 & 25
John Sellers Cutlery Factory	
Livingstone Works	
Mappin Bros	40
Murrey Works	
Monmouth Works	12
Portobello Works	
John Sellers, Cutlery factory	
Sheaf Island Works	
Sidney Works	20
Soho Grinding Wheel	60
Stanley Works	
Union Grinding Wheel	30
Victoria Works	
W Mammatt and Sons (Sheffield Plate)	
W& S Butcher	
Ward and Payne Edge Tool Factory	33
Wm Hutton and Son	
Wostenholms	350

Table 7: Firms with steam power in 1896, and the power of the engine as given on Goad's Fire Plans.

The evidence that remains in the form of engine housing and the relatively late adoption of steam power by the Sheffield industries suggests that horizontal engines were the most common form adopted. Unfortunately documentary evidence for installation of steam engines is very scarce.

Suppliers of Steam Engines.

Only one reference is made to an engineer connected with supplying steam engines to the cutlery trade before 1800. This was John Bown of Bradford, who was a partner of Ward and Willis in the early years of the Shalesmoor Grinding Wheel.[128]

The trade directories until the 1860s listed the manufacturers separately as steam engine and boiler makers. After that date they are cited under Millwrights and Engineers. In 1833 three manufacturers are listed: Josiah Gallimore at 33 Bridge Street, William Smith in Sheldon Row and J&B Wood at 45, Duke Street, Park. In 1841 only Wood Brothers remained of these initial manufacturers, but they had been joined by Thomas Arnold, a boiler maker at Harmer Lane, and Booth and Co at Park Iron Works, which Davy Brothers were to take over in the 1860s. In 1879 eighteen firms are specifically named as being engine makers under the millwrights list and in 1898 thirteen appear, excluding the manufacturers of gas engines.[129]

On the scant documentary evidence available from firms' records it is only possible to link Davy Brothers as suppliers of steam engines to the cutlery trades.[130] Firms outside Sheffield, such as W & J Galloway of Manchester, were also known to have been used by the directors of Soho Works to fix their patent boilers in 1850.[131] In April 1853 the engine was seriously damaged by an accident which resulted in the tenants making other arrangements. A new 60 HP engine was brought from Messrs Hick and Son of Bolton for £1640. Money was borrowed to the sum of £600 from the Union Building Company and John Booth, hatter, at four percent per annum. Boulton and Watt were thought to have supplied the Soho Grinding Wheel with a steam engine in the

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128 Flavell, N. 1996 op cit p154

129 Whites Directories.

130 5/6/1851 Soho Minute Books MD709 Sheffield Archives and Sheffield Independent 14/4/1855 (see p172)

131 28/10/1850 ibid

first decade of the 19th century[132] and in the Fairbank correspondence papers details are given of a 80HP Boulton and Watt engine at Ponds Forge.[133] A half horse power engine built on the Boulton and Watt principle but supplied by Peel, Williams & Co of Manchester is documented at the Furnace Hill Foundry for driving grinding equipment, wheels and troughs in 1815.[134] The Soho steam engine in Fairbank correspondence, unfortunately undated, is referred to as a 30 horse power Murray engine, but this may have been an additional engine installed at a later date. Two engines were recorded in the minute books of 1835.[135]

The local cost of replacing parts of an engine should it break down were found in the Soho Minute Books. In April of 1833 there was an accident with the engine thought to be the result of the piston rods being too weak but the exact cause was not ascertained.[136] New metal pistons were made in 1835, 9.5 feet long and 3 inches in diameter, weighing 225lbs. Shanks and Barr were to undertake the work for 21s per inch for the piston and 6d per lb. for the rods.[137] In 1851 it was decided to replace number one engine as the old one was no longer safe to work. Messrs Galloway reported that they could repair it for £950 with a further £20 for the main gearing and that number two engine could be repaired for £170 and Davy brothers reported that they could repair it in a similar way to the one at Globe Works for £780.
The engine however was not the only requirement in the production of steam power and as with water power peripheral equipment should be taken into account when comparing cost per horse power obtained.

Engine Houses

As the most direct connection between the engine and the shafting system was desirable, engine houses were sited within or at one end of the main

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[132] Flavell, N. 1996 op cit. p 155 gives ,details of a report in the *Iris* 12 March 1811 for a "steady man to work and mange a Watt [sic] patent engine in Coulson Croft" and MD1738 Bundle 2 (51) Letter from Thomas Dunn stating that engine to be installed is "to be a 40 in Boulton Double powered one....£5000 was subscribed for it in an hour".
[133] CP25 (32) Fairbank Collection, Sheffield Archives.
[134] Flavell, N. 1996 op cit. p157
[135] 17/4/1835 Soho Minute Books MD 709 Sheffield Archives
[136] 29/4/1833 MD 709 Sheffield Archives
[137] 17/4/1835 MD 709 Sheffield Archives

building. This was as much the case in the cutlery industry as in the larger textile mills further north.

Beam engine houses are characteristically tall narrow buildings, often in the late 18th century with a strong masonry 'lever wall'[138] which supported the beam at its pivotal point.[139] Externally, later larger engine houses had characteristically large arched windows. An example of such a building can still be seen at Cornish Place. The recent RCHME report suggests that it housed a single-beam engine. 'The north-west wall has a tall round-headed window with a rusticated stone surround.'[140] This can clearly be seen on an 1879 illustration from J Taylor's *Illustrated guide to Sheffield and Surrounding District* (Figure 25).

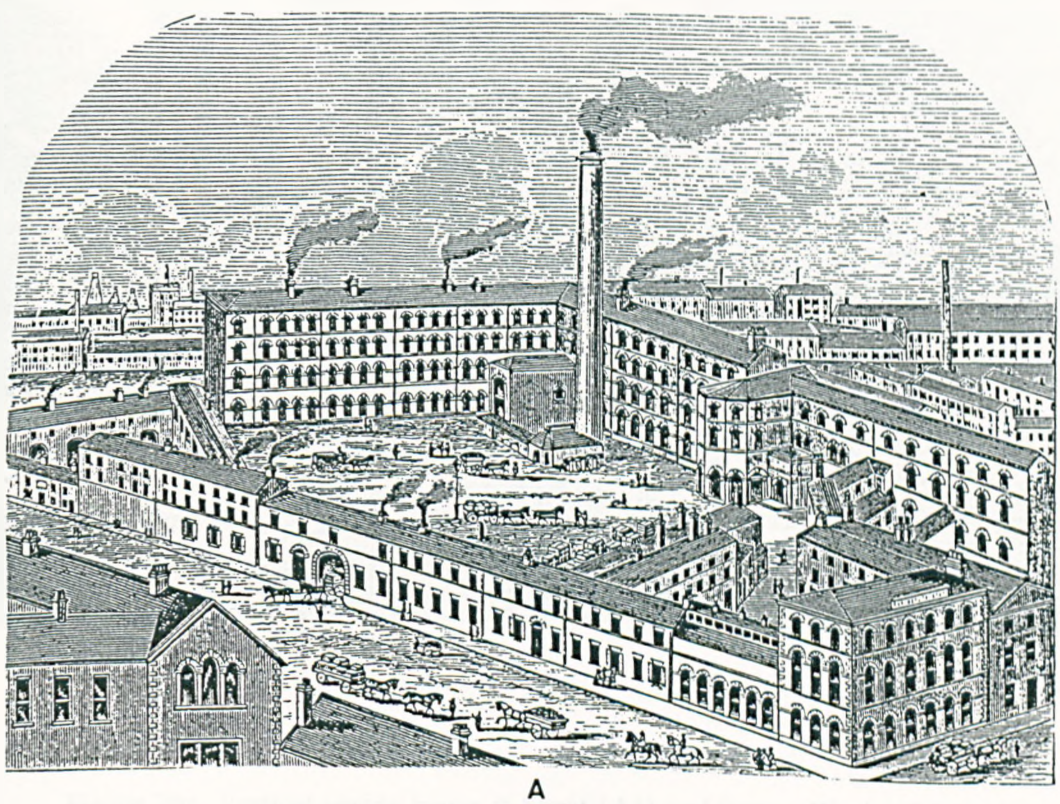

Figure 25: Illustration of Cornish Place 1879 . Note the tall beam engine house with large arched window (A1)

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[138] Also referred to in some parts of the country as a "bob" wall. It is not known what the local term was.

[139] Giles, C. and Goodall, I. 1992 ibid. P 138

[140] Goodall, I. 1996 **RCHME Historic Building Report: Cornish Place, Cornish Street Sheffield** RCHME, Swindon p 13

The original engine floor has been removed and two new floors inserted at a later date. Its corner position 'attached to the inner angle of the two ranges'[141] was typical of the siting of vertical engine houses as it allowed direct connection with the main transmission system.[142] Another beam engine house can be seen in an illustration of Spring Works, belonging to Thomas Turton and Sons, steel, file and saw and railway spring manufacturers and at Globe Works (Figure 26 a&b) .

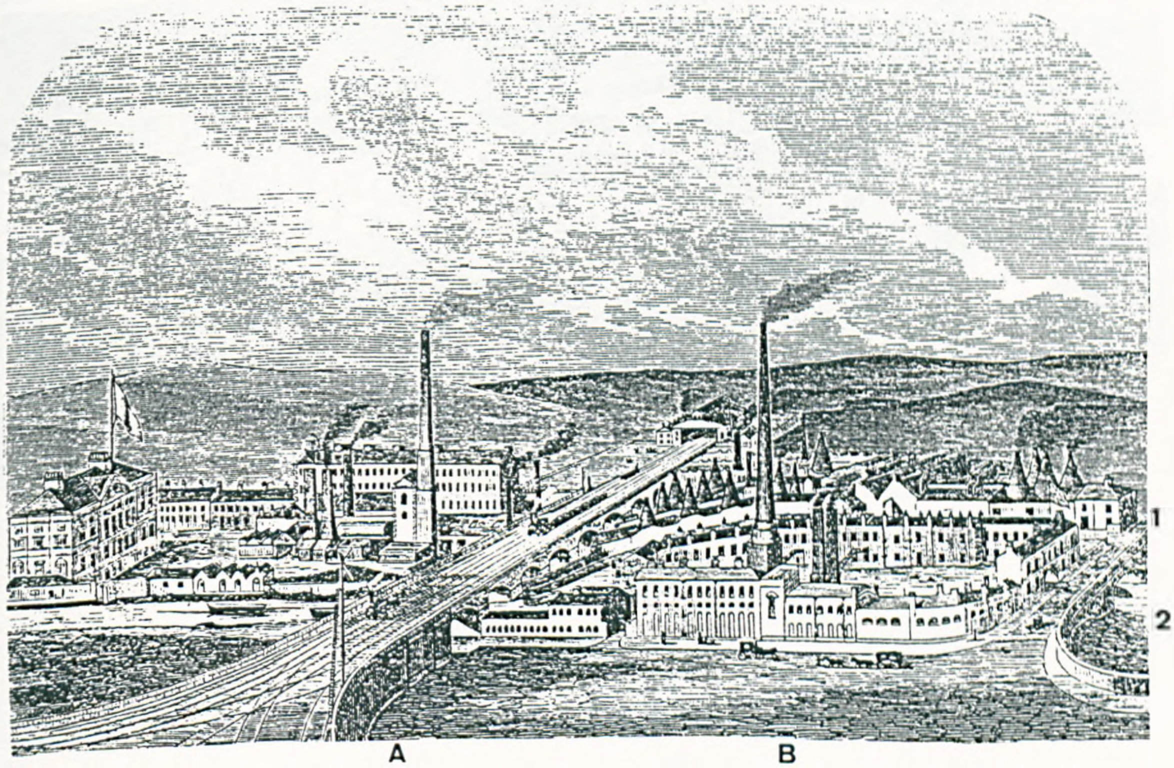
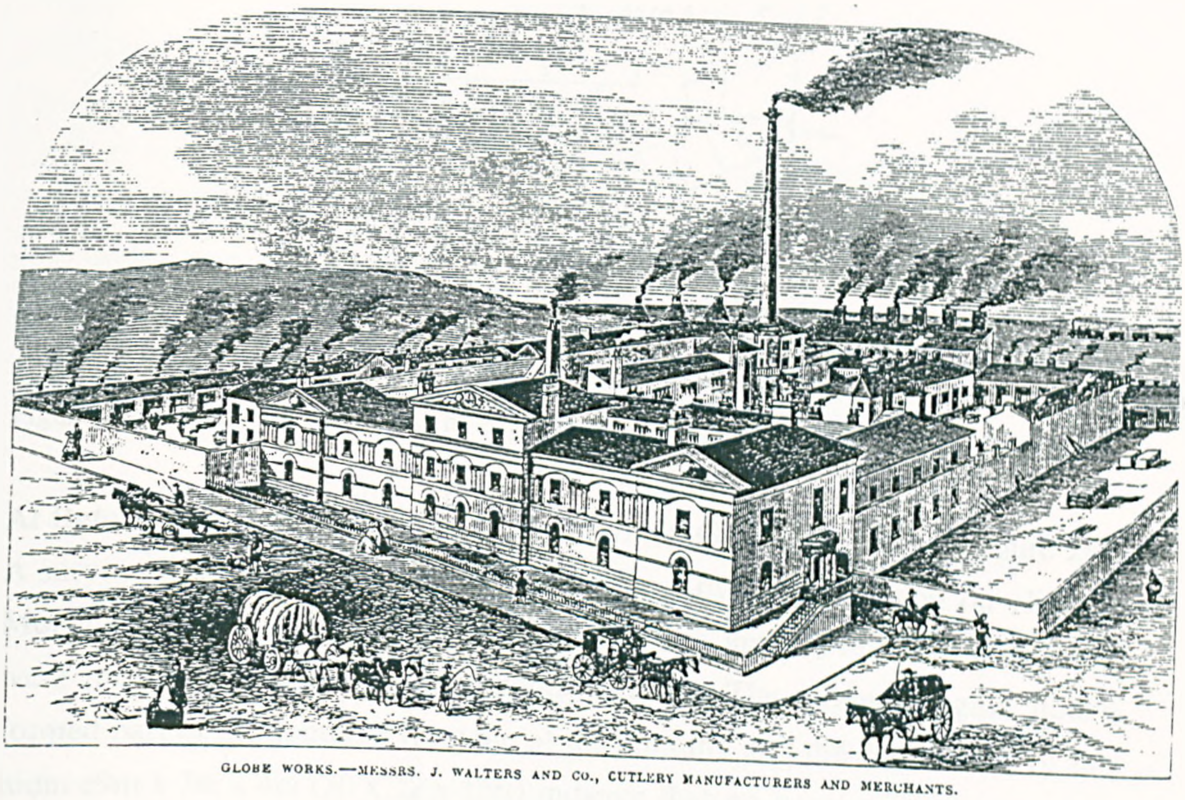


Figure 26a: Vertical engine house at Sheaf (A1) and Spring Works (B2)

[141] ibid p13
[142] Giles, C. and Goodall, I. 1992 op cit p143



GLOBE WORKS.—MESSRS. J. WALTERS AND CO., CUTLERY MANUFACTURERS AND MERCHANTS.

A

Figure 26b: Vertical engine house at Globe Works (A1)

At Truro Works, Britannia metal works, an engine house was located in a corner building (Figure 27). From the evidence above this would suggest a vertical engine but rebuilding of this section of the works in 1860 suggests that a horizontal engine was probably installed at this date. The room has a 'high ground floor ceiled with fireproof brick arches'.[143] A small steam engine operated in this area until the 1950s.

[143] 1995 **RCHME Historic Building Report: Truro Works, 169 Matilda Street, Sheffield** RCHME, York p3

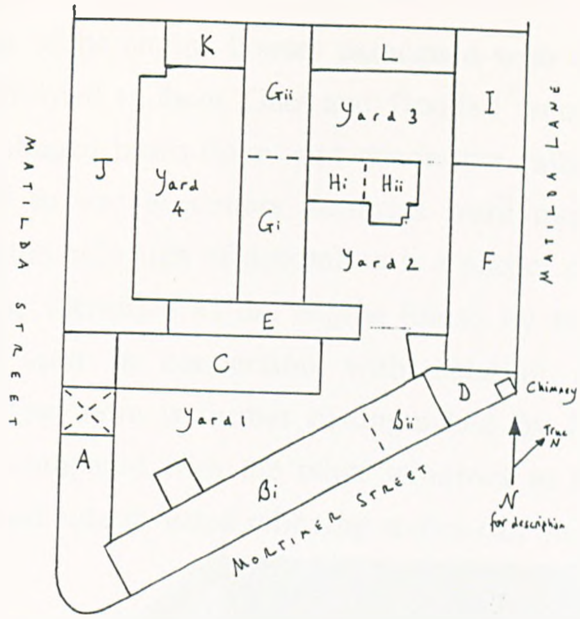


Figure 27: Plan of Truro Works. The engine (D) was located in the corner of the complex (RCHME 1995).

At Butcher's Wheel three engines are shown on Goad's fire plans (Figure 28). A survey of the buildings carried out by the Royal Commission on Historic Monuments, as a result of initial research by the author, revealed that these were probably medium sized horizontal engines. The original engine house formed part of the southern frontage of the building and the dimensions of the room c9m x 7m x 4m (30 x 22 x 13ft) indicate that no beam engine or vertical engine could have occupied the space.

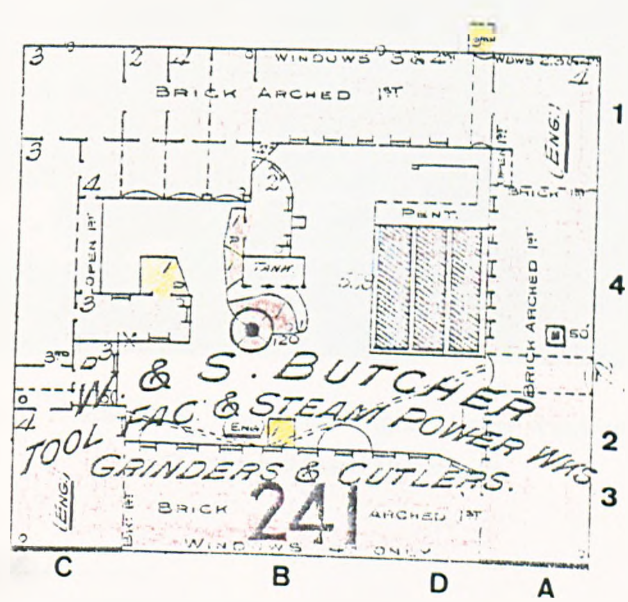


Figure 28: Plan of Butcher's Wheel from Goad's Fire Plan 1896 (674/B1/24) Sheffield Archives). Note the three engines (A1,B2, C3) and boilers in the yard (D4).

A feature of many of the engine houses associated with the textile industry is the decoration afforded to them. Giles and Goodall recorded fluted columns, moulded beams, shaped beam floors and decorative railings.[144] Those engine houses identified in use at cutlery factories were more conservative. At Butcher's Wheel the only sign of decoration is a plaster cornice.[145] In addition the room could be identified as the engine house by two heavy composite beams 'perhaps used in connection with hoisting components during maintenance.'[146] The room is further distinguished by having larger round arched openings compared with the other windows in the southern facade and on the courtyard side inverted relieving arches can be seen (Figure 29 a & b).

Figure 29a: Frontage of Butcher's Wheel showing the larger windows (A1) used for the room which housed the engine.

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[144] Giles, C. and Goodall, I. 1992 op cit p 140

[145] A plaster cornice was also a feature of several textile mill engine houses such as Old Lane Mill, Northowram (op cit p140)

[146] Giles, C. 1996 **RCHME Historic Building Report: Butcher's Wheel, 72 Arundel Street, Sheffield** RCHME, Swindon p 8

Figure 29b: Inverted arches in the courtyard to add strength to the original boiler room.

The original chimney survives only in 'a vestigial form on the lower levels as a lift shaft'.[147] No physical evidence survives for a second engine in the southern block except perhaps 'thicker walls to the north and east [which] may be connected either with the method of stabilising the engine or with a system of power transmission'.[148]

Documentary evidence suggests that at Union Wheel (Figure 30) the engine house was attached to the centre of the building, although by 1920 this had been converted to house an electric motor. The external position of the engine house and details on the 1920 plan show that it was designed to drive a rope race. Giles and Goodall referring to textile mills write:

'The introduction of rope drive encouraged the use of slightly different engine house positions. The principal requirement where multi-storeyed buildings were concerned was not the closest possible communication between the engine flywheel and the transmission system but instead a slight removal of the components to allow the optimum angle for connection between the

[147] ibid p9
[148] ibid p 11-12

flywheel or rope drum and each of the floors within the building. Thus external sites were favoured, using prominently projecting engine houses at either corner or the centre of the mill.'[149]

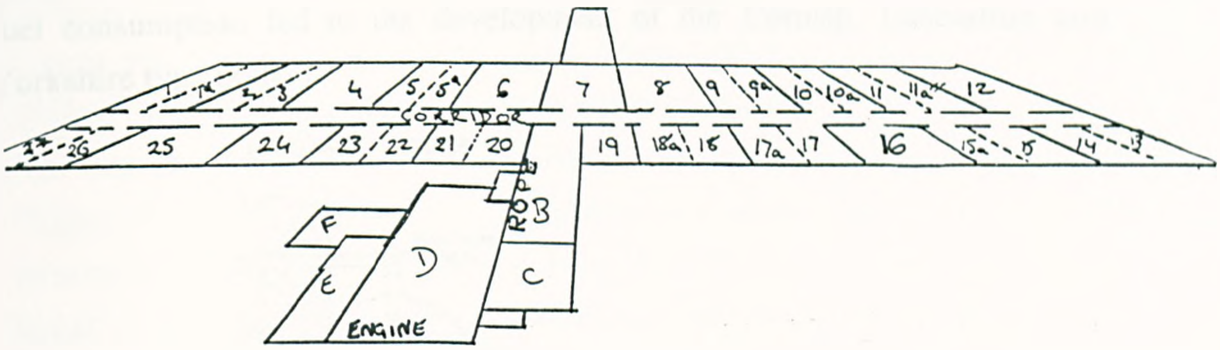

Figure 30: Plan of Union Wheel showing centrally located but detached engine house and rope drive. (After insurance plans UGW plan 27 Sheffield Archives)

Clearly the siting of the Union Wheel engine house was a classic example of the rope drive engine. Another example is that installed at Alpha Works, Carver Street as shown on the 1905 plans.[150]

Boilers

Two types of boilers were associated with steam engines: the haystack and the wagon type. The haystack boiler was a copper or iron cylinder with a

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[149] Giles, C. and Goodall I. 1992 op cit. p143
[150] AP5 Sheffield Archives

domed top, 'raised up to allow space for the fire below'.[151] It was contained within a brick casing rather than a proper boiler house (Figure 31a) and lacked a roof. Haystack boilers can be identified on maps by their circular shape.

Wagon boilers were rectangular in plan with square or egg shaped ends (Figure 31b). Increased surface area of an internal flue meant that they could operate at a higher pressure than the haystack type. 'The need for economy in fuel consumption led to the development of the Cornish, Lancashire and Yorkshire type boilers.'[152]

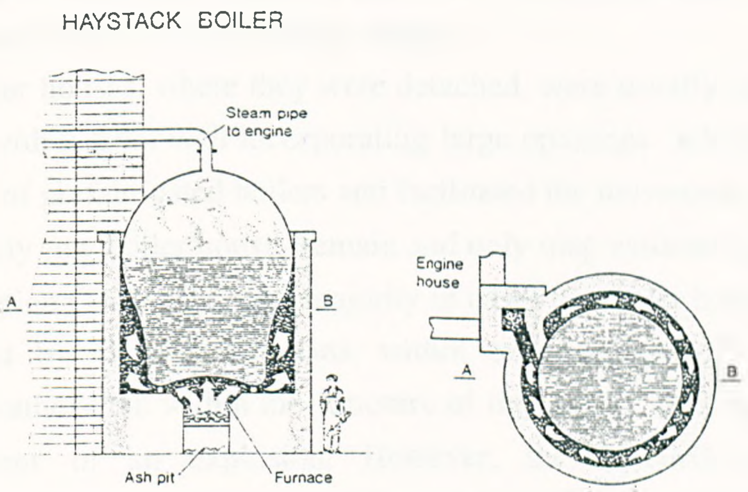

Figure 31a: Haystack Boiler (from Giles and Goodall 1995 op cit p147)

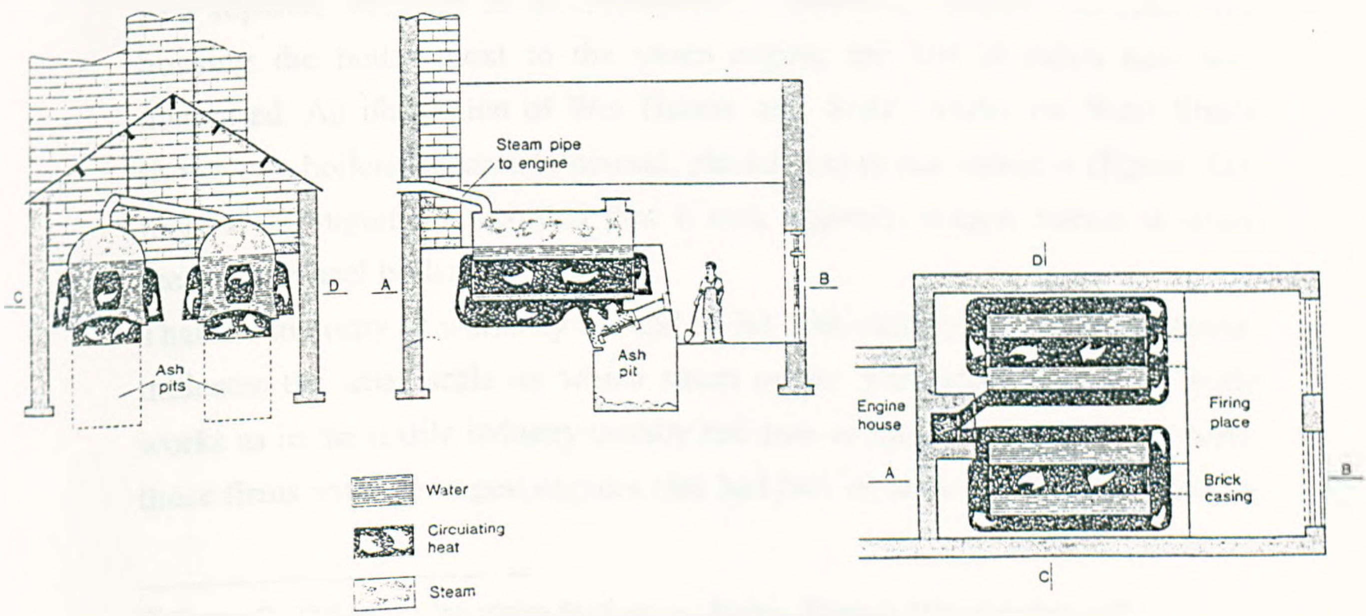

Figure 31b: Wagon Boilers (ibid)

[151] ibid p145
[152] ibid p146

The Cornish boiler was invented by Richard Trevithick and came into use in 1812. Inside was a tube, about half the diameter of the shell, running its length and attached at one end to a fire grate or furnace. Brick flues directed the flames and smoke down the tube under the boiler front. Here they split and passed along each side of the boiler to the rear before escaping up the chimney.[153] The Lancashire boiler introduced by Fairbairn in 1844 had two furnace tubes each a third the diameter of the external shell. Both types were strong and long lasting and the typical boiler, eight feet diameter (2.4 m) and 30 feet long (9.1m), could work to a pressure of 120 pounds per square inch.[154] The Yorkshire boiler was of a similar design.

Wagon boiler houses, where they were detached, were usually single storeyed structures with a front wall incorporating large openings 'which allowed the installation of prefabricated boilers and facilitated the movement of coal.'[155] Unfortunately few boiler houses remain and only map evidence can give clues to their location (Table 8). In the majority of cases the boiler houses were built, as indicated by Goad's fire plans, within or underneath[156] the crowded courtyards rather than within the structure of the works, reducing the fire risk in the event of an explosion. However, the RCHME reports have demonstrated that some boilers were housed internally, as at Butcher's Wheel and Truro Works.[157] By 1896 the boilers at Butcher's Wheel had been moved to a separate structure in the courtyard as shown on Goad's fire plans. By housing the boilers next to the steam engine, the loss of steam heat was minimised. An illustration of Wm Hutton and Sons' works on West Street shows two boilers, separately housed, placed next to the chimney (Figure 32). In 1803 Montgomery recorded that it took eighteen wagon horses to draw the Soho Wheel boiler.[158]

That the majority of works by the end of the 19th century only had one boiler, indicates the small scale on which steam power was adopted. Larger scale works as in the textile industry usually had two or more. In the cutlery trades, those firms with the largest engines also had two or more boilers. For example

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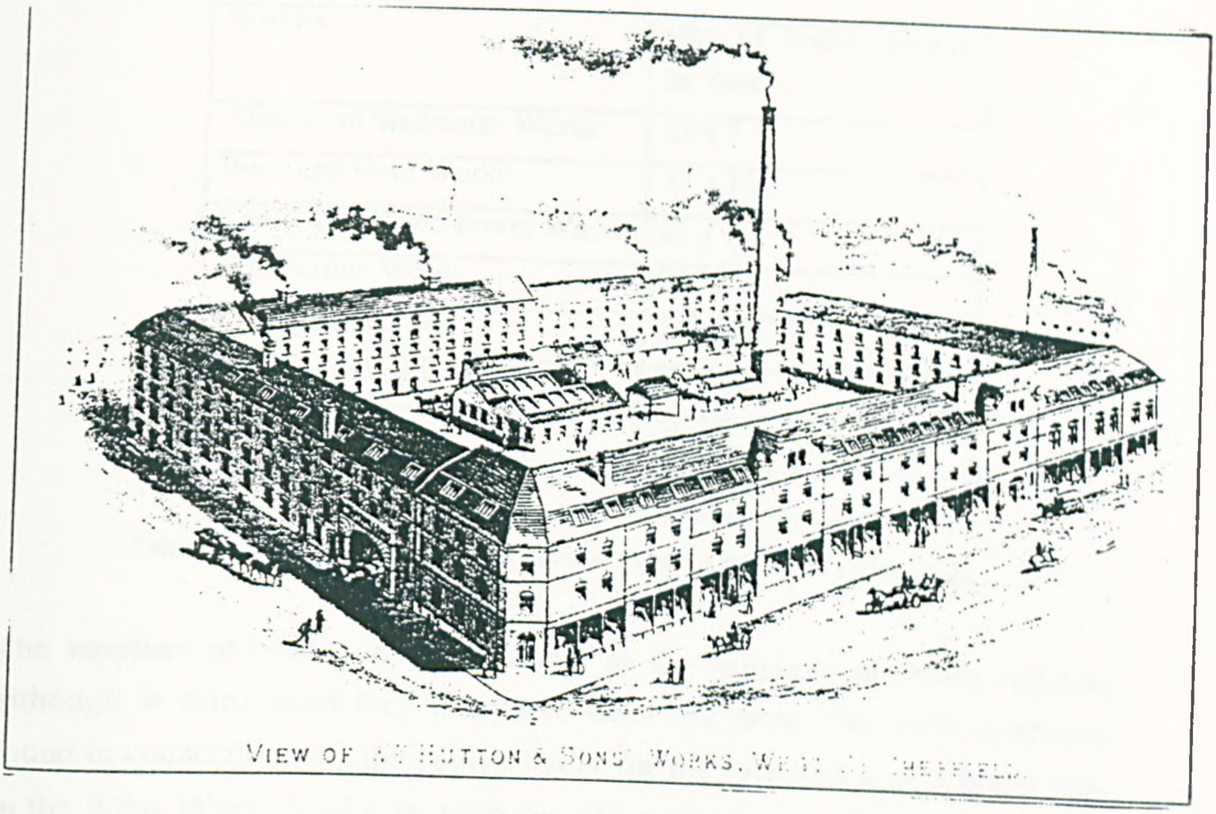
153 Hayes, G. 1995 reprint 2nd edition **Stationary Steam Engines** Shire Aylesbury p27
154 ibid
155 Giles, C. and Goodall, I. 1992 op cit p148
156 e.g. Murrey Works, Rockingham Street
157 RCHME Butcher's Wheel p9 Truro Works p 3
158 Flavell, N. 1996 op cit p384

Wostenholm's who had a 350HP engine and Continental Works with a 300HP engine both had two wagon shaped boilers. Soho Grinding Wheel was

Works	Number of boilers
26 Eyre Lane, Cutlery	1 wagon
624 Rockingham Street	1 wagon
79 Rockingham Street	1 wagon
A Millward and Son	1 wagon
Albion and Melbourne Works	1 wagon
Albert Works	1 haystack
Aberdeen Works	1 wagon
Arundel Works	2 wagon
Argus Works	1 wagon
Beehive Works	1 wagon
Bone and Horn Works	1 wagon
Bradbury and Son (silver)	1 wagon
Burell, Wilson Co	1 wagon
Cambridge Steam Power Works	2 wagon
Central Cutlery Works	1 wagon
Clarendon Works	1 wagon
Clintock Works	1 wagon
Colver Brothers, Grinding	1 wagon
Continental Works	2 wagon
Cross Rockingham Lane	1 wagon
Ct 3 Sidney Street	2 wagon
Division Lane	1 wagon
Empire Cutlery Works	1 wagon
Exchange Works	1 wagon
Furnival Works	1 wagon
G & W Lowe knife factory	1 haystack
G Travis and Co	1 wagon
Hallamshire Works	1 wagon
J Rodgers and Son	2 & 2 wagon
John Sellers Cutlery Factory	1 wagon
Livingstone Works	1 wagon
Mappin Bros	2 wagon
Murrey Works	1 wagon
Monmouth Works	1 wagon
Portobello Works	1 wagon
John Sellers, Cutlery factory	1 wagon
Sheaf Island Works	2 wagon
Sidney Works	1 wagon
Soho Grinding Wheel	3 wagon
Stanley Works	2 haystack & wagon
Union Grinding Wheel	2 wagon
Victoria Works	1 haystack
W Mammatt and Sons (Sheffield Plate)	1 wagon
W& S Butcher	3 wagon
Ward and Payne Edge Tool Factory	2 wagon
Wm Hutton and Son	2 wagon
Wostenholms	2 wagon

Table 8: The types of boilers identified from Goad's Fire Plans 1896

Figure 32: Hutton Buildings, West Street. Illustration showing two wagon boilers (A1).
(From Tweedale G 1996 *The Sheffield Knife Book* p211)



recorded in 1896 as having a 60 HP engine which had three wagon shaped boilers and J Rodgers and Son, Norfolk Street, who had two engines of 80 and 25HP, had four wagon shaped boilers. Usually at least one boiler was needed per engine, hence at Butcher's Wheel three boilers are recorded as well as three engines, but there were advantages in having two or more boilers, as emphasised by Fairbank as early as 1830 in his proposals for a grinding wheel in Thomas Street.

'It is thought advisable to have two engines as well as three boilers in order to prevent any great degree of risk of loss whilst one might be worked by one and for the same reason three boilers are considered better than two.'[159]

The sizes of boiler houses can be estimated from the maps (Table 9) and plans. That at George Barnsley and Son, steel converters and refiners, manufacturers

[159] CP2(132) Fairbank Collection, Sheffield Archives.

of files, saws, awl blades, shoe, curriers, tanners knives etc., Cornish Works[160] was 34ft 8in x 17ft 2in (10.59m x 5.23m).[161]

Works	size of boiler house in feet
Albion and Melbourne Works	23 x 7
Bone and Horn Works	32 x 10
Cambridge Steam Power Works	21 x 7
Hallamshire Works	23 x 10
J Rodgers and Son	35 x 10
Monmouth Works	30 x 10
Stanley Works	21 x 7
Wostenholms	39 x 20

Table 9: Sizes of Selected Boiler Houses shown on Goad's Fire Plans.

The suppliers of boilers are as unknown as the suppliers of steam engines, although in some cases they may have been the same. The only evidence found in connection with the cutlery trades for the installation of a boiler was in the Soho Minute books. In 1826 the old boiler was replaced with a new wagon boiler. Iron was acquired from the Butterley Iron Co and Mr McNaughan was employed to make it in August. The old boiler was later sold.[162]

Supplying Water for Steam Engines

In order to maintain sufficient supplies steam powered sites could be situated by rivers, boreholes, or reservoirs. 'The reservoirs were used both to supply the boilers and to receive the hot water condensate from the steam engine.'[163] Fairbank proposed a reservoir of 42304 cubic feet for the wheel at Thomas Street stating that 'it will soon be filled and by proper management may be so controlled as to keep the cold water separate from the warm and to work it over again and again if necessary'.[164]

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160 Not to be confused with Dixon's Cornish Place on the opposite side of the road
161 CA206/7400 2 of 3 Plan of Cornish Works
162 3/8/1826, 21/8/1826, 1/2/1827 MD 709 Soho Minute Book Sheffield Archives.
163 Giles, C. and Goodall, I. 1992 op cit p152
164 CP2 (132) Fairbank Collection, Sheffield Archives

Evidence for water supplies is not always easy to find, not only in the field but also from maps. A search of the 1850 1:500 survey revealed no reservoirs that were obviously connected with the supply of water for steam power. However, Goad's fire plans, indicated that Washington Works had a reservoir 90ft x 50ft in plan. Some works had water tanks situated above or near the boilers. These were either torpedo shaped or rectangular. As the depth is not known the quantity of water held cannot be assessed but in plan they varied from ten to forty feet long (3.05 to 12.19m) and from three to ten feet wide (0.91 to 3.05m) (Table 10). An example of a water tank can be seen at Leah's Yard, Cambridge Street (Figure 33).

Figure 33: Water tank in Leah's Yard, Cambridge Street. The wagon boilers are located under the yard.

Where water could not be stored initially, as at Soho Wheel in the 1830s, it could be bought from another works. For example a 35 year agreement was signed with Mr. Vickers and Son for a rent of £21 to supply sufficient water for the engines and up to a five horse power increase for which they had to take out a loan from the Sheffield and Rotherham Bank for £800.[165]

[165] MD709 2/2/1837, 2/3/1837 and 1/6/1837 Sheffield Archives

Works	Size of tank in plan (ft)	Shape and where situated
Livingstone Works	11 x 6	rectangular, under boiler
624 Rockingham Ln	26 x 4	rectangular, 10ft above yard
Bone and Horn Works, Back Lane	10 x 3	torpedo, in yard
Monmouth Works	20 x 7	rectangular, end of boilers
Sheaf Island Works	16 x 7	rectangular, end of engine house
Central hammer Works	16 x 4	torpedo, above boilers
Jas. Deakin	15 x 5	rectangular, in yard
Argus Works	12 x 10	rectangular, over end of boiler house
John Sellers	12 x 10	rectangular, over end of boiler house
Don Plate Works	24 x 4	torpedo, in yard
Empire Works	10 x 4	torpedo, in yard
Mr Hibberds Bone Works	12 x 2	torpedo, in yard
William Hutton and Son	20 x 10	rectangular, over boilers
Colver Bros	19 x 10	rectangular, iron Tank over boilers
Soho Wheel	38 x 4	rectangular, tank over boilers

Table 10: Size of water tanks in plan in 1896 from Goads Fire Plans

The Cost of Maintenance

As so few firms' records survive in the local archives, the amount of money spent on coal and the wages paid to an engine attendant are not readily available. Fairbank estimated that for the proposed grinding wheel at Thomas Street 'the annual expenditure, wear and tear, coals for the engine, interest on the capital depreciated on the buildings and machinery, ground rent, wages for two engine men and 5% gross rental for contingencies' would amount to £836-2-5.[166]

At Soho works the amount spent on coals per month was on average £30-0-0 in 1830 and 1831 (Table 11).[167]

Month/Year	Amount spent on coal
May/1830	£37-19-0
June/1830	£25-8-6
August/1830	£32-12-6
August/1831	£32-12-6
September/1831	£38-5-0
October/1831	£40-0-0
November/1831	£21-7-6

Table 11: Accounts for coal jotted down at back of the Soho Minute Books

166 CP2 (132) Fairbank Collection, Sheffield Archives
167 MD709 Sheffield Archives

The prices above mean that c£7-0-0 a week were spent on coal in those years. In 1909 Haslam, estimating the weekly running costs of a 45HP steam engine to generate electricity including coal, oil, water and labour at £6-15-9.[168]

How was Steam Power Transmitted to the Machinery?

The introduction of electricity removed the need for large complex shafting systems to transfer power from the engine to the working areas. For this reason very little evidence remains for the transmission of power from steam engines.

At Butcher's Wheel the RCHME survey highlighted two large gearing boxes visible externally on the Brown Lane frontage 'indicating the probable presence in this area of a system of power transmission from the engine to the working areas'.[169] Apart from this evidence there are no 'clearly associated features of power transmission which would have enabled drive to be taken from the engine house to the different working areas'.[170]

Indications of transmission between floors in other parts of the building are also lacking. The exception is a hole in the floor of one of the hulls at Butcher's Wheel (Figure 34) possibly used by shafting from the engine situated on the ground floor of this block.[171]

Figure 34: Possible power transmission shaft hole at Butcher's Wheel

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[168] Haslam, A.P. 1909 <u>Electricity in Factories and Workshops</u> Crosby, Lockwood and Son, London p166
[169] Giles, C. 1996 op cit p 8
[170] ibid p9
[171] Pers. comm. Peter Neaverson on visit by AIA Conference Sept 1995.

Evidence for the motive power to the grinding wheels on the second and third storeys of the southern block comes from the sloping floor which possibly allowed a belt drive from a line-shaft inside the south wall. 'There is evidence in the eastern room for transfer of power up from this shaft to a wall box near ceiling height, with power transferred to the adjacent room to the east'.[172]
Evidence for the use of mechanical power on the top storey of the southern block at Butcher's Wheel comes from signs of wall boxes, hangers and grease stains, suggesting the use of line shafting,[173] although for what purpose is not clear. These features may be twentieth century additions.
At Cornish Place 'ashlar blocks and openings in the inner side wall of the engine house indicate that the drive was transferred into the ground floor room of the River Don Range, and from there into the ground floor of the Ball Street range and up to all floors of the building'.[174] Wall boxes suggest that power was taken to every room in the building.
As much of the cutler's work was done at workbenches placed against the windows, overhead line shafting rarely appears to be centrally located within the rooms; thus there are few brackets on cast iron columns as found in the textile mills, where the rooms were much wider, to accommodate the looms. For the most part, as demonstrated in Chapter 5, the workrooms were a maximum of seven metres wide but were usually between four and five metres. Thus any line shafting brackets were usually attached to the wall. This is particularly noticeable at Cornish Place (Figure 35).

In summary, it has been shown that steam power was used by less than a third of all workshops and factories by the end of the 19th century. It had limited benefits to what was still a handicraft trade beyond the branches of grinding and forging. Steam power, because of its potential for higher power output, allowed a greater concentration of workers on one site, thus providing more accommodation for the growing trade. In 1802 when Thomas Dunn wrote to his father regarding Soho Works he mentioned that 'grinding room is so scarce that there are about 200 grinders who cannot get a trough in the

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[172] Giles, C. 1996 op cit. p10
[173] ibid p11
[174] Goodall, I. 1996 op cit p13

corporation'.[175] It cannot be denied that steam power led to the introduction of large multi-storeyed tenement factories, erected largely by speculators.

Figure 35: Wall brackets for line shafting at Cornish Place

Physical evidence for steam power is difficult to find. Many of the chimneys have been demolished, together with the associated boiler houses. Engine houses may be located, but usually only with the aid of maps such as Goad's fire plans. Equally scarce are the names of the suppliers of the engines and the cost of running and maintenance. With experience, evidence for power transmission may be found. Steam power continued in use into the twentieth

[175] MD1738 (2/151) quoted in Flavell N 1996 op cit p155

century and could be used to generate electricity for later electric motors, as will be examined in the last section of this chapter. They were however a power source only available to larger works; smaller works had to wait until the gas engine was introduced in the last quarter of the century before they too could afford power, for example to drive buffing and polishing machines.

Internal Combustion Engines

Gas Engines - To What Extent Were They Adopted in Sheffield?

Unfortunately no official surveys were carried out regarding the use of gas engines within the industry. However the annual reports of the Sheffield Gas Lighting Company, presented by Frederick Mappin, indicate the number of gas engines in use within the town, the range of sizes installed and the amount of gas which they used in a twelve month period (Table 12).

Year	Engines Installed in previous 12 mths	Gas Consumed in million cubic feet	Price of gas per 1000 ft³	Total engines in use	Range of engine sizes (HP)
1895	47	-	-	427	-
1896	58	66	-		-
1897	63	89	2s		-
1898	63	100.5			
1899	79	129.9	-		-
1900	105	-	4s		-
1901	100	-	4s		0.5 - 93
1902	93		1s8d	787	
1903	83	218.14	1s6d		
1904	(24 in 6mths)	255.446	1s4d		0.5 - 130
1905	43	228	1s2d		0.5-200

Table 12: Number of gas engines in use in Sheffield 1895 - 1905[176]

The figures provided, though not specific to the cutlery trades, show the popularity of gas engines in Sheffield at the turn of the century. But Frederick Mappin was always surprised that more use was not made of these engines. In 1896 his report stated that 'he was not, however, satisfied that the manufacturers and others fully appreciated the advantages derived from gas engines. He had before him a list of various purposes for which these gas

[176] GCR 13 and 14 Sheffield Archives. Note these are the total number of gas engines recorded by the gas company and refer not only to the Cutlery Trades but all trades in Sheffield,

engines were employed, ...[e.g.] lathes, sawing wood, electric lighting, chopping hay, pearl cutting, file cutting, ventilating... and electroplating.'[177]

In 1897 Mappin was 'surprised that those useful machines, gas engines, had not been used more frequently and come into use more rapidly than had been the case in Sheffield; for Sheffield had so many industries that required a small amount of steam power that he would have supposed the advantages that a gas engine offered would have brought the company a much larger consumption that they had yet experienced'[178] and in 1901 'It surprised him very much that in a place like Sheffield where there were so many small manufacturers, that they did not make more use of these engines'.[179]
The only specific evidence for the use of gas engines by the trades is where they are shown on Goad's fire plans, and possibly from some field evidence. In total, 21 gas engines, associated with the cutlery trades, were identified from the map evidence (Table 13) but there are no indications as to the power they produced.

Works
Canton Works
Columbia Works
Don Plate Works
J Rodgers and Co, Eyre Lane
CA Clark
Otto Works
308 Well Lane, silversmith
Montgomery Works
Fitzwilliam Works
Beta Works
Acorn Works
Nelson Works
W Norton and Son
Love Street Cutlery Factory
Deakin and Son, Tiger Works
Mazeppa Works
Brown Lane, Workshop
Lockwood Brothers
Spoon and Fork Works, Cambridge Street
Murrey Works

Table 13: Works associated with the cutlery and related trades which had Gas engines in 1896 (Data from Goad's fire plans).[180]

[177] GCR 13 Sept 1896 Sheffield Archives
[178] Sept 1897 ibid.
[179] GCR 14 Sept 1901
[180] 674/B1/1-31 Goad's Fire Plans, Sheffield Archives.

The advantages of using gas engines instead of steam engines were detailed in one of the Finsbury Technical Manuals in 1890:

> 'A great convenience of the gas engine consists in its being always ready for use at a moments notice. It is started by simply turning on the gas, lighting the gas jet and giving the fly wheel a turn or two. Some engines are provided with automatic self-starting arrangements. It is thus specially adapted for intermittent work. There being no boiler, it does away with the risk and danger of explosion, as well as the tedious process of getting up steam. When kept properly cleaned, the gas engine does not make the room in which it works uncomfortable with heat or dust. Moreover, the space required is small, as is also the first cost, attendance and maintenance.'[181]

These advantages were also noted by Frederick Mappin in several of his annual reports to the United Gas Light Company. In 1897 he said 'it was easy to see the advantages they possessed, they required no ground space for boilers, no chimney, no boiler cleaning or repairing or insuring and they could be started and stopped at will'.[182] In 1898 he stated that 'Gas engines gave far less trouble and he believed that for ordinary work they were far more economical than any other mode of obtaining power'.[183]

It was the small amount of space required to house the engines that made the gas engine popular with the smaller works. Some new firms may have named their works after the installation of a gas engine, such as Otto Works, 35 Howard Street[184], occupied by Gregory and Son, cutlery manufacturers. According to Robinson, the most common type of engine was the Otto (Figure 36a).[185] Other makes included the Atkinson Cycle engine, Atkinson Differential, Crossley Single and Crossley Twin and the Simplex Gas Engine (Figure 36b-f).

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[181] Robinson, W. 1890 Gas and Petroleum Engines Finsbury Technical Manuals E and FN Spon, London p4

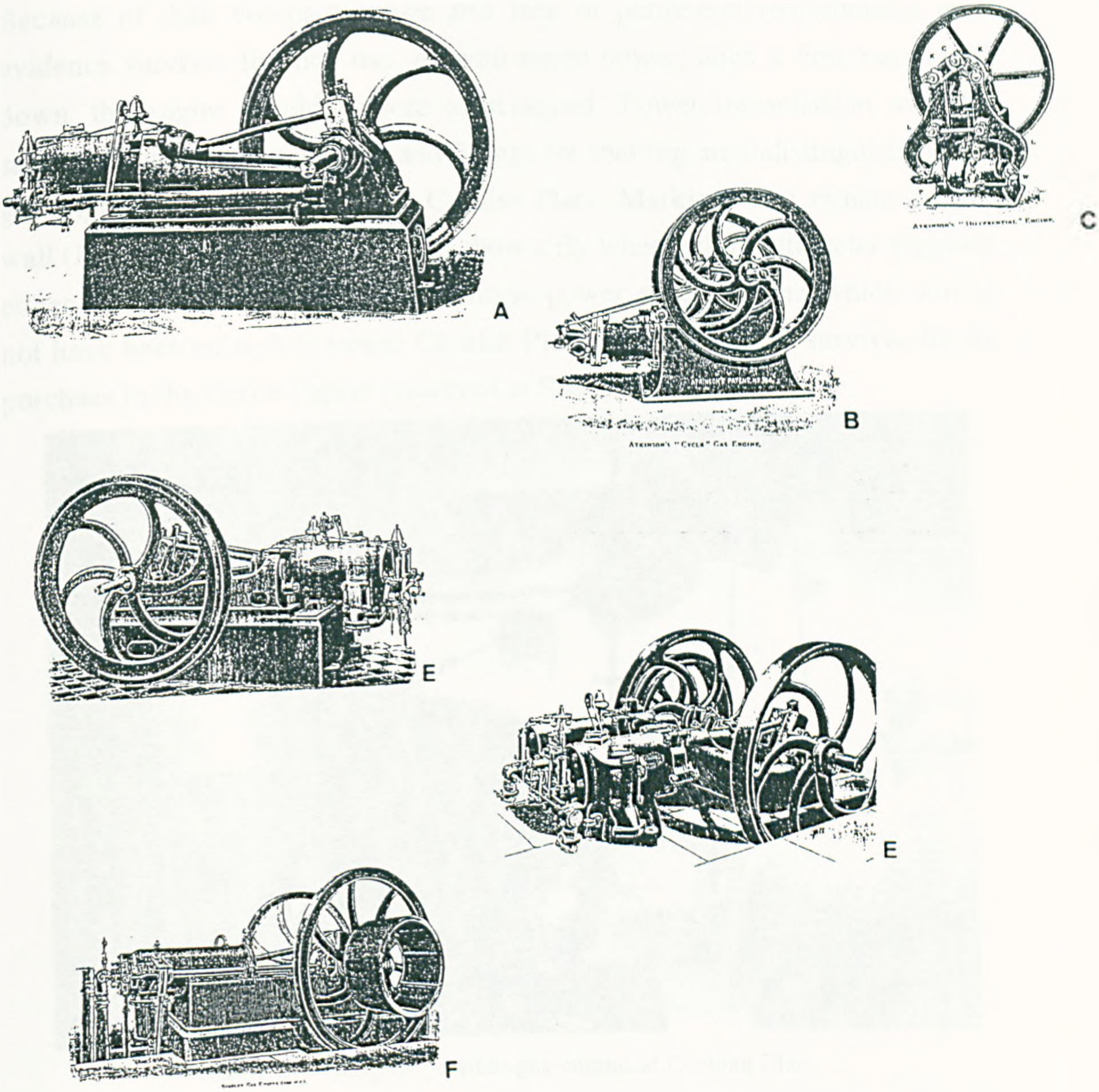
[182] GCR 13 Sept 1897 Sheffield Archives

[183] ibid Sept 1898

[184] This property had been occupied in the 1850s by Joshua Yates, Table knife manufacturer and in the 1870's by Wigfall and Co, manufacturers of table, shoe, bread, butchers, spring knives etc. (Information from the rate books)

[185] Robinson, W. 1890 op cit. p9.

Figure 36: Types of Gas engine available at the end of the nineteenth century. A: Otto, B: Atkinson "Cycle," C: Atkinson "Differential," D: Crossley Single, E: Crossley Twin, F: Simples Gas Engine (Illustrations from Robinson W 1890)



There were no Gas engine manufacturers in Sheffield prior to 1896[186] but the 1898 trade directory listed four, J&P Hill. at Backfields and Norfolk Iron Works, Moorwood, Sons and Co Ltd at Harsleston Street and South Street, FH Stacey at London Road and 34 Cemetery Road and James Walker and Son 87

186 GCR 13 Sept 1896 Sheffield Archives Mappin says "he anticipated that as people understood the advantages of the engines better, more would be used and he hoped that Sheffield would begin to manufacture them as well as steam engines."

Frogatt Lane and 87 Eyre Lane and in 1900 Gallimore and Eaglesfield of Froggat Lane and Eyre Street were added to the list.

Because of their compact nature and lack of peripheral requirements little evidence survives for their use. As with steam power, once a firm has closed down, the engine would be sold or scrapped. Power transmission was the same as from the steam engine, and fittings for shafting are indistinguishable. A gas engine had been installed at Cornish Place. Markings that remain on the wall (Figure 37) of the engine room show a fly wheel whose diameter suggests either a 100HP gas engine or a five horse power steam engine which would not have been enough to power Cornish Place.[187] No evidence survives for its purchase in the Dixon Papers preserved at Sheffield Archives.

Figure 37: Siting of possible gas engine at Cornish Place

There is some evidence that gas engines were used in some small rural workshops such as at Franklin House, Nook Lane, Stannington. In this workshop, measuring just 18 square metres, a line shaft still exists (Figure 38) in the roof space.

[187] Pers. comm. Ken Hawley May 1996 and sizes and flywheel to power ratios from Hutton, W.S. 1900<u>**The Modernised Templeton**</u> Crosby, Lockwood and Son, London p461

Figure 38: Line shafting at Nook Lane Workshop, Stannington thought to have been driven by a small gas engine.

The current owner of the building reported that it had been installed by her father to run a small machine, likely to have been a small glazing machine, for a short time but 'he did not get on with it'[188] so rarely used it. The use of belts in such a small area must have been very hazardous, especially as five men worked in the shop. There are also reports of a gas engine at Alpha Works, Stannington, installed for driving drilling machines, grinding and glazing wheels.[189] Alpha works has now been converted to domestic accommodation. No evidence survives for the cost of installing gas engines in Sheffield.

[188] Pers. comm. Owner 21/3/1996.
[189] Interview with Colin Goodison, who worked at Alpha Works in the early 1900s, by Dennis Smith 1970.

The gas company records provide some idea about the cost of running a gas engine. In 1901 it was reported that a 2HP engine would cost 1d an hour to drive and in 1902 of the 787 engines installed, 405 of them used less than £10 worth of gas each per year.[190]

In summary, the introduction of the gas engine, and in particular the use of small gas engines, allowed smaller workshops to take advantage of the benefits offered by power sources for the processes of grinding, buffing, polishing and drilling. However their introduction at the end of the century has left no traces other than in the documentary sources.

Oil Engines

The benefits of gas engines were however soon overshadowed by the introduction of, firstly, oil engines and secondly, electric motors at the turn of the century.

Oil engines which used the Otto cycle were invented in the 1880's by the Priestman Brothers. These were later developed in 1890 by Herbert Ackroyd Stuart and Rudolf Diesel.[191] Although there is no surviving evidence for these engines either in the field or in documentary evidence it is likely, but unproven, that some were installed into workshops of the cutlery industry. They provided an independent source of power and had advantages such as 'economy of running, reliability, and the fact that, providing fuel and water were on hand, it would run for days without attention. The majority of the engines were simple in design and offered foolproof operation.'[192]

Electricity

In 1878 Werner Siemens believed that 'the electric motor will in the course of time produce a complete revolution in our conditions of work, in favour of small scale industry'.[193]

The use of electric motors brought many benefits. They were more efficient, could be placed where required, thus power was not lost in the shafting, and

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190 GCR 14 reports for Sept 1901 and March 1902 Sheffield Archives

191 Edgington D 1996 **Old Stationary Engines** Shire, Aylesbury, p5-6

192 ibid p7

193 DuBoff, R. 1967 *The introduction of Electric Power in American Manufacturing* **Economic History** Review 20 p518

they could be 'started and stopped at any time by merely closing the main switch and moving the handle of the starting switch'.[194] As overhead shafting was no longer required the lighting conditions improved in many workshops. Working conditions were also safer as there was less lubricating oil dropping from shaft bearings.[195] But Haslam recognised that where town gas could be obtained at 2s per 1000ft^3 (in Sheffield it was c1s3d[196]) then the choice for the small user was 'principally between the gas engine and the electric motor.'[197] The comparative costs given were £70 for a 13HP electric motor, capable of powering a small works, with starting resistance, mains switch and fuse for £30-0-0 plus £8-10-0 for fixing and wiring. A thirteen horse power gas engine, with water vessels, accessories, and gas and water pipes, cost £90 plus £18-0-0 for fixing and foundations. The weekly running costs were £2-1-9 for the electric motor including electricity, oil and attendance, repairs and an allowance for a depreciation in cost. The gas engine's weekly running costs amounted to £2-4-0.[198] In addition the price of any shafting required had to be added to both sets of costs although in general the electric motor required much less, as it could be more conveniently sited.[199]

The Sheffield Electric Lighting and Power Company was formed in 1891[200] In 1898 a New Electric Light Company was formed, and charged two pence per unit of power.[201] Haslam advocated that rather than rely on the town's supply, manufacturers would benefit from installing their own generating plants. This would increase their independence and possibly reduce the cost per unit of electricity. The costs and types of generating plant are summarised in Table 13.[202]

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[194] Haslam, A.P. 1909 op cit p125
[195] ibid p6
[196] price for 1910
[197] ibid p125
[198] ibid p132
[199] Gas engines needed substantial foundations, and pipes for the exhaust. Ibid p 129
[200] Hawson, H. K. 1968 <u>**Sheffield: The Growth of a City 1893-1926**</u> JW Northend Sheffield p18
[201] Hawson, H. K. 1968 op cit p 255
[202] Haslam, A.P. 1909 op cit p140-166

Type of Plant	Requirements	Size of room	Cost in Install (per week)	Working costs	Costs per unit (pence)
Gas 45HP	Substantial foundations, pipes to gas and water and exhaust, dynamo	8'6 x 24	£560	£7-5-2	1.55
Oil Plate engine 30HP	Dynamo		£800	£6-19-0	1.47
Steam	2 crank high speed non condensing engines and 40 kW dynamo		£1050 if more simple engine used reduced by £150		1.45

Table 13: Relative costs of electric generating plants c1909

Existing steam, gas or oil engines could therefore be used to generate electricity although no evidence has been found in the field for such an adaptation.

Between 1905 and 1923 generating rooms were added to Butcher's Wheel. One was attached to the southern block, the other to the northern. Both take the form of single - storey gabled projections into the yard (Figure 39).[203]

Figure 39: Generating room at Butcher's Wheel built between 1905 and 1923 (A1)

[203] Giles, C. 1996 op cit p12

Elsewhere, evidence for individual electric motors is apparent. Where the rooms were used for grinding, the shafting was usually mounted at floor level (Figure 40).

Figure 40: Electric Motor and truncated blocks which carried the shafting from which belts ran to the troughs at Butcher's Wheel.

In some cases the mounting blocks for the shafting can still be seen on the second floor of Butcher's Wheel (Figure 40). 'Small truncated concrete pyramids were used to support the main drive shaft from the motor ....[and] the electric motor is retained within the room.'[204] Where the belts had to pass some distance across the room, wooden bollards were used (Figure 41).

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[204] ibid p11

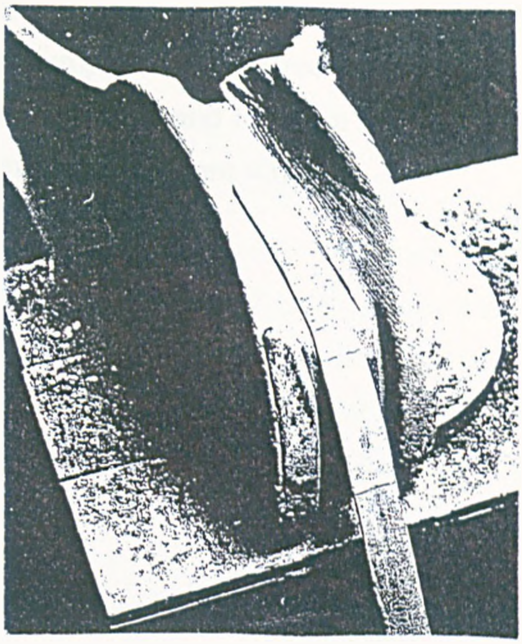

Figure 41: Wooden Bollard over which belting ran. This picture was taken in 1969 at Butcher's Wheel. (Mr Brightman G157 1020-33 Local Studies Library)

Another example where evidence for the use of an electric motor survives is at Kendal Works, in the top storey of the workshop block facing Carver Lane. Here line-shafting was found under the central workbenches and under the benches against the windows of the floor below (Figures 42). These line shafts were used to drive buffing wheels. The electric motor remained when the site was first visited in January 1995, but has now been removed due to conversion of the premises to offices.

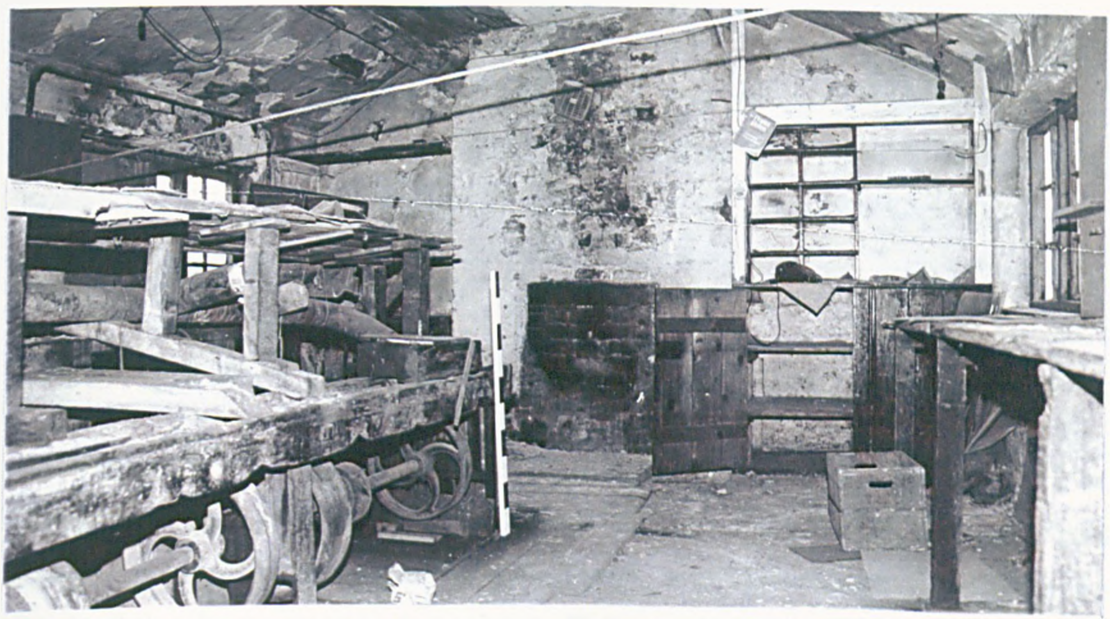

Figure 42: Evidence for line shafting under a workbench at Kendal Works.

Basil Walker[205] had an electric motor connected to some overhead line-shafting to drive a hack saw. This cut lengths of metal rod on to which he would cut makers marks. Plans for Harrison Bros. and Howson in 1905 show a 20HP motor for driving silver buffing machines (Figure 43).[206]

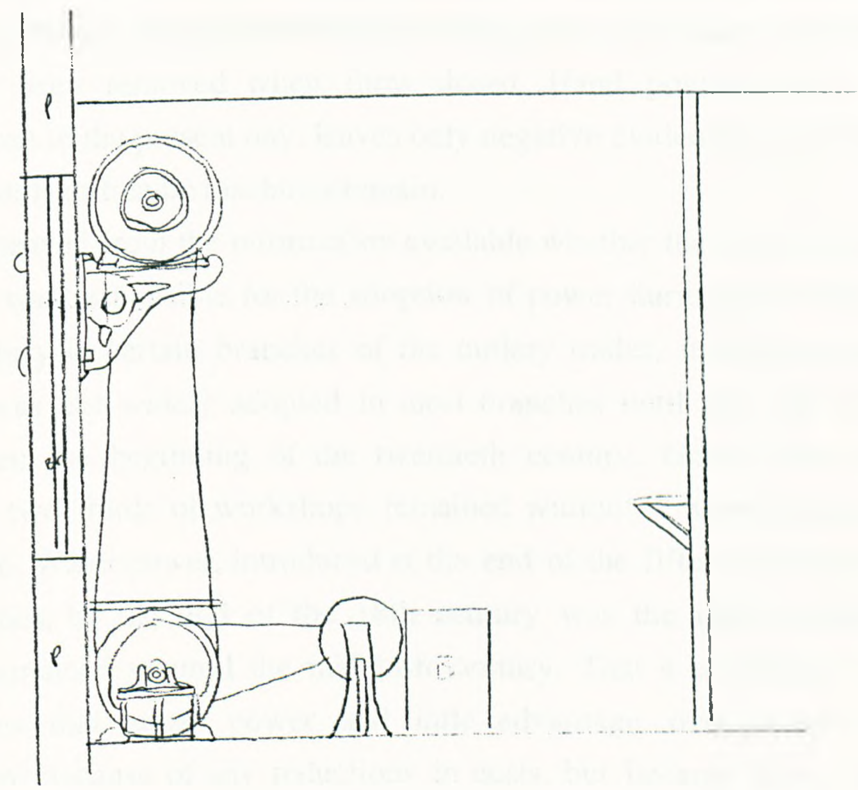

Figure 43: Evidence for a 20HP electric motor to drive buffing machines at Harrison Bros. and Howson (AP5 Sheffield Archives).

However, even with the introduction of the electric motor many rural workshops remained without prime movers, simply because they were not required for the processes carried out. This was particularly the case in rural file cutting workshops as well as some urban cutlers' workshops.

205 His premises were on Nursery Street until March 1995

206 AP5 Sheffield Archives

Conclusion

In terms of archaeological remains, only water power has provided long lasting evidence that will remain even after the buildings have gone. The introduction of subsequent power sources in many buildings has removed much of the evidence for steam power. In some cases large structures associated with its use, for example chimneys, engine and boiler houses, may survive. Gas power leaves little evidence distinguishable from steam power and many old electric motors have been removed when firms closed. Hand power, which has remained in use to the present day, leaves only negative evidence unless some remnants of tools or treadle machines remain.

It cannot be proved from the information available whether the opportunity to reduce costs was responsible for the adoption of power during the course of the 19th century in certain branches of the cutlery trades. It can be argued that power was not widely adopted in most branches until the end of the 1890s or even the beginning of the twentieth century. Goad's fire plans suggest that two thirds of workshops remained without a wheel, engine or motor in 1896. Water power, introduced at the end of the fifteenth century to the metal trades, by the end of the 18th century was the most significant source and remained so until the mid 19th century. That it continued to be used indicates that steam power had little advantage over it and was introduced not because of any reductions in costs, but because there was a lack of accommodation on the rivers for the increasing amount of trade.

The slow adoption of the gas engine in the last decade of the 19th century, as indicated by Mappin, shows that power was not regarded as essential to the processes involved. Even today some processes are undertaken by hand in small scale workshops, such as drilling holes in scales when hafting a knife, saw piercing, and the forging and the putting together of scissors. The finishing of goods is also done by hand because the use of power is not necessary, even though some of the skills have been lost. One finisher remarked that she only knew how to use two of the tools of the ten or more available to her.[207]

[207] Pers Comm January 1996.

The space needed to accommodate engines and motors was another reason why power was not more widely adopted before the end of the century, when reduction in size lead to a reduction in housing cost. It can be concluded that perhaps the biggest impact since the adoption of water power was the introduction of the electric motor which could be used to power glazing wheels, drills and presses and was easily accommodated in the small workshops. To some extent however the introduction of power to many workshops was delayed because of the fierce independence of the 'little mester' who sensed that regulated working hours would also threaten their liberty. Another consideration is the availability of a workforce. 'Labour saving machinery, when adopted abroad, was normally to compensate for a lack of skilled labour and necessarily resulted in the production of more standardised mass-produced goods....Concern with quality was more than just a whim, but an economic necessity; the handicraft aptitude and skills of the local community were decisive in the continued existence and success of the cutlery trades in Sheffield.'[208] Sheffield had the skilled workforce and it was used to produce quality rather than quantity of products. This was the real reason for the slow adoption of power to the Sheffield trades, except in branches such as grinding, where it was essential to keep pace with market demands, and even here the skill of the grinder was not diminished. Only in forging, with the introduction of stamps, did it lead to mass-production.

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[208] Taylor, S.A. 1988 op cit p35

Looking Towards the Future

'The historic city is essentially a product of the fashions prevailing amongst those who shaped it at the time and place of its creation.'[1]

One of the dilemmas of modern planning and conservation is to decide what should be kept of the past and why. In 1978 Ford wrote 'our cities should provide visible clues to where we have been and where we are going'.[2] It can be argued that heritage planning policy should be pro-active, shaping a new city 'in which the conserved buildings and sites play an important contemporary role'.[3] Of the 2700 nineteenth-century cutlery workshops, identified by analysis of the ratebooks, only 50-60 remain in Sheffield in 1996. Many of these surviving buildings are empty, or only partly occupied, leading to decay in the fabric of the structure. The last three chapters have assessed how the buildings and features associated with the industry might be identified; this chapter examines some of the ways of retaining such structures in the townscape for future generations. How far and by what means are buildings protected under present legislation? Should the legislation be changed? Can structures once used by the cutlery industry be adapted for twentieth and 21st-century purposes? These questions will be answered using case studies of work currently being undertaken by entrepreneurs in Sheffield.

Current Planning Legislation

Today all current planning law is based on four statutes issued in 1990:

a) Town and Country Planning Act (TCA), for main-stream planning control, permission for development, works to trees and advertisements;

b) Planning (Listed Buildings and Conservation Areas) Act (P(LBCA)A) which provided for the drawing up of a statutory list of buildings of special interest and the designation of conservation areas;

c)Planning (Hazardous substances) Act;[4]

d)Planning (Consequential Provisions) Act.

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[1] Ashworth, G.J. 1991 <u>Heritage Planning</u> Geo Pers Netherlands p8

[2] Quoted in Ashworth, G.J. 1991 op cit p11

[3] Ashworth G.J. 1991 op cit p4

[4] Planning (Hazardous Substances) Act does not affect the re-use of industrial buildings as it refers to land rather than buildings.

These were updated by the Town and Country Planning (Development Plan) Regulations in 1991, part of the Planning and Compensation Act of that year. The main statute that affects the reuse of workshops in Sheffield is P(LBCA)A although all planning applications have to meet the guidelines laid down by the TCA 1990 and subsequent update in 1991.

Listed Buildings

Under the provisions of the P(LBCA)A 1990 the Secretary of State for National Heritage has a duty to compile or approve lists of buildings of special architectural or historic interest.[5] A resurvey of existing sites and proposed additions was commissioned in 1990 and carried out by field officers from English Heritage with the assistance of ground workers from local planning authorities. The new list for the Sheffield region was completed in December 1995 and contained 33 buildings relating to the cutlery industry and allied trades. These were principally the large- and medium-scale works such as Cornish Place, Butcher's Wheel, Victoria Works and Central Works (Table 1). The exceptions are 52-56 Garden Street, The Howard, and 120A Broomspring Lane. The list reflects the types of buildings remaining, the majority of the small scale and more characteristic buildings of the cutlery industry having been destroyed in the slum clearances decreed by Sheffield's Development Plans of 1923 and 1945 and by bombing during the Second World War. The additions to the list relating to the cutlery and allied trades were Portland Works in Randell Street, Kutrite Works in Snow Lane and Spital Hill Works. Two buildings which were part of existing partially-listed complexes were also added: the scissor forge at 23 Carver Street (Kendal Works) and the frontage of Sylvester Works (Elliott's). All were added as Grade II structures. Abbeydale Industrial Hamlet was upgraded to Grade I.

On What Criteria Were the Buildings in Sheffield Listed?

The definition of a '"listed building" in P(LBCA)A 1990 is a building which is included in a list complied under s1(1). A '"building" includes a 'structure or

[5] Planning Policy Guidance Note 15: 3.1

Name	Address	Description [6]	Grade
Abbeydale Works	Abbeydale Road South	Scythe works	I&II*
Arundel Street	Arundel Street 92&92A	Little Mesters workshops	II
Arundel Street	Arundel Street 113	House and cutlery works	II
Beehive Works	Milton Street	Knife and tool works	II
Brooklyn Works	Green Lane	Steel and file works	II
Broomspring Lane	Broomspring Lane	Grinding hull 15m N of 120A	II
Broomspring Lane 120A	Broomspring Lane	Cutlery forge and assembly shops	II
Butcher's Wheel	Arundel Street 72	Steel and cutlery works	II
Carver Street Scissor forge	Carver Street 23	Courtyard forge	II
Cornish Place East Range	Cornish Street	Cutlery and sheet metal works	II*
Cornish Place West Range	Cornish Street	Cutlery and steel works	II*
Garden Street 52-6	Garden Street	Workshops	II
Globe Works East Side	Penistone Road	Edge tool works and owners house	II
Howard Hotel	Pond Street	Workshops and pub	II
Kendal Works	Carver Street 23	Courtyard workshops	II
Kutrite Works	Snow Lane	Cutlery works	II
Leah's Yard	Cambridge Street 20-22	Shop and courtyard workshops	II
Milton Street Brook & Son	Milton Street 96	Works and houses	II
Morton's	West Street 98-104	Workshops	II
Portland Works	Randall Street	Cutlery works	II
Sheaf Works	Maltravers Street	Cutlery works	II
Shepherd's Wheel	Hangingwater Rd	Grinding wheel, dam and goit	II*
Solly Street 216-18	Solly Street	Cutlery and silverware workshops	II
Spital Hill Works	Spital Hill	Edge tool and silver works	II
Stag Works	John Street	Cutlery works	II
Sylvester Works	Sylvester Street	Cutlery works	II
Taylor's Ceylon Works	Thomas Street	Cutlery works	II
Taylor's Eye Witness	Milton Street	Cutlery works	II
Truro Works	Matilda Street	Workshops	II
Venture Works	Arundel Street 103	Workshops and offices	II
Victoria Works	Gell Street 94	Small scale works	II
Well Meadow Street	Well Meadow Street 35	Workshops and crucible furnace	II*
Well Meadow Street	Well Meadow Street 54	Workshops, houses and crucibles	II

Table 1: Shows building relating to the cutlery industry and allied trades which are listed.

[6] Unless specified complete works are listed. Elsewhere, for example Well Meadow Street, only the workshops, houses and crucibles are listed.

erection, and any part of a building so defined, but does not include plant or machinery comprised in a building.'[7] A building can be listed under resurvey or 'spot listing following proposals from local authorities, amenity groups,[8] and other bodies or individuals that particular buildings should be added to the list.'[9]

Four criteria of equal weighting are used to assess whether a building should be added to the list:

Architectural interest: buildings of importance to the nation for the interest of their architectural design, decoration and craftsmanship; also important examples of building types and techniques and significant plan forms;

Historic interest: buildings which illustrate important aspects of the nation's social, economic, cultural and military history;

Close Historical Association: Buildings associated with nationally important people or events;

Group Value Buildings which comprise an important architectural unity or fine example of planning.

Age and rarity are also important considerations. In general all buildings prior to 1700, in anything like their original condition are listed, as are most structures built before 1840. After 1840 the *best* examples and after 1914 only *exceptional* sites, for example key industrial, educational and residential buildings, are added to the list. This establishes a need for national databases of sites, as are now being created by English Heritage's Monuments Protection Programme, the National Monuments Record (NMR) and the *Index Record for Industrial Sites (IRIS)* recently initiated by the Association for Industrial Archaeology. These will be covered in greater detail in a later section.

The guide to '*Historic Buildings in Sheffield*' indicated that industrial buildings had been included in the list because they were 'especially important to an understanding of how Sheffield developed in the eighteenth

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[7] Mynors, C. 1995 Listed Buildings and Conservation Areas FT Law and Tax Pearson Professional Ltd, London p3-4

[8] Six amenity groups are recognised by the P(LBCA)A: Ancient Monuments Society, Council for British Archaeology, the Society for the Protection of Ancient Buildings, the Georgian Group, the Victorian Society, which have to be notified by the local authorities of applications to demolish or alter Listed buildings. Where appropriate the Twentieth Century Society is also consulted but the local authorities are not obliged by law to do so.

[9] PPG15 6.7(ii)

and nineteeth centuries.'[10] That Abbeydale was upgraded reflects that fact that it is considered to be an 'outstanding industrial survival of national significance'.[11] The guide goes on to state that 'the selection of buildings for listing inevitably reflects important themes which have helped shape the architectural character of the city. For Sheffield, one of the strongest and most evocative themes is the sense of the city being a massive and complex workplace embracing a multitude of skills'.[12] These statements indicate that all the criteria outlined in P(LBCA)A 1990 were important when assessing the workshops of the cutlery industry of Sheffield. The process of listing only part of a complex of linked buildings, such as Kendal Works and Sylvester Street (Figure 1 a&b) in the past, as well as of many other industrial buildings and structures in England and Wales, however appears to have made a nonsense of the listing process.

Figure 1a : The workshop block at Sylvester Works, dated c1840 was listed before 1995.

[10] Sheffield City Council and English Heritage 1995 **Historic Buildings in Sheffield** p17-18
[11] ibid p4
[12] ibid p5

Figure 1b: The office block at Sylvester Works, built in 1870, was not listed until 1995.

An example is the entrance gateway to Green Lane Works; although an impressive piece of architecture, listing only this element misses the point that without the success of the company, based in the workshops around the courtyard, Hoole, stove grate manufacturer, would not have been able to afford to erect it. Another case is Sheaf Works, where the architecturally-impressive office block was safeguarded by listing, but associated buildings have been demolished, again destroying the unity of the site and failing to recognise its importance as the first integrated cutlery works in Sheffield.

It can therefore be concluded that listing as a method for preservation does not work as well as it should. Boland has stated the obvious in *A Strategy for Industrial Archaeology in the Black Country*.[13] 'Listing...actually militates against the protection of most sites by creating a perceived hierarchy which can, and does, encourage planners (and others) to pursue the 'tail-chasing' argument that "if it is not listed it can't be important."

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[13] Boland, P. and Collins, P. 1994 *A Strategy for Industrial Archaeology in the Black Country* **Industrial Archaeology Review** Vol XVI no 2

Some headway was made in 1994, however, when Planning Policy Guidance Note Fifteen (PPG15) recognised the importance of retaining the context of a building. Section 2.16 reads:

'Sections 16 and 66 of the Act require authorities considering applications for planning permission or listed building consent for works which affect a listed building to have special regard to certain matters, including the desirability of preserving the setting of the building. The setting is often an essential part of the buildings character...Also, the economic viability as well as the character of historic buildings may suffer and they can be robbed of much of their interest, and of the contribution they make to the townscape and countryside, if they become isolated from their surroundings e.g. by new traffic routes, car parks and other developments.'

Development Plans

Listing however is only one way to protect the remaining buildings associated with the cutlery industry. In 1994 PPG15 outlined what was expected from the Town and Country Planning (Development Plan) Regulations in 1991. The guidelines emphasised the government's commitment to *sustainable development* while recognising the importance of the historic environment but also gave details of how change was required if local economies were to survive.

Section 2.2 of PPG15 recommended 'structural, local and unitary development plans' as the means for ensuring 'that conservation policies were co-ordinated and integrated with other planning policies affecting the historic environment'. In Sheffield's case the Central Area Local plan, issued in 1988 and the Unitary Development Plan (UDP) (1991) set out to 'Promote creative conservation of the City's heritage buildings'.[14] This was further expanded in the section on plans for the Built Environment, the introduction to the section on historic buildings reads:

'Despite Sheffield's rapid growth over the past 150 years, it still retains many old and interesting buildings which contribute to its special character. These include archaeological monuments and sites....which need special consideration when they are affected by development. Individual buildings which are of sufficient merit to be Listed as buildings of architectural or historic interest also require special protection from demolition or inappropriate alterations.....Sheffield has a large number of Conservation Areas, containing both Listed and less important buildings which contribute to

[14] **Sheffield: A City for the People, Unitary Development Plan** (draft) 1991 Strategy p18 SP1 (f)

their character. The UDP also identifies Areas of Special Character which may become future Conservation Areas. The following policies are intended to control development in both types of area so that their character is preserved and enhanced.'[15]

In order to make these outlines effective, plans were laid down to give advice to developers, using planning applications to regulate development and 'carry out enhancement schemes...which include physical improvements to buildings, spaces and street'.[16]

Conservation Areas and Areas of Special Character:

The Conservation Areas mentioned in the introduction to the UDP included **Bolsterstone** and Midhopestones, Birkendale, **Brightholmelee[17], Kelham Island**, Wadsley, **Ecclesfield and Grenoside**, Norfolk Road, Hackenthorpe, Beauchief Abbey and Hall, Greenhill, **Norton**, Oakes Park, Totley, **Broomhall**, Broomhill, Dore, Endcliffe, General Cemetery, Hanover, Northumberland Road, Ranmoor and Whirlow as well as the areas around the Town Hall and Cathedral.

In all these areas, Conservation Area consent has to be obtained before any development or alteration can take place to any structure in the area. In accordance with the law the UDP outlined the circumstances in which planning permission would not be given in Conservation Areas.[18] These included changing the original intended use of a building if it affected the character or appearance of a building, demolition, and flat roofed extensions. In effect they were applying the criteria of listed building consent to major building work, even if a building was not listed. However, as all the buildings falling within the conservation areas associated with the cutlery industry were listed, listing building consent took precedence over Conservation Area consent.

[15] ibid. 1991 p146
[16] ibid 1991 section BE9 p147.
[17] Those in bold type had connections with the cutlery industry and allied trades
[18] UDP p149

In order to help preserve buildings in Conservation Areas, English Heritage in 1987 awarded Sheffield 'Programmed Town Status' which allowed grants to be made available for work to the external fabric of buildings.[19]

None of the areas designated to be areas of Special Character in the UDP plan had any connection with the cutlery industry or related trades except for Attercliffe, a major centre for steel making and tool manufacture. A major company in the area is Spear and Jackson. However, in the earlier Central Area Plan, eight 'areas of interest' with the potential for being designated Conservation areas, had been identified and it was these areas that contained the majority of the buildings relating to the cutlery trades:

- Arundel Street
- Well Meadow Street/Upper Allen Street
- Garden Street/Solly Street
- St George's/ Portobello
- Glossop Road / West Street
- Trippet Lane/West Street (extension to Town Hall Conservation Area)
- Carver Street (lower end)/Cambridge Street (extension to Town Hall Conservation Area)
- High Street (lower end) - extension to Cathedral Conservation Area

The thinking behind these areas was outlined in section ENV12[20] of the Central Area Plan:

'The further purpose of designating Industrial Conservation Areas will be to seek the more intensive use of buildings and areas for industrial and commercial purposes through the provision of grants.....Sheffield's Industrial heritage contributes greatly to the overall character of the Central Area and it is important that the historically significant areas are protected. These areas, however are still occupied by present-day industrial concerns and any preservation work will respect their operating requirements.'

None however were converted to Conservation Area Status. By 1989 most had already lost many of the buildings that would have once identified them as the main centres for cutlery production in the nineteenth century (see Chapter 1).

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[19] Central Areas Local Plan 1988 p91
[20] ibid p91

The Garden Street and Well Meadow areas had been too badly damaged by the bombing in the Second World War, followed by slum clearances which stripped the area of its characteristic courtyard workshops that once formed the backbone of the industry. The odd example does still survive, such as 52-56 Garden Street (grade II listed). A case for keeping this 'socially poor' but economically 'productive' area of town with its slums and overcrowded dwelling could hardly have been argued, no matter how academically interesting it would be today.

The Arundel Street area was also badly damaged during the war and although some structures remain, such as Butcher's Wheel, many of the small workshops which were characteristic of the area have now disappeared. Those structures that still exist are, however, being used by a variety of firms, not just those connected with the cutlery trades. Special 'character' protection allows more freedom for economic development than would be allowed in a conservation area.

The majority of workshops in West Street, Broad Lane, St George's, Trippet Lane and Carver Street had been demolished prior to 1989, and thus a conservation area would have had no marked effect in these districts in terms of protecting workshops that once belonged to the cutlery trade. The High Street Conservation Area around the Cathedral has never had many workshops associated with the cutlery trades, and those that did exist had mainly become redundant in the course of the 19th century due to higher rates pushing firms out to the west of the city centre.[21]

Thus there is no reason why these areas of special character should have been converted to conservation areas on the basis of the surviving cutlery workshops alone. The majority of cutlery workshops in these districts are now protected by the 1995 list and as such the owners are constrained by the legislation referring to listed building consent.

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[21] Details of location and reasons for relocation in the nineteenth century are outlined in Chapter 1.

The Legal Requirements of Maintaining or Converting Important Historic Structures

Urgent Works and Repairs Notices

PPG15 section 7.4 states that :

'There is no specific duty on owners to keep their buildings in a good state of repair (though normally it will be in their interests to do so), but local authorities have powers to take action where a historic building has deteriorated to the extent that preservation may be at risk.'

This refers to repair and urgent works notices (section 7.9-7.11 PPG15) which can be issued by local authorities, in respect of occupied or unoccupied structures, if they believe that a building is not being properly preserved by it's owner. In general, however, if a building is occupied it is in the owner's interest to maintain it, and thus most repairs and urgent works notices are served on unoccupied sites. The Secretary of State can also order urgent work to be carried out on unlisted structures in Conservation areas.

Urgent Works notices: The repairs have to be kept to a minimum and not involve the owners in any expense beyond making the building safe. The costs can be recovered if this policy is adhered to and would not cause the owner unnecessary hardship.

Repairs notices should detail all work that the authority considers necessary, along with details of relevant legislation, but it cannot be used as a means of restoring the building.[22] If a notice has not been complied with within two months, the local authority can purchase the building using a Compulsory Purchase Order (CPO). However the local authority should not take on the preservation of the structure but sell it on at cost to a 'private individual or body....which has access to funds to carry out the necessary repairs to the building'. [23] CPOs are used as a last resort. Statistics show that in 60% of cases the serving of a repairs notice is enough to prompt either action or sale by the owners.[24]

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[22] Robbins vs Secretary of State for the Environment 1989 ([1989] I all E.R.878) quoted in PPG15 7.10

[23] PPG15 7.13

[24] PPG15 7.15

Case Study 1: The use of a repairs notice at Cornish Place

Recently in Sheffield there was need to serve a repairs notice on the owners of Cornish Place, the works of James Dixon. Two fires in August 1995 had led to the demolition of the top of the office block that faces Cornish Street. The structure had also become a target for vandals and thieves who had even made off with a cast iron stair case. The *Sheffield Star* reported on the 29th November 1995 that legal action was being sought to force the owners to carry out emergency repairs, which they had refused to do on two previous occasions. Before the repairs notice was served, the building was sold to Skinner Developments, who plan to convert the building into housing association accommodation.[25] One year on, no further developments have taken place and Cornish Place still remains derelict.

Problems of Listed Building Consent

Conversion of listed structures, such as Cornish Place, require listed building consent. Penalties of up to twelve months in prison and a fine can occur if consent is not applied for or if work takes place after permission has been refused. The fine imposed is based on the financial benefit which would have accrued as a result of the work.[26] It is the aim of the planning legislation to find 'a proper balance between the special interest of a listed building and proposals for alterations or extensions .... based on specialist expertise; but it is rarely impossible, if flexibility and imagination are shown by all parties involved'.[27] It should be stated here that building controls apply to both the exterior and interior of the building.[28] Even repainting of the interior in some cases would constitute a breach of planning regulations if it was deemed to have altered the characteristics of the building. Fixtures and curtilage are also considered to come under listed building consent if they have been 'fixed to the building, or within the curtilage and forms part of the land'[29] since before July 1948. However theft remains a problem, especially before and while conversion takes place. At Kendal Works for example, in the early stages of

[25] Telegraph 2 Feb 1996.
[26] P(LBCA)A 1990 s9 (5) amended Planning Compensation Act (PCA) 1991 Sced 3 para 1 Mynors, C. 1995 p 269
[27] PPG15 3.15
[28] PPG15 3.2
[29] ibid

building work, several of the cast iron fire places were removed by intruders.[30] While Victorian fixtures and fittings remain fashionable this will continue to be a problem of sites that cannot be made secure.

The application for listed building consent and subsequent work at Kendal works highlights some of the problems faced by owners of historic buildings.

Case Study 2: Kendal Works

A proposal was made to convert the complex to offices. This included the retention of the listed building which faced Carver Lane but the demolition of an unlisted building, once the warehouse (Figure 2).

Figure 2: The warehouse block at Kendal Works, now demolished.

However as outlined above, when applying for listed building consent, the curtilage of the building is also considered when it predates 1948. When planning permission was given in August 1994, in accordance with the P(LBCA)A 199O, certain conditions were attached. In many ways the ideas to

[30] Cast iron fire place such as Chapter five figure 11 are fashionable decorative pieces fetching high prices at the current time.

be found in PPG15 issued five days later appear to have been followed. The Notification of Planning Permission for Kendal Works read:

'Before the development is commenced, full details of the following shall have been submitted to and approved by the Local Planning Authority:-

- repairs, refurbishment and means of preventing use of the external stairway to the workshop building;
- Schedule of treatment to include method of cleaning and pointing all external walls.
- Materials, appearance and external finish of all guard rails, railings and grills;
- repairs and refurbishment and finish of the retained entrance gates including details of remote control mechanism;
- materials , appearance and external finish of all new windows and doors
- a schedule of all windows to be retained and refurbished and details of their external finishes;
- all chimney stacks and pots
- schedule of treatment and decorative finish of all internal walls, floors, ceilings and internal joinery;
- treatment of hearths and fireplace openings;
- samples of proposed external facing and roofing materials and surfacing materials to drive and courtyard; sample panels of proposed pointing of brickwork
- new joists in North Block'

The reasons for the conditions were made clear on a visit to the building. The staircase to the first floor of the building, although used for centuries by those who worked here, did not meet modern health and safety requirements. This has been solved by adding a new staircase to the forge building to the left of the staircase which will be housed internally. Figure 3 shows the state of the building in 1994.

It was clear that some cleaning and repairs would have to be carried out to make the building safe for occupation, but listing demands that the character of the building is not altered. The window frames were rotten and would have to be replaced, as would the joists and floor boards. It was also clear that the roof would need replacing, largely due to a collapsed chimney. The need to list the treatments that would be used for cleaning the fabric of the building was important. English Heritage have specific guidelines as to how the fabric of buildings should be treated, and any breach of these could lead to prosecution. By providing samples of all new fabrics, the planners could make sure existing features of the structure were not destroyed.

Provision was also made for archaeological recording and preservation where necessary in accordance with an agreed scheme.[31]

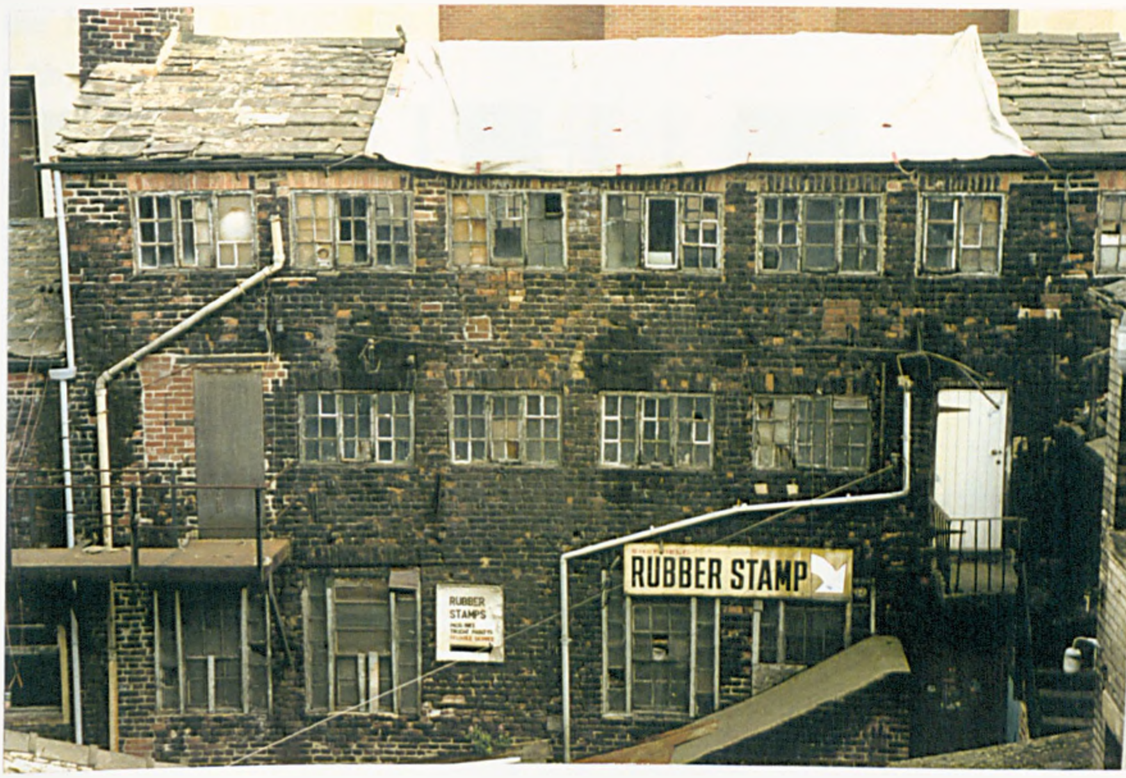

Figure 3a: External view of the workshop block at Kendal Works, indicates the urgent need to repair the roof and to repoint the walls. The unstable nature of the chimneys also caused concern.

B C

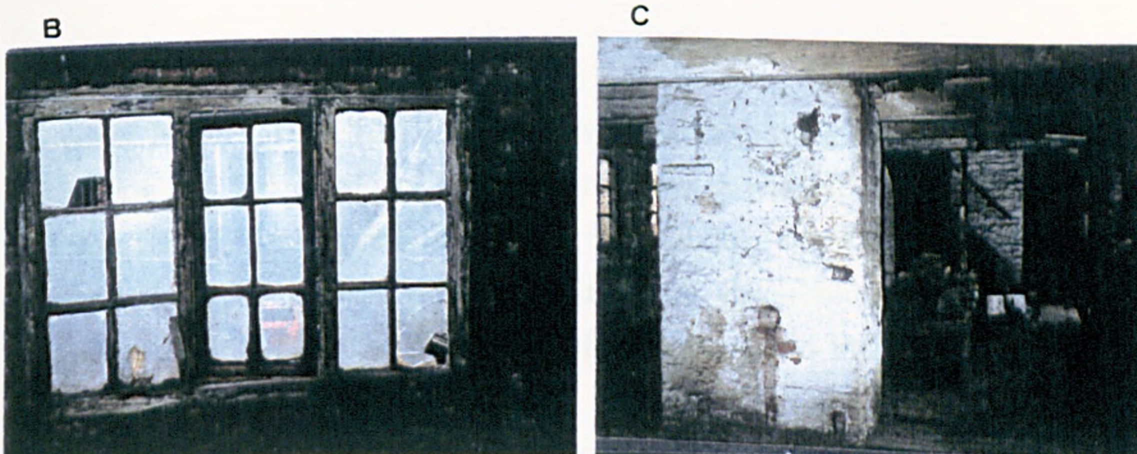

Figure 3b&c: The windows and floors also needed replacing in many cases.

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[31] Department of Land and Planning Directorate 1st Sept 1994.

In this case the owner was sympathetic to the need to record the buildings, and being interested in the history of the site made a photographic record of the buildings and surviving machinery before beginning work (Figures 4 a&b).

Figure 4a: Photograph by the owner of line shafting before it was removed from Kendal Works (1994).

However he was more than frustrated when after having obtained planning permission and the go-ahead to start work he was held up by the possibility that the Royal Commission of Historic Monuments for England (RCHME) would be brought in to do some recording work under section 8(2)(b) of the P(LBCA)A 1990. This states that demolition of a listed building is not fully authorised until the RCHME has been notified, and provision of at least a month given for recording work to take place, unless they state in writing that they do not wish to do so.[32] Further guidance is given in PPG15 sections 3.22-3.24.

[32] Mynors, C. 1995 op cit p 212.

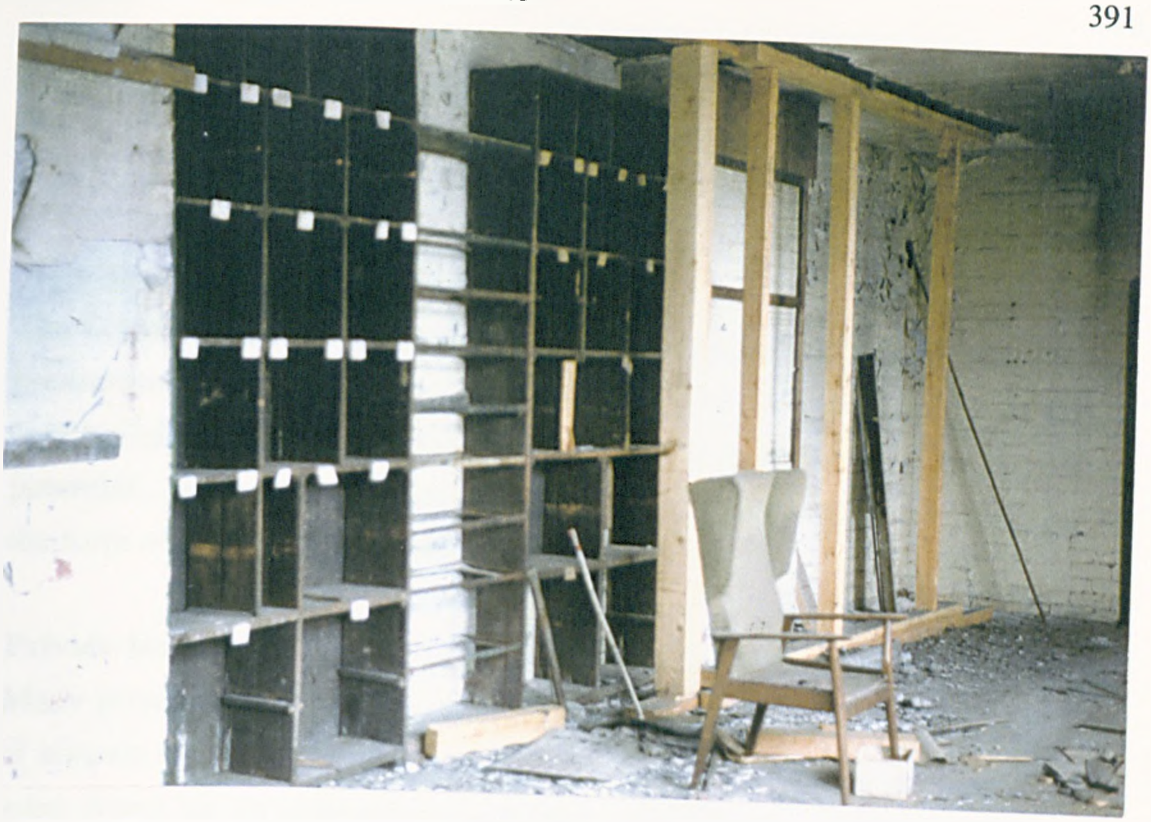


Figure 4b: Shelving in the Packing shop before it was demolished. Also taken by the owner. (1994)

The reading of the Act suggests that the application to the RCHME to record the building should have been made before full planning permission was granted.[33] This would certainly have been less frustrating for the developer, who, having started work than had to stop again for a month even though no recording work took place.

Whilst work was being carried out, the new list was being drawn up. This proposed the extension of listing,[34] to include the warehouse structure. However, due to the impossible task for the English Heritage fieldworkers of keeping track of all buildings which they assess for listing, the building was demolished before the new list appeared.

In this case listed building consent has aided the retention of the older workshop block, but because of earlier incomplete listing, the integrity of the site has been lost. The owner argues that he has returned the workshop to its former setting, but this denies the evolution of the site. It could be argued

[33] This is possibly the result of planning permission being granted just five days (26th August) before PPG15 was issued.

[34] SYIHS Society had put forward recommendations for the extension when the new list was announced

however that some retention of the original building was better than allowing the whole site to develop into yet another carpark.

Who Should Maintain Historic Structures?

The Cornish Place case study has highlighted that not everyone cares for the preservation of old industrial buildings. Goody however has suggested that 'old buildings and man-made spaces should be regarded as a resource with potential....that can be realised through the application of human resources in the form of management expertise and finance.'[35]

Private Investors

Many private investors take on the refurbishment, conversion or maintenance of historic structures. During the affluent years of the 1980s a number of plans were drawn up for converting workshops for example to offices, studios and domestic accommodation. Below are some case studies.

Case study 3: Conversion Plans for Anglo Works, Trippet Lane

The owners of Anglo Works on Trippet Lane had plans drawn up by Elden Minns and Co Ltd for conversion to offices, which secured planning permission and listed building consent. In the Axonometric diagram (Figure 5) it can be seen that the original frontages of buildings A and C were to be retained and the modern windows would resemble closely those that they replaced. In total, seven offices would be created around a courtyard. Internally the room arrangement would be altered to make the best use of the available space but was not substantially different from the original. (Compare Figures 6 (first floor plan) & 7).

What was proposed would have given the building a new lease of life while sensitively retaining the existing exterior. It was not carried out for two reasons. Firstly the client did not consider the plan 'ruthless enough' in destroying the historic fabric of the site and secondly the client went into liquidation. The building remains empty and vandalised at the end of 1996.

[35] Goody, B. 1982 New Use for old stones Council of Europe, Strasbourg p10

Figure 5: Axonometric diagram showing the planning proposals made for Anglo Works, Trippet Lane. (Plans reproduced by kind permission of Eldon Minns and Co Ltd.)

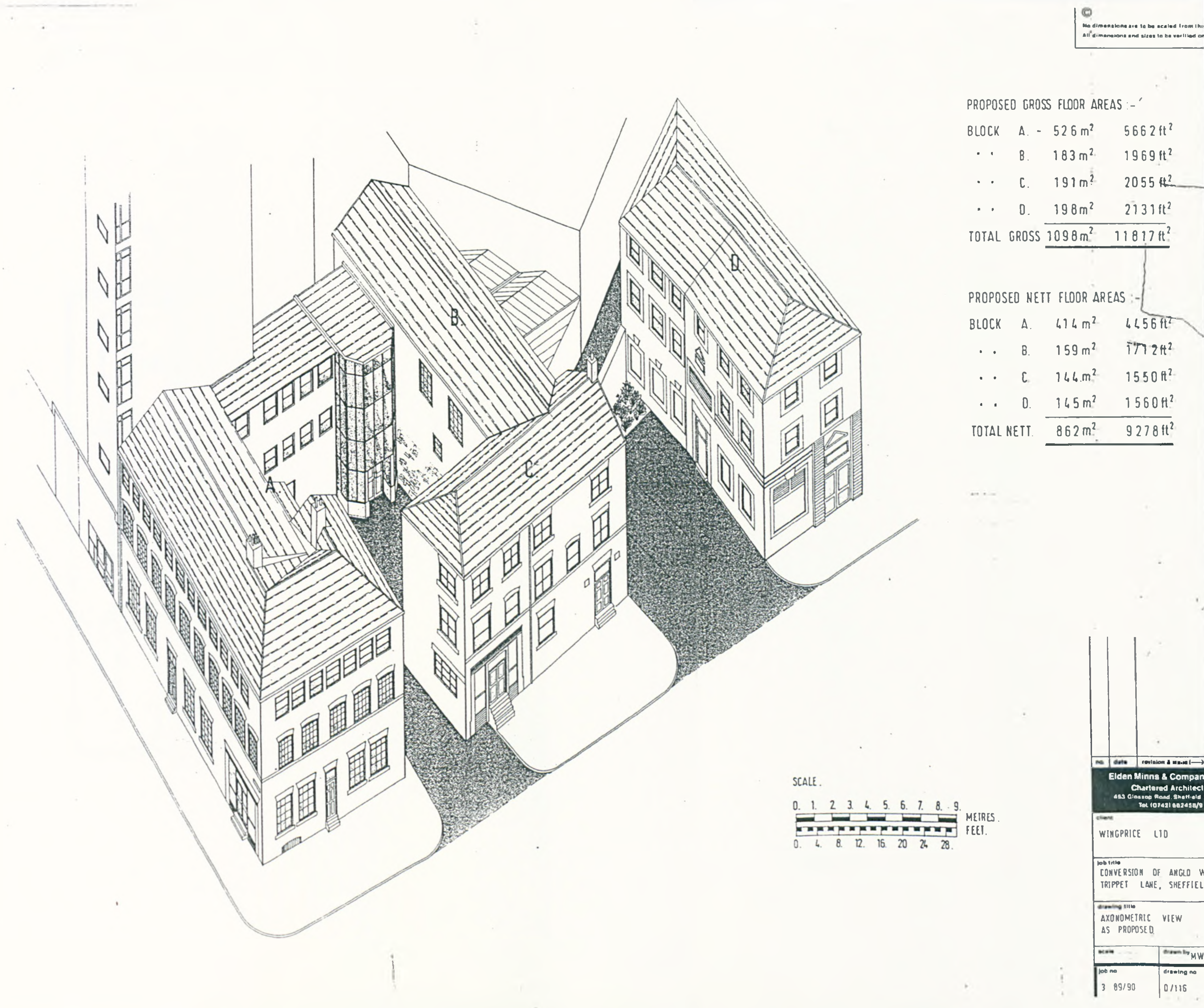


Figure 6: Existing ground floor plan. Anglo Works. (Plans reproduced by kind permission of Eldon Minns and Co Ltd.)

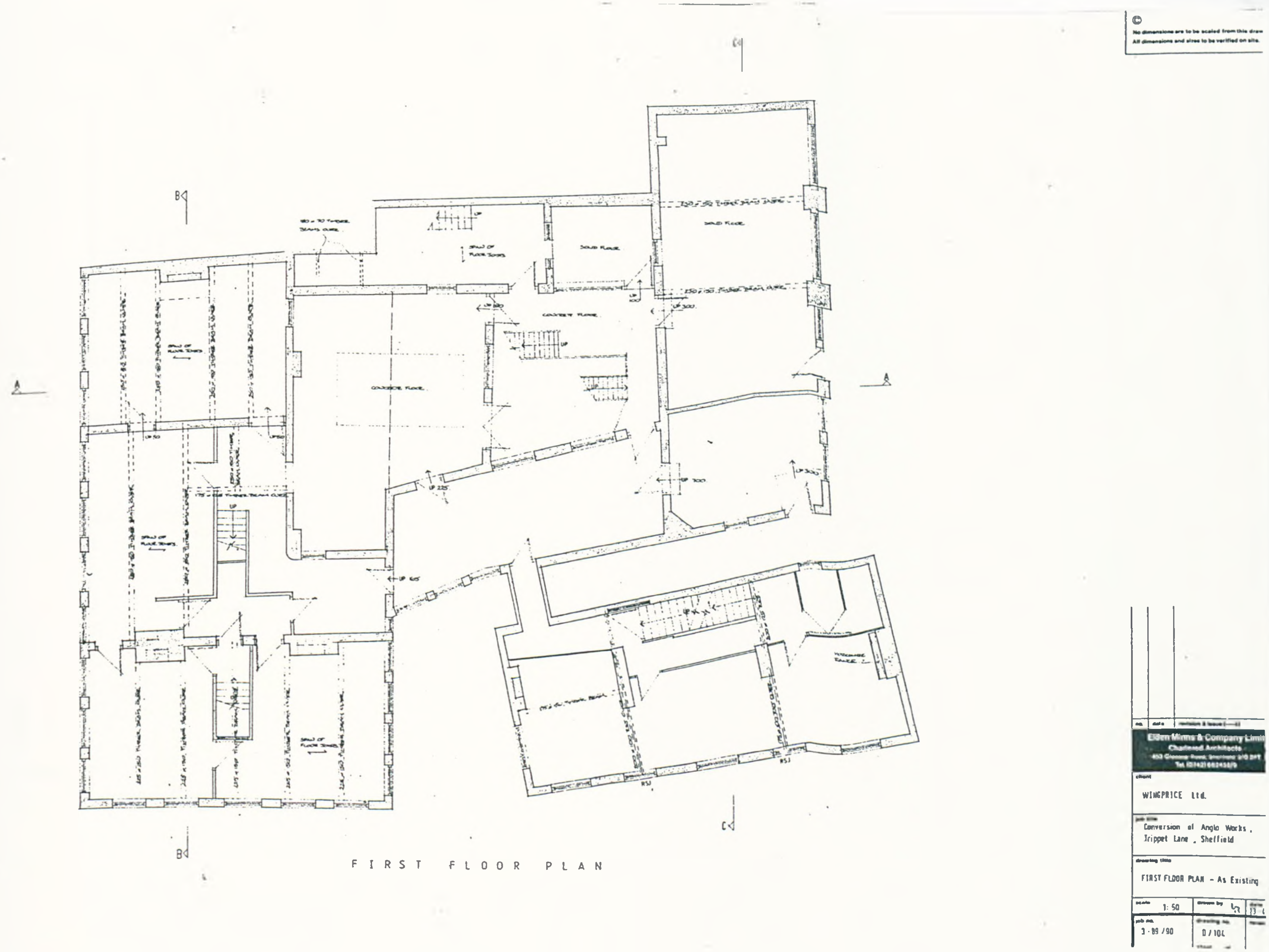
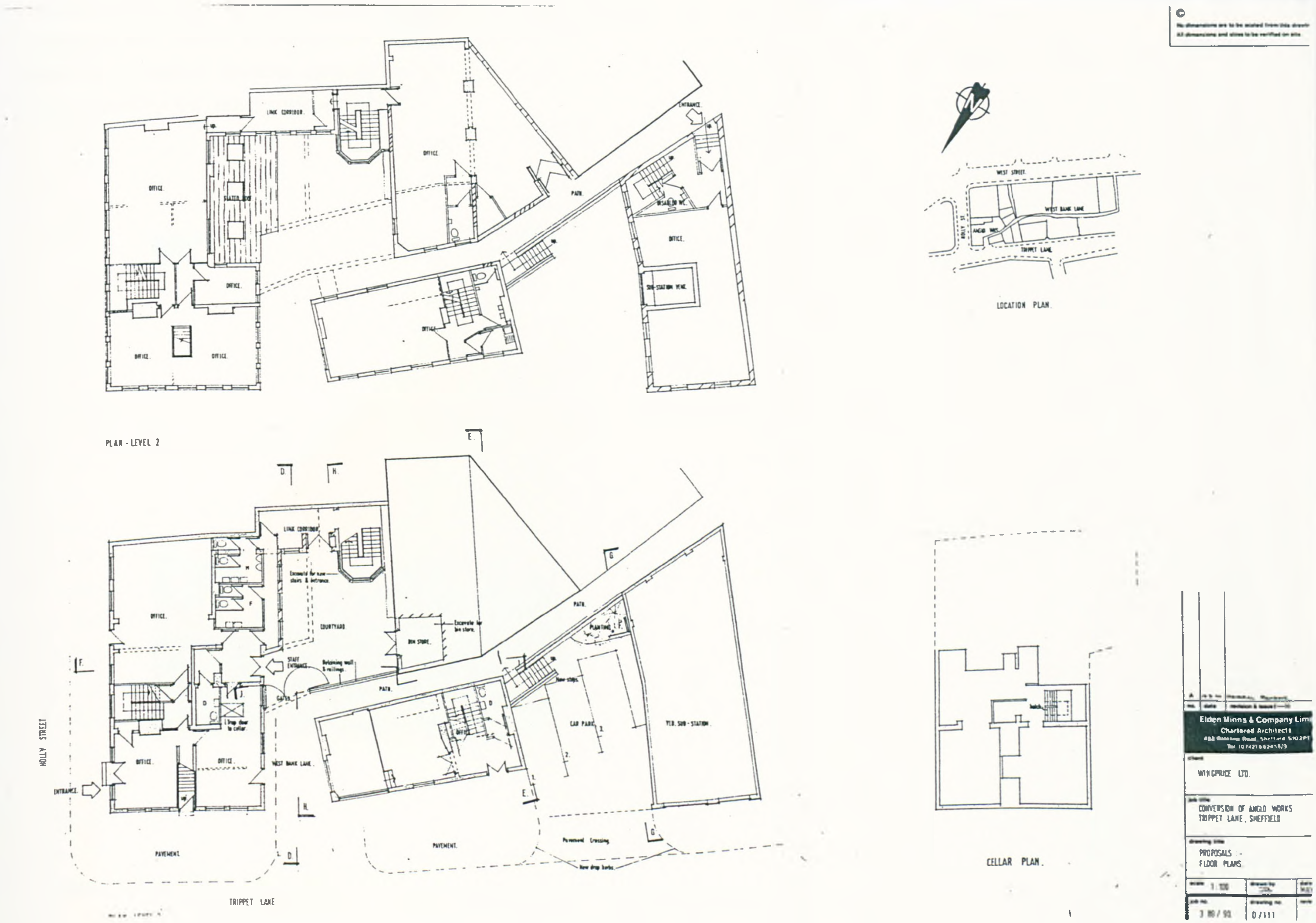


Figure 7: Proposed floor plans, Anglo Works.(Plans reproduced by kind permission of Eldon Minns and Co Ltd.)



Case Study 4: The Conversion of Truro Works, Matilda Street.

This is perhaps the most successful of all the plans examined in this chapter, because it was carried out without substantial loss of the fabric of the structure. The building was bought by Sheffield Hallam University and converted into student accommodation. The result is that the building retains much of its original character externally, and is still recognisable as having been utilised by the cutlery trades (Figure 8).

Figure 8: Truro Works, Matilda Street. Converted by Sheffield Hallam University to Student Accommodation.

Other Examples

Other owners have retained the workshops as industrial workspaces. In Butcher's Wheel for example traditional processes such as scissor forging still exist alongside electroplating, a drum stick manufacturer and a tailor. Simple conversions also work. At Nursery Street, Basil Walker shared a building with an artist who appreciated the large amount of light in the top storey workshop. In Garden Street the workshops that once belonged to Kirkanson and Son have been converted to studio accommodation and music practice rooms. More adventurous plans have included the conversion of Globe Works to craft workshops, offices and a pub, although this venture has now failed. The water powered sites, now largely derelict or ruined, have become part of the 'Five Weirs Walk' system along Sheffield's Rivers and therefore provide a leisure resource for the city. The possibilities are endless and demonstrate that not all workshops to be preserved have to be converted into museums such as Shepherd's Wheel, Abbeydale and Kelham Island.

Grants

Owning a listed building does not automatically qualify the owner for a grant to maintain it. Between 1983 and 1993 the government spent an average of £1.4 million per year on the preservation and conservation of historic buildings and monuments.[36] Grants made by English Heritage for maintenance are based on decisions about the quality of the building, the urgency and nature of the repairs and the financial need for a grant from public funds.[37] Wherever possible English Heritage promotes the reuse of industrial buildings. Only in extreme cases will it provide grants to repair the structure,[38] if it will prevent the building from being demolished. None however have been awarded to Sheffield. Between 1983 and 1993 only 25% of grants went to proposals for changing the use of the building while 32% went to maintaining a building in its existing, similar or original use and 30% went on conversion to museums. However the majority of grants are made for buildings which are not capable of beneficial use.

Between 1983 and 1993 a total of 40% of grants went to commercial companies and public bodies, 24% went to local authorities, 17.1% to trusts and charities and 18% to private individuals and others.[39]

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[36] English Heritage 1995 Conserving the inheritance of industry: English Heritage Grants for industrial archaeology 1984-1993 EH, London p1

[37] ibid p3

[38] This refers to making the structure stable. EH will not provide the money to convert the building.

[39] English Heritage 1995 op cit p5

Grants from English Heritage often require a matching offer, and this is reflected in the size of grants awarded. In the twenty years studied 50% of grants awarded were under £10000. The aim is that 'clearly defined steps towards relatively modest goals may be completed satisfactorily, while there may be more difficulty in achieving ambitions for projects requiring greater resources.'[40]

Local Societies and Trusts

Building preservation trusts and local societies if money allows, will take on threatened buildings if no other investment is forthcoming. In Sheffield the South Yorkshire Industrial History Society (SYIHS) have in the past bought sites such as Wortley Top Forge, a unique water powered heavy forge, Rockley Furnace, built between 1698-1704, and most recently the site of the Bower Spring Cementation furnace. Currently it is negotiating to buy some nail-makers shops at Hoylandswaine.[41] However as yet it has not taken on any workshops of the cutlery industry, although it was fundamental in raising awareness of Shepherd's Wheel in the 1930s and the Abbeydale Industrial Hamlet in the 1950s. Other locally active societies are the Victorian Society and Hallamshire Historic Buildings Society who like SYIHS also raise awareness of threatened buildings. The only active building preservation trust is the South Yorkshire Historic Buildings Trust (SYHBS) formed in 1993.

It is significant that none of these groups have taken on the preservation of any buildings connected with the cutlery trades. The reason given by the SYHBS, when consulted about their work with buildings associated with the industry, was the size of the remaining structures and the immense costs involved when renovating complex sites.[42] Cornish Place for example was beyond the means of these local societies having four large ranges and many ancillary buildings within its curtilige.

Those small-scale workshops which remain are in private ownership thus making preservation difficult without the consent of the owner. This has been the case at Woodside Lane, Grenoside where a file cutters shop is in direct

[40] ibid p7
[41] See Bayliss, D. et al 1995 p20,23,25 and 27 for further details
[42] Pers comm. Ruth Harman, chairman of SYHBT, 29/10/96

need of preservation if it is not to collapse completely in the next three to five years (Figure 34a chapter 4).
The preservation of such buildings by local societies and trusts, however, inevitably means conversion to a museum and the end of a building as a workspace. With public money running out, especially with the current debts of the city council, museums will not, in the future, be a means of preservation, but of decay.

Sites Where Structures No Longer Exist, But Where There are Some Remains Connected with the Processes of Making Cutlery: The Effects Of PPG16.

So far, this chapter has considered standing structures, but, as the preceding chapters indicate, the majority of the workshops associated with the industry have now been demolished. Little is likely to remain of basic workshop structures, any foundations revealing little about the function of the building. However, at water-powered sites, where earthworks connected with the function of the site remain, and in the case of integrated works, where remains of the steel making process are likely to survive, the implications of PPG16 are more relevant.
In 1882 Lubbock issued the Ancient Monuments Act which for the first time put forward the idea that the 'landowner did not have the right to destroy remains of former settlement which happened to be on his property.'[43] This was the beginning of scheduling historic monuments. More recently this has been governed by the 1979 Ancient Monuments and Archaeological Areas Act. The 1990 and 1991 Planning Acts did not cover the scheduling of ancient monuments.

Formal interpretation of the 1979 Act appeared as another Policy Guidance Note (PPG16) in 1990, hastened by the 'concern arising from the Rose Theatre discoveries...and attendant litigation'.[44] PPG16 recognised that 'Archaeological remains should be seen as a finite, and non-renewable

[43] Pearce, D. 1989 Conservation Today Routledge, London p16
[44] Pugh-Smith, J. and Samuels, J. 1993 *PPG16: Two Years On* Journal of Planning Law p203 referring to R. vs Secretary of State for Environment ex parte Rose Theatre Company (1990) 1 All E.R. 75

resource, in many cases highly fragile and vulnerable to damage and destruction.'[45] It suggested therefore that 'When important remains are known to exist or when archaeologists have good reason to believe that important remains exist, developers will be able to help by preparing sympathetic designs, using for example, foundations which avoid disturbing remains altogether or minimise damage by raising ground levels under the proposed new structure'.[46]

If any research has highlighted the possibility of archaeological remains, a field evaluation of a site can be carried out under section B21 of PPG16 before any planning decision is made. This usually involves a ground survey and trial trench carried out by trained archaeologists, but in the case of standing buildings elevations and plans have to be drawn up. The results of such a survey should then be attached to the planning proposal by the developer. Even if the planning authorities decide to allow development to go ahead, they are entitled to make sure that the developer has made provision for the recording of the remains before any development takes place. This can be done voluntarily under the British Archaeologists and Developers' Code of Practice or by enforcement of the 1990 planning laws. The implementation of some of the recommendations made by PPG16 can be seen in the case of the conversion of Sheaf Works.

Case Study 5: Sheaf Works (Figure 9)

Norwest Holst Developments received planning permission with certain conditions for the conversion of Sheffield's first integrated cutlery site, Sheaf Works, to offices and a pub in 1995. Throughout the application for planning permission there were various concerns raised about the extent to which this building would be changed, including the removal of the roof and a stone

[45] PPG16 I(6)
[46] ibid I (12)

Figure 9: Development work at Sheaf Works (June 1996). The pub has now been completed.

staircase and the replacement of many of the windows.[47] Twenty-one days notice of the commencement of work were to be given to the Local Planning Authority and the archaeological body authorised by the authority. Access was to be given to the archaeologists at any reasonable time while excavation works were carried out. In this case they were looking for any evidence of cementation furnaces, or crucible furnaces that may leave some underground structures. Plans were submitted outlining the existing elevations and ground floor plans, drawn up by Met Surveys of Wakefield , alongside the plans for conversion drawn up by Carey Jones Seifert Ltd of Leeds. This allowed the planners to assess the amount of change taking place. Conditions attached to the planning permission granted also provided for drawings to be made of the existing skirting, architraves and coving and provision for their storage had to be approved before work began. The clock also had to be repaired.

English Heritage recommended that the original windows be retained and secondary glazing used rather than replacing the originals with new double

[47] Letters contained in the planning file for Sheaf Works , Sheffield City Council Planning and Land Dept.

glazing. Full details of all alterations had to be approved by the LPA before permission to commence the development was given. Requirements included: plans showing extent of stone repairs and method statement for carrying out repairs and full details of materials for extension and other replacements such as stairs, windows and doors.

Once again the detailed nature of the information required when applying for listed building consent shows how the P(LBCA)A 1990 and PPG15 and PPG16 can help to preserve the architectural and historic character of once important buildings with the cutlery trade.

Recording Programmes

PPG15 and particularly PPG16, although they go some way to protecting the nation's heritage in conjunction with the acts that they interpret, rely on the buildings being recorded locally and nationally. The main source that should be consulted when planning applications arise regarding historic buildings is the **Sites and Monuments Record**, usually held by the county archaeologist. But the maintenance of such records is not statutory. In new proposals by the government it is suggested that it should be a compulsory duty to establish and maintain such records.[48] A lack of resources in recent years has meant that sites in South Yorkshire are poorly recorded and often do not contain sufficient information for a decision to be made about a site's importance. In particular, very little was known about small-scale cutlery workshops other than those in the Statutory List. This has to some extent been rectified by lodging the information found during the course of this research with the SMR officer. Another shortfall in the region is the abolition of the county archaeologist's post at the beginning of 1996. Most observations and rescue excavations within the city are now carried out by ARCUS, an archaeological consultancy unit based at the University of Sheffield, with assistance from the SMR Officer.

Recognising the national shortage of material on historical sites the **Monuments Protection Programme** was launched. The industrial archaeology section of the programme was originally directed at the shortfall of scheduled monuments, estimating in 1992 when it started that of 12000

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[48] Department of National Heritage 1995 Protecting Our Heritage: A consultation Document on the built heritage of England and Wales London p 46 section 4.4.13

scheduled archaeological sites on record, only 2% related to industrial structures, with an unknown number of listed industrial buildings.[49] By the end of the programme the total (all periods) will be nearer 35000.[50] The outcome of MPP is that many of the sites surveyed subsequently will be protected by scheduling, listing or being recommended to the planning authority as worthy of vigilance.

For MPP, industries were placed in the categories of Extractive, Inorganic Manufacture, Engineering and Metal Working, which includes cutlery production (although this is yet to be covered), Organic materials and manufactures, Power and Utilities, and Transport and Communications.[51] For each category three principal 'steps' of research are followed. Firstly there is the identification of the resource. This involves collecting information from the SMRs and the National Archaeological Record (NAR) held by RCHME. 'Between the two sources it is estimated that we can approach between 60 and 70 % of the total number of archaeological sites in England.'[52] But for industrial sites the information is severely lacking in these sources, 'the data for industrial archaeology is still held by a myriad of small autonomous groups and by single individuals;'[53] Secondly, an evaluation of sites identified takes place to assess how important they are. This is when most information is gathered by consultants visiting the experts in each area as identified in 'step one' of the research. At this stage it is hoped that sites which have not been already identified are recognised. 'Step three' is to decide what protection should be offered. At this stage all sites not meeting the criteria of 'importance' are weeded out and a short list is drawn up, the sites visited and reported on. The report takes the form of a single sheet detailing above ground structures and whether the consultant considers that the site should be given protection. Four categories are given:

1) Those which are not sufficiently important to merit protection (0);

2) Sites, when viewed as a whole are locally important (*);

3) Sites, when viewed as a whole are nationally important (**);

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[49] Stocker, D. 1995 *Industrial Archaeology and the Monuments Protection programme in England* in Palmer, M. and Neaverson, P. eds 1995 <u>Managing the Industrial Heritage</u> Leicester Archaeology Monographs 2, Leicester p 105.

[50] ibid p105

[51] Lancaster University Archaeological Unit 1995 <u>MPP Industrial Monuments Specification</u>

[52] Stocker, D. 1995 op cit p105

[53] ibid p107

4) Internationally important sites (***).[54]
English Heritage then decides whether to recommend listing or scheduling to the Secretary of State for the Environment.

MPP, when completed,[55] will inevitably aid the listing and scheduling processes and allow informed decisions to be made. The fear that some sites will be missed because the information is not available from the SMR is to some extent overcome by the consultation process in 'Step two'. If sites do not stand out at this stage they are probably not worth keeping. After all, evolution of our landscape will continue.

Other initiatives to improve our knowledge of industrial buildings have come from the Association for Industrial Archaeology. In 1993 the *Index Record for Industrial Sites* was launched, with the aim of forming a national record which could be called upon by planners and others when a building was threatened. The AIA recognised that many people had information about sites that were not known about. The problem however was to persuade them that the information should be in the public domain. At the last conference forms had been received from nearly every county in England but as with all recording programmes as time elapses more sites disappear.
All three records of industrial sites cover the cutlery industry. It is hoped that this thesis in some way helps to make the identification of sites related to the Sheffield trades easier for future generations.

Future Legislation

In the winter of 1996 the consultation period for new guidelines relating to 'the built heritage of England and Wales' has just elapsed. In the opening section the consultation document outlines that the government regard the conservation of historic buildings as a positive process but its main priority states, 'it involves actively caring for the heritage, maintaining it in good physical condition, making it readily accessible for study, enjoyment, recreation and tourism.'[56] It regards conversion as a way to regenerate urban

[54] ibid p108
[55] Many industries are now at stage three assessment
[56] Dept. of National Heritage 1996 Protecting Our Heritage section 1.8

areas and increase the economic viability of rural areas. The author suggests, in the case of the workshops of the cutlery industry, reuse, by manufacturers and commercial ventures, should always take priority over recreation and tourism. Sheffield cannot be turned into a museum.

The government has put forward several suggestions for change in the listing procedure. It suggests that listing is carried out from now on by thematic surveys rather than a geographical programme. This has already been started by surveys of post war buildings, military structures and farm buildings. MPP surveys are also following this direction. It has also suggested that provisional listing could take place while the decision is taken whether or not to give full listed status to a structure.[57] This would stop pre-emptive action, as at Kendal Works when a building was destroyed before listing took place. However this raises the issue of compensation, if a building was not subsequently listed. It also considers whether the financial circumstances of the owner should be taken into account when listing a structure.[58] This would almost certainly mean that some buildings of national importance would be lost, although if in good condition the value of listed buildings usually increases. The consultation document suggests that instead of giving money to local authorities for the preservation of historic buildings, as specified by the 1953 Act, it would be more effective if the money was passed directly to building preservation trusts.[59] Finally it puts forward the suggestion that the exterior only of some buildings could be listed. This in some ways would be more economically viable to some developers. The nature of the workshops of the cutlery industry prohibits interiors from being retained in any conversions, thus any alteration destroys the internal character of the building. Listing the exterior would allow us to 'remember' the past as Ruskin said[60] whilst looking towards the future.

Conclusion

This chapter has demonstrated that current legislation can help to secure the future for important historic buildings associated with the cutlery industry.

[57] ibid sections 2.13-2.15
[58] ibid sections 2.20-2.25
[59] ibid section 5.11
[60] ibid section 1.6

However the legislation regarding historic sites and monuments may need some adjustment to be effective in the future. It has also demonstrated a number of ways in which a building can be redeveloped so that it is economically viable. In this way the fabric of a building is protected by constant use and maintenance. Although demolition may at first sight seem the best possible option, improving skills in renovation, refurbishment and conversion mean that conversion can be a profitable alternative.[61]

In the future what remains of the workshops of the cutlery industry will be the 'product of the fashions prevailing.....arrived at by consensus, *but* a consensus of the taste forming elite which will vary over space and time'.[62] While Ford is perhaps right in suggesting that 'our cities should provide visible clues to where we have been and where we are going'[63] the future of our cities depends on heritage planning being 'proactive', making use of conserved buildings in a contemporary role. Allowing the 'pendulum [to] swing too far so that buildings of dubious value are being propped up at great expense'[64] should be guarded against. It should be remembered that what survives today is the result of constant evolution; no building has been frozen in time, although walking into the courtyard of Butcher's Wheel, one sometimes feels that here working practices have changed little over the last 100 years.

No city can be turned into a museum of its past; to suggest that all workshops connected to the cutlery industry need preserving so that Sheffield can remember its roots denies the continuity of the industry into the 1990s. Preserving the buildings will not preserve the trade. If the industry is to continue, it must adjust to current market forces, diversify its products, and maintain the quality for which it is renowned. However the name of 'Sheffield' alone will not sell goods, no matter how fiercely it is defended against fraudulent use. Current cutlery firms will have to continue to advertise and come up with innovative ideas, such as Richardsons' 'Laser' knives which 'never need sharpening' and who ignored:

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[61] See **The Building Conservation Directory** published annually by Cathedral Communications Limited, London

[62] Ashworth, G.J. 1991 op cit p8

[63] Ford 1978 quoted in Ashworth, G.J. 1991 op cit p11

[64] Goody, B. 1982 op cit p8

'At heart, the industry [has] remained hidebound and Victorian, its business leaders more concerned with the ceremonies of the Cutlers' Company than with modernising the industry.'[65]

Some buildings will be and should be retained to remind future generations of the past and help them to plan for a better future. The reuse of old buildings has in some cases helped to promote companies by giving them a distinctive image, rather than occupying a prefabricated building which blends in with the rest of late twentieth century industrial design. One such firm is 'Gripple' (wire fastener makers) who although not using a cutlery works, converted The Old West Gun Works on Savile Street East into some of the best office and working space in the city.[66] This is using the image of the structure in the same way as nineteenth century industrialists, to convey the idea of a successful business. Inevitably some will become museums, but others will continue to evolve through new uses as they have done for a century and a half. Planners should strive to encourage innovative uses that perhaps leave only the external characteristics intact. The workshops of the cutlery industry were largely built by speculators for a multiplicity of purposes and therefore there should be no problems, where they are still structurally sound, finding a useful purpose for the surviving buildings in the twentieth and twenty-first centuries, especially as at the end of the twentieth century there is a return to the entrepreneurial small firm.

[65] Tweedale, G. 1996 op cit. p146.
[66] Production of the "Gripple" has no impact on the structure of the building thus it was possible to convert the structure without damaging it's listed fabric.

Conclusion

This thesis has defined the characteristics of the structures occupied by the Sheffield cutlery trades and has attempted to provide some understanding of the cost and financing of the erection of these premises. It has highlighted the complex nature of the cutlery industry in the late eighteenth and nineteenth centuries when trade sub-divisions combined a system of outworking with the independence of the 'little mester'.

By 1750, the cutlery industry was well organised and continued to grow, making full use of the water-power available. Increasing specialisation in the eighteenth century meant that workshops within the urban area were located in close proximity to one another as each small firm was dependent on at least one other. This pattern continued to develop in the nineteenth century. Ratebook evidence suggests that the introduction of steam power did not lead to the large integrated works that were characteristic of the textile industry, but rather that the industry continued to be based in small scale workshops. Tenement factories were erected to overcome the accommodation shortage of the rapidly expanding industry. These larger works were mainly erected in the Riverside area where land was available for expansion.

The speculative nature of many of the premises used by the industry is emphasised by the data available on the cost and financing of their erection. The evidence in the Fairbank field and building books shows that without being able to borrow money the cutler would never have been able to afford to erect his own workshop. Analysis of the building registers at the end of the nineteenth century shows that 69% of workshop buildings were initiated by speculators principally from the professional classes and especially those who were executors of wills. Only 12% were builders speculating in industrial structures. However cutlers formed a significant minority of those putting up the money for new workshops, accounting for 31% of all the owners identified.

It is unfortunate that so little evidence remains regarding the sources of finance used for new buildings. Comparing the evidence from Sheffield with other industries, it seems reasonable to suggest that the most likely sources were loans from family or friends, the use of plough-back or the formation of partnerships. The cutler is unlikely to have had any savings and building societies were concerned more with domestic rather than industrial property. The use of bank loans was only open to the larger firms. Evidence from the Sheffield Union and Sheffield and Hallamshire banks suggests that these were rarely used for the erection of new structures but rather as a means of boosting working capital. Shares were occasionally used when a large building was erected speculatively and by larger firms to create capital for expansion.

The predominant use of the vernacular style rather than architect designs for the majority of workshops further emphasises the low cost and speculative nature of the buildings. Only the large integrated works have any form of architectural embellishment designed to impress clients, the local community, or in some cases retain the confidence of shareholders. However even these larger works often retained the vernacular sign for workshops behind the frontage. This served to emphases the superior status of the manager compared with the workforce and is particularly noticeable at Eye Witness Works, Milton Street.

Structurally, the workshop buildings have little to distinguish them from other domestic or industrial buildings. This is another indication that many were speculatively built to suit the needs of a wide range of trades. However within the cutlery industry the use of particular 'cells' of production by branches of the trades maybe identified from the five types of window which can be found in the region. In particular buildings used for grinding and file cutting have distinguishing characteristics. The lack of taking-in doors, a common feature in the textile and boot and shoe industries, emphasises the small scale on which many firms worked.

Internally, the buildings can offer more information about the branch of the cutlery industry for which it was used and how the building was organised. Evidence for hearths, for example, suggests that a workshop has been used for forging, troughs or solid floor in an upper storey indicate grinding, while the lack of any of these features suggests that the finishing of cutlery took place. It is however unusual to find the characteristic tools of particular trades, such as the hammers, parsers and stiddies, leg frames and stocks which were usually removed when a firm closed.

By assessing the relationship of rooms within medium and large scale works it is possible to identify whether a building was designed as an integrated or tenement works. Where the rooms are interconnected it suggests that a building was erected for the use of one firm. If workshops can only be accessed from an external staircase or central corridor, a different firm is likely to have occupied each 'cell'. However, even in these larger works, whether integrated or tenement, the evidence suggests that individual workspaces were no larger than in the smaller workshop structures. Larger firms, taking charge of their own advertising and sales rather than using factors like the smaller firms, led to the development of larger workrooms such as warehouses and packing shops. Analysis of room size and organisation within a building can miss evidence for the complex sub-letting which took place of rooms and benches within the workshops and factories.

Evaluating the evidence for the use of power reveals that even at the end of the nineteenth century its adoption was not widespread except in the process of grinding and forging. The continued use of hand-power, indicated in the documentary and the lack of archaeological evidence, suggests that labour was versatile, cheap and plentiful and that the larger firms found it more profitable to employ out-workers to maintain and increase their range of products rather than invest in expensive machinery.

Water-power continued to be used into the twentieth century for grinding as steam power offered little technological advantage. Evidence for its use still survives in the form of water courses, although many of the structures have now been demolished or fallen into decay.

Little evidence is left of the use of steam power. Chimneys have been demolished and the engine houses which were usually integrated into the main structure of the works rarely stand out unless they housed beam engines. All traces of the engines have been removed and evidence for power transmission is often difficult to find. The size of the engines and the cost of steam power prohibited many from using it. Some "little mesters" may have seen it as a threat to their independence, the hours of work being regulated by the engine rather than themselves. Only with the introduction of gas engines and later electric motors was power more widely adopted in the smaller workshops increasing the efficiency in the finishing of cutlery.

It can be concluded therefore that the majority of workshops utilised by the cutlery industry were speculatively built, suggesting that the specialist needs of the industry were few. The slow adoption of power by the industry suggests, that like many other industries, the Industrial Revolution was about slow development and continuity rather than rapid change.

This thesis has gone some way to making the identification of buildings used by the industry easier and has demonstrated that even where documentary evidence does not exist, the structures identify the branch of the trade which occupied the workshop and the type of firm, whether it be large scale or an independent "little mester". To take this work further would require a more detailed survey of all the remaining sites that were once used by the cutlery industry, as has been carried out for Truro Works, Cornish Place and Butcher's Wheel.[1] A project planned by the RCHME, based on the research of this thesis and work by the South Yorkshire Industrial History Group, has however been delayed by financial constraints. Similar studies need also to be carried out for other industries so that similarities and differences between them become more clearly defined. In relation to this thesis, studies on the Birmingham jewellery industry and the Prescot watch and file trades would make interesting comparisons. It has already been recognised that such typological studies would allow structures to be evaluated in their national context and thus aid planning decisions in the future.[2] Landscape surveys should however be included within these typological surveys thus increasing our knowledge of industrial location and interaction with the market place and other industries. In the case of the cutlery industry the study of the urban landscape through map evidence was particularly important in recognising the interaction of the industry with steel production and the provision of horn, bone, and packing materials in addition to access to the home and world markets on which the industry depended.

The issues facing the reuse of the remaining workshops of the cutlery industry are complex. Past legislation has not worked as well as it ought to have done in protecting the buildings, especially the integrity of large-scale sites. However it is suggested that many workshops once occupied by the cutlery industry can be successfully adapted for reuse, a concept in keeping with many of the structures which were designed to be used by any trade. Some buildings should be retained as museums, preferably preserved in the state in

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[1] RCHME reports 1995-1996.

[2] Palmer, M. and Council for the Association for Industrial Archaeology 1991 **Industrial Archaeology: Working for the Future** AIA, Leicester

which they were left, but it can be argued that their establishment is a luxury of economic prosperity. In times of depression museums are not always a secure means of preserving past structures. The ideal means of preservation is the continuity of the trade within the building; however, the "little mester", due to changing economic circumstances and a lack of investment in training, is disappearing, and for the small scale workshops this is an unlikely option.

To end on an optimistic note, the cutlery industry today continues to thrive with world leaders such as Richardson's and Taylor's Eye Witness still based in Sheffield. In total there are 110 firms recorded by the Cutlery and Allied Trades Research Association (CATRA), employing 5400 people.[3] Half of these firms continue to occupy the traditional buildings of the industry built in the nineteenth century.

[3] Figures for Standard Industrial Classification 28.6 Cutlery, tools and general hardware, Annual Employment Survey September 1995, Office of National Statistics.

List of Sites mentioned in the Text.

Rural

Alpha Works, Stannington	SK301883
Cross Hill 132, Ecclesfield	SK361935
Crown Works, Ecclesfield	SK357937
James Vicker's Workshop 643 Stannington Road, Stannington	SK355868
Nook Lane, Franklin Cottage, Stannington	SK309886
9, Woodside Lane Grenoside	SK332943
Topside, Grenoside	SK329939
Back Lane, Grenoside	SK329939
Rock House, Nethergate, Stannington	SK301882
Scythe Works, Ford	SK441384
Syke Farm, Dungworth	SK288894

Sheffield

A Wright and Son, Arundel Street	SK355867
Abbeydale Industrial Hamlet	SK326820
Aberdeen Works, Trafalgar Street	SK349872
Alpha Works (Harrison Bros and Howson), Carver Street	SK352873
Anglo Works, Trippet Lane	SK352874
Billy Thornton's Workshop, Canning Street	SK349872
Butcher's Wheel, Arundel Street	SK355868
Challenge Works, Arundel Street	SK355867
Cornish Place (Dixons), Green Lane	SK351883
Cutlers' Hall, Church Street	SK354876
Eye Witness Works, Milton Street	SK348867
Garden Street 52-54 (Stan Shaw's)	SK347876
Globe Works, Penistone Road	SK348883
Howard Hotel, Howard Street	SK357869
Hutton Buildings, West Street	SK348874
Kendal Works, Carver Street	SK352873
Kirkansons's, Garden Street	SK347876
Kutrite Works	SK351877
Leah's Yard, Cambridge Street	SK352872
Morton's, West Street	SK347873

Sheaf Works, Maltravers Street	SK361877
Sylvester Works (Elliotts), Sylvester Street	SK354865
Truro Works, Matilda Street	SK357867
Venture Works, Arundel Street	SK356869

Water-Powered Sites

Clough Wheels, Sheaf	SK356861
Frank Wheel, Rivelin	SK300874
Hind Wheel, Rivelin	SK309876
Holme Head Wheel, Rivelin	SK315881
Holme Wheel, Porter	SK327858
Ibbotson Wheel, Porter	SK319857
Kelham Island	SK352882
Little London Wheel, Rivelin	SK314880
Little London Wheel, Sheaf	SK347847
Malin Bridge Wheel, Loxley	SK325894
Moscar Wheel, Sheaf	SK339836
Mousehole Forge, Rivelin	SK325891
Plonk Wheel, Rivelin	SK307876
Pond Forge, Sheaf	SK359874
Rivelin Bridge Wheel, Rivelin	SK322885
Roscoe Wheel, Rivelin	SK317883
Second Coppice, Rivelin	SK294873
Shepherd's Wheel, Porter	SK317856
Third Coppice, Rivelin	SK295873
Upper Coppice, Rivelin	SK293873
Upper Cut Wheel, Rivelin	SK312878
Wadsley Forge, Don	SK336905
Walkley Bank Tilt, Rivelin	SK324888
Wolf Wheel, Rivelin	SK302875

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NVT12 Needham Veal and Tyzack, outworkers agreements 1914-18
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Sheffield Deeds Catalogue Books 1-4
Sheffield Ratebooks
Soho Minute Books MD709
Soho Rent Books (A143)
Special List on Building Societies
TC762 Wages Agreement
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W.D. 474 Sheffield Reform Freehold Benefit Building Society papers

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