Chapter Four

Field techniques

Fieldwork is a means of gathering data. This seems a simple enough statement, but it has many implications. What data should be gathered? For what purpose is it being gathered? And how is it to be gathered? The practice of industrial archaeology involves both the recording of upstanding structures and also the survey, and even excavation, of the physical context of those structures. Recording above- and below-ground features are not necessarily similar processes. The process of excavating below-ground features usually destroys the stratigraphy of a site, and therefore some means of recording the data collected as objectively as possible is essential to allow both interpretation and probable reinterpretation at a later date. With upstanding structures, unless demolition is imminent, the recording process is non-destructive and re-evaluation at a later date can often be done by going back to the structure itself rather than to data previously collected. This may mean that the level of detail required, and therefore the amount of data collected, is different for above- and below-ground structures.

There are clearly questions to be answered about the nature of field data before the techniques of collecting it can be described, and so some discussion about the theoretical basis of the recording process is necessary. Recording data obtained from excavation has been dominated by the idea of 'contexts' and 'stratigraphic units' derived from the seminal *Principles of Archaeological Stratigraphy* (E. C. Harris 1979). Harris's theories were based on the geological principles of stratigraphy and therefore firmly rooted in the processual archaeology of the 1960s and 1970s. Given the belief that raw data could be collected objectively, descriptions were drawn in physical terms only, thereby emphasising the role of natural or environmental factors in the shaping of human activity. Several attempts have been made to apply these principles to the recording of standing buildings (Ferris 1989; Davies 1993) which has led to a considerable debate on their validity for upstanding structures. Post-processual archaeologists place much more emphasis on human intervention in the stratigraphic process itself: they argue that what the stratigraphic units actually represent are not natural events but events shaped by human beings. They have also rejected the notion that scientific objectivity is possible in the recording process, since every individual recorder approaches a site or structure with ideas and theories that influence what is actually recorded.

This, of course, can lead to the untenable position that anyone's interpretation of a site or structure is as good as another's, a criticism often levied against post-processual archaeology in general. The way forward is to accept that recording, or the gathering of field data, is subjective, but to make it as objective as possible by ensuring that the recording process is part of an accepted research agenda. Most archaeologists now agree that the purpose of data collection is not to test scientific hypotheses but to illuminate broad historical issues. A research agenda requires that these issues be made explicit so that a recorder can make informed decisions about what to record for a particular site or structure. The agenda itself is derived from the current priorities perceived by whatever organisation has initiated the recording process.

A research agenda, particularly one applied to standing structures, will therefore involve informed decisions about what data is necessary for a particular project, which is in itself a subjective act. But a degree of objectivity can be achieved in the data-gathering process itself by the acceptance of certain techniques. These may involve the use of pro-forma context sheets, even for standing buildings. The design of these, which dictates both the level and type of data to be collected, is part of the research project, and in a sense therefore subjective, but they can, for example, encourage consistency of data collection from one site to another. On the other hand, it is important that a recorder should note differences as well as similarities, and so context sheets need to be used flexibly and to complement rather than replace photographs, drawings and site notes.

Recording, or the collection of field data, is therefore not usually an end in itself, but part of an accepted research agenda, be it for structures or sites. The techniques used in meeting the requirements of such an agenda will be explored in this chapter.

Site identification

The survival of above-ground evidence for the industrial period means that the standard archaeological discovery techniques of field walking, geophysical survey and aerial photography are not always appropriate. None the less, there are sites with no above-ground evidence where such techniques are of value. Aerial photography, for example, can reveal the earthworks of windmill mounds and the alterations to water courses for the supply of power to mills and mining sites. Field walking is usually the only means available for locating sites for which there is little documentary evidence, such as pitsteads for the manufacture of charcoal and early bloomery sites, the latter often detected by slag scatters. It is also valuable for the location of features which were either in a ruinous condition, such as lime-kilns or coke ovens, or so ephemeral, like many horse-drawn waggonways, that they escaped the attention of map surveyors. Field walking and aerial photography are particularly appropriate techniques for the upland areas which were rarely surveyed on the large scale applied to populous lowland areas in the mid-nineteenth century.

Ordnance Survey (OS) maps do, however, form the basis of the desk-based surveys for discovery purposes which precede most field projects. For example, Cornwall Archaeological Unit made use of a Tithe Map of 1842 and the first and second editions of the 1:2,500 OS maps of 1877 and 1908 for their historic audit of the town of Hayle. The gazetteer derived from the maps was then evaluated in the field and the surviving monuments classified according to site type (Buck and Smith 1995). The evidence from these early editions can be combined with the information obtained from aerial photographs – a technique being utilised by the RCHME aerial mapping programme and which has revealed large numbers of industrial sites in, for example, the Yorkshire Dales, Dartmoor and Exmoor National Parks. County-based voluntary societies and individuals have produced numbers of gazetteers of sites, as has the Association for Industrial Archaeology in the regional guides produced to accompany its annual conferences. These gazetteers are essentially lists of extant sites which can act as pointers to more detailed analysis of the areas covered. The most intensive use of maps for an area survey has been that carried out in the Ironbridge Gorge (Alfrey and Clark 1993). The authors took as their basis the plots shown on the 1902 edition of the 25-inch OS map, which they argued had an historical significance in representing the way in which the land had been organised in the past. Incorporating evidence from earlier maps and other documentary evidence, each plot was treated as an archaeological site and each feature within it given a context number. This ensured that equal weight was given to all types of feature, and therefore a degree of consistency attained. The plot survey is valuable in ensuring that the *total* landscape is considered and not just the important upstanding

structures. It is, however, a time-consuming technique which is probably appropriate only for particularly important landscapes like the Ironbridge Gorge: other areas might not merit such meticulous collection of data. The authors were also fortunate in that many of the plots could still be identified in a landscape which had not, on the whole, undergone intensive redevelopment in the twentieth century.

Maps and documents have played an important part in the identification of water-power sites prior to field investigation. Michael Davies-Shiel has produced an invaluable series of distribution maps of the water-powered industries of the Lake District, ranging from textile mills to corn mills, bobbin mills and paper mills (Davies-Shiel 1978) which give a good idea of the intensity with which water-power resources were exploited. A similar theme was pursued by a research group at Sheffield University, involving the analysis of a wide range of documentary sources to investigate how Sheffield rivers were harnessed for the secondary metal trades (Crossley 1989). The group produced a map of each of the rivers showing the water-power sites in relation to each other: for each site, they researched the uses and changes of ownership and, in most cases, eventual abandonment (Figure 25). Follow-up fieldwork then confirmed any site remains on the ground, including dams, goits and occasional slag scatters. This combination of documentary research followed by field investigation could be applied to other small area surveys.

The most comprehensive thematic survey has been that carried out on textile mills in the north of England by RCHME in association with other local bodies. This again has provided a methodology which can be applied to other categories of buildings. This class of building was under immediate threat, and so the first part of the research agenda was to ascertain the extent of the surviving evidence. For the West Yorkshire survey, the editions of the 25-inch OS maps between 1920 and 1935 were selected for initial study, since they showed the maximum number of mills. Some 1,800 mills were identified in this way: each was then visited and, if extant, recorded using a standard form for speed and consistency. The authors have since recognised the limitations of this method, as the functions of various mill buildings were more complex than previously realised, but it did enable the rapid recording of over 1,400 mill sites with standing remains. From this pilot survey, the investigators were able to finalise their research agenda. They decided to collect further data on mills which met three main criteria: the mills chosen should have contributed to the development of the factory system, to the structural evolution of mill building or to the community of which they formed a part. Some 120 mills were selected on these criteria. As well as normal ground-level photography and building measurement, oblique aerial photography played an important role in the discovery and interpretation of such complex sites (Giles and Goodall 1992). A similar map survey in Greater Manchester revealed 2,400 mill sites of which over 1,000 were actually recorded and a smaller number investigated in greater detail (Williams with Farnie 1992). The East Cheshire survey tackled a more limited area, that of the boroughs of Macclesfield and Congleton, and so was able to produce detailed studies of nearly all the 242 mill sites identified (Calladine and Fricker 1993). This close scrutiny was able to reveal the amount of evidence, both structural and documentary, which survived for the mid- to late eighteenth century and resulted in a greater understanding of the development of the hitherto unresearched silk industry of the region.

English Heritage has been instrumental in the recognition of a large number of industrial sites through its Monuments Protection Programme (MPP). This was designed to review the Schedule of Ancient Monuments, using data derived from Sites and Monuments Records (SMRs) and the NMR. For industrial sites, however, the necessary data did not exist and an industry-by-industry survey was instituted, using the thematic classification of industries devised by Arthur Raistrick (1972). The initial steps of the survey of each industry relied on the collection of published data or that supplied by individuals, culminating in a graded list of known

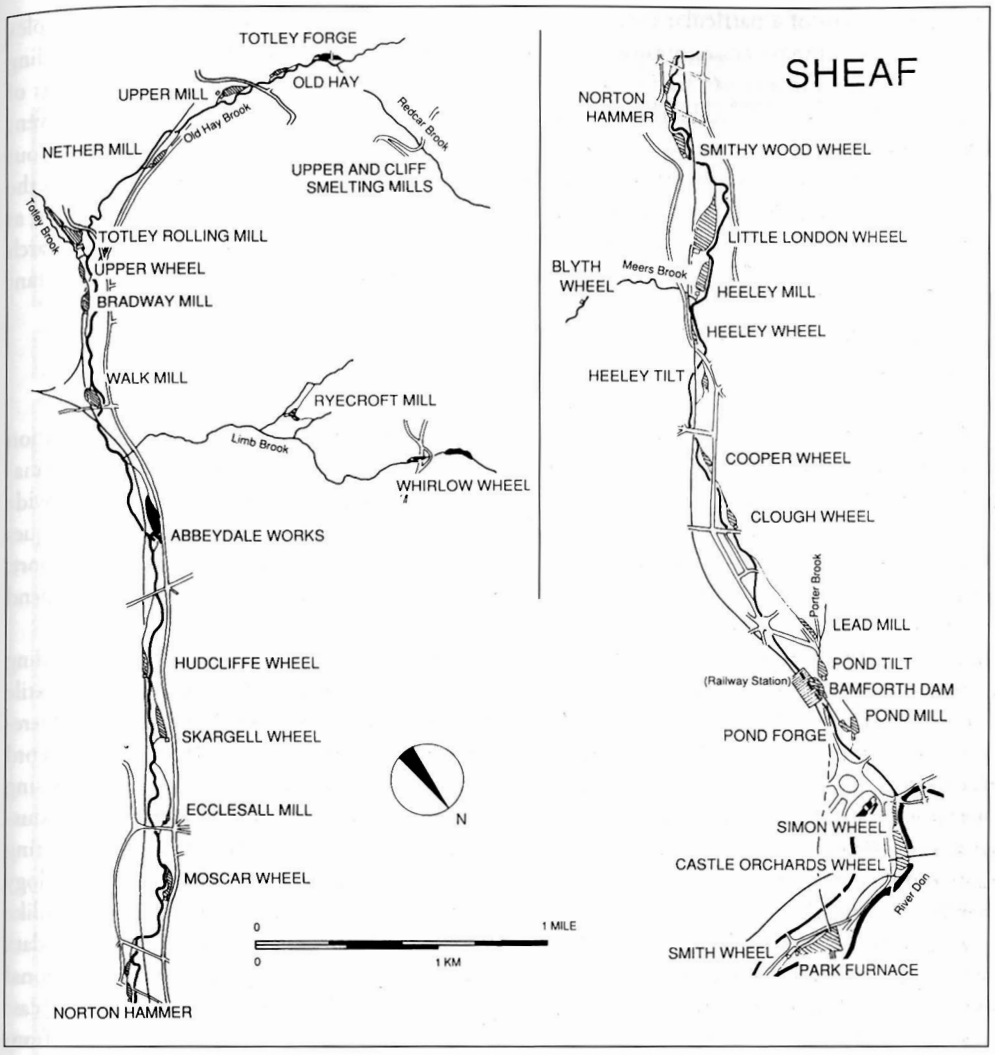

Figure 25 An example of the maximum use of a small river, the water-powered sites along the River Sheaf in Sheffield, South Yorkshire. These were mostly concerned with metal-working involving rolling mills, tilt hammers and grinding wheels.

Reproduced by courtesy of David Crossley, University of Sheffield.

sites which was then made available for public consultation. MPP then moved from discovery to recording by means of field evaluations of selected sites, which were classified using preferred terms based on the *Thesaurus of Monument Types* (RCHME and English Heritage 1995). Each site description contained a list of components on the site, also defined in preferred terms. Within each industry, a number of key sites are then recommended for scheduling. The programme is a long-term one, which began with the extractive industries in the early 1990s since these were adjudged most at risk (Stocker 1995).

The RCHME textile mill surveys and the English Heritage MPP have been important both in creating a research methodology for selecting buildings and sites which were key elements in

the development of a particular industry and for appreciating the relationship between complex site layouts and the processes of production. Recognition of the function of a particular building or feature should in all cases lead to a search for associated features which normally form part of a particular sequence of production. Like the Ironbridge Gorge plot survey, this helps to prevent concentration upon the obvious to the exclusion of the more mundane components, without which the site cannot be fully interpreted. The method of identification of industrial sites in the last decade has attempted to move away from concentration upon the individual monument, as demonstrated in the early lists and gazetteers of industrial sites, to the setting of specific research agendas for the investigation of historical problems in which field data can play an important role.

Recording

Recording sites or structures is the process of obtaining factual information by direct observation in the field. Its purpose is to create an archive, usually both written and illustrative, for permanent storage, a process usually described as 'preservation by record', and in many cases to provide an interpretation of the site or structure. The term 'recording' covers a wide range of techniques from the provision of a written description to a fully measured site plan and researched report. The level of recording, and therefore the techniques, used for a particular site or structure depend on its importance, its above-ground survival and the degree of threat to it.

Several of the identification techniques referred to above include an element of rapid recording by written description only, as, for example, the standard form used in the West Yorkshire Textile Mills Survey. This is the most basic level of recording, perhaps the most 'value-free' and therefore objective gathering of data. The Association for Industrial Archaeology's IRIS (Index Record for Industrial Sites) project is attempting to extend this system to all industrial sites by utilising local voluntary effort. The project involved the construction of a hierarchical wordlist for industrial sites which has attempted to break down the features on a systematic basis, differentiating between the site and the components which comprise it (Association for Industrial Archaeology 1993). This wordlist has now been incorporated into the *Thesaurus of Monument Types*. Unlike the early NRIM record cards, the IRIS recording form has been designed to meet national data standards to enable direct transfer to Sites and Monuments Records and the National Archaeological Record. Figures 26 and 27 illustrate a form compiled for the charcoal-fuelled blast furnace at Duddon in Cumbria (Plate 35). The inclusion of class and site terms selected from the hierarchical wordlist enables computer indexing to assess the relationship of this particular site to other ironworks. The availability of printed reports as well as documentary sources is included, as the form itself is meant to serve as an index to more detailed work already carried out, including measured survey, photography and excavation. Similar rapid recording techniques using photographic and written descriptions have been used by RCHME for their surveys within urban development corporation areas of all buildings of historic or architectural interest dating from before 1945. These covered Bristol, Leeds, Sheffield, Teesside, and Tyne and Wear. Only within the Black Country, for which little previous work existed, did the survey move beyond the basic level and seek to describe the historic forces which had led to the formation of the built environment in the area (RCHME 1991).

RCHME has endeavoured to standardise its recording procedures for all classes of building by the adoption of four levels of recording: these range from Level 1, a simple visual record as described above, to Level 4 which is a fully researched and illustrated record with photographs and measured drawings (RCHME 1996) (Figure 28). Each level incorporates the previous one but amplifies certain aspects such as phasing and national significance and therefore, it could be

AIA - Index Record for Industrial Sites

Box 1

SITE NAME
DUDDON IRON FURNACE

Address: Duddon Bridge, near Millom

District/~~Borough~~: Copeland

Parish/~~Township~~: Millom without

Box 2

***IRIS* NUMBER**
CU / AIA / MP4

Part of: Iron smelting complex

Associated with:

SMR no: 2704

NMR no:

Box 3

NGR1 [S . D][1 . 9 . 6 . 6][8 . 8.3 . 0] **NGR2** [.][. . .][. . .]

Box 4

Class: Ferr Sme

Site Term: Iron Smelt Works

Site Significance: L / R / N / I 1736 < . 1700 . 1750 . 1800 . 1850 . 1900 . 1950 . > 1867

Charcoal iron furnace with surviving stack, the most complete survival of its type in England. The context remains unaltered, with storage barns for ore and associated woodland charcoal sites.

At Risk? : In use / Partly in use / Disused Scheduled Ancient Monument
(County Monument No. 402)

Fixtures? Y/N/U
Machinery? Y/N/U

Site Details: Stone-built charcoal iron furnace with single blowing arch and single casting arch. The chimney over the stack is intact. A wheel pit and bellows floor have been excavated. Stone-built charging bridge with store rooms under its arches connected to the furnace stack by reconstructed wooden bridge. Adjoining the charging bridge is a two-storey building used as offices and a smithy. Water-power came from a head-race from the River Duddon.

PRIME MOTIVE POWER

Muscle
Wind
Water
Hydraulic
Steam
Pneumatic
Electric
Combustion
None

SITE COMPONENTS

No	Component Term	Period	Form	Importance	Status
1	Wheel Pit	1736-1867	Foundations	H/M/L	L/S/G/N
2	Bellows Chamber	1736-1867	Foundations	H/M/L	L/S/G/N
3	Casting Floor	1736-1867	Foundations	H/M/L	L/S/G/N
4	Blast Furnace	1736-1867	Structure	H/M/L	L/S/G/N
5	Charging Bridge	1736-1867	Structure	H/M/L	L/S/G/N
6	Stores under bridge	1736-1867	Structure	H/M/L	L/S/G/N
7	Office	1736-1867	Structure	H/M/L	L/S/G/N
8	Smithy	1736-1867	Structure	H/M/L	L/S/G/N
				H/M/L	L/S/G/N
				H/M/L	L/S/G/N

IRIS FORM ver 2

Figure 26 Both sections of a completed IRIS form for Duddon Furnace in Cumbria.

AIA - Index Record for Industrial Sites
(page 2)

Box 5

***IRIS* NUMBER**
CU / AIA / MP4

Box 6

Other Status:

Site History: Between 1711 and 1748, eight blast furnaces were constructed in this area to make use of local charcoal and water power. Duddon Furnace was erected in 1736 and worked until 1867 with very little alteration to its original form. The original pair of bellows was replaced in 1785 by two cast-iron blowing cylinders and a new 27' waterwheel was installed. It became a SAM in 1963 but was turned down for Guardianship. Emergency repairs were carried out in 1973, followed by a 21 year lease to Cumberland C. C. in 1974. The site was then leased on a 50 year term by the Lake District Special Planning Board in 1980.

ASSOCIATED PERSONS/COMPANIES

Name	Details
Cunsey Co	1736
Hall, Kendall & Co	
Kendall, Latham & Co	
Joseph Richard Latham	
Harrison, Ainslie & Co	worked site from 1828

Site Recording: by Lake District Special Planning Board.

Sources:
1. J.D. Marshall & M. Davies Sheil, Industrial Archaeology of the Lake Counties (1969)
2. Alfred Fell, The Early Iron Industry of Furness & District, (1908)
3. A. Lowe, 'Archaeology & the Lake District National Park' in
4. R. White & R. Iles (eds) Archaeology in the National Parks (1991)
5. P. Riden, A Gazetteer of Charcoal Iron Furnaces in GB in use since 1660 (1993)

Date of Last Visit: September 1993 Reporter: M. Palmer

Compiler: M. Palmer Date: 18.12.95

Society: Association for Industrial Archaeology

Box 7

Continuation Box: Site History continued

Archaeological excavation was carried out between 1981 and 1985, followed by major consolidation work.

argued, moves from the objective to the increasingly subjective. These four levels can usefully be applied to sites as well as structures of the industrial period.

Level 1 surveys require a visual record of exteriors only, supplemented by the minimum of information needed to identify type, location and approximate date where possible. This level is used when the aim is to gather basic information about a large number of buildings, e.g. for statistical sampling or planning purposes. The initial survey used in the textile mills project was a Level 1 survey applied to structures, as was the assessment of engine houses for management purposes carried out by the Cornwall Archaeological Unit (Sharpe *et al.* 1991). Structures identified from documentary sources were visited in the field and graded using the monument appraisal criteria originally developed for MPP. Symbols were devised for categories such as type and function (Figure 29) and the standard entry (Figure 30 and Plate 36) was supplemented by a written description, location map and assessment of condition. This method of recording can clearly be applied to many other classes of industrial structures. Cornwall Archaeological Unit has also made use of what is essentially a Level 1 standard of recording for mining landscapes, using a plot and sketch technique for locating features not recorded on existing maps (Herring 1988). Their surveys were based on 1:2,500 OS maps and involved the setting up of a tight grid of fixed points by means of a plane table, microptic alidade or electronic distance measurement (EDM). Ranging poles were erected at each fixed point and surface features were then pace-sketched along perpendicular offsets within the several triangles formed by the poles. Any errors were thus confined to individual triangles whose average

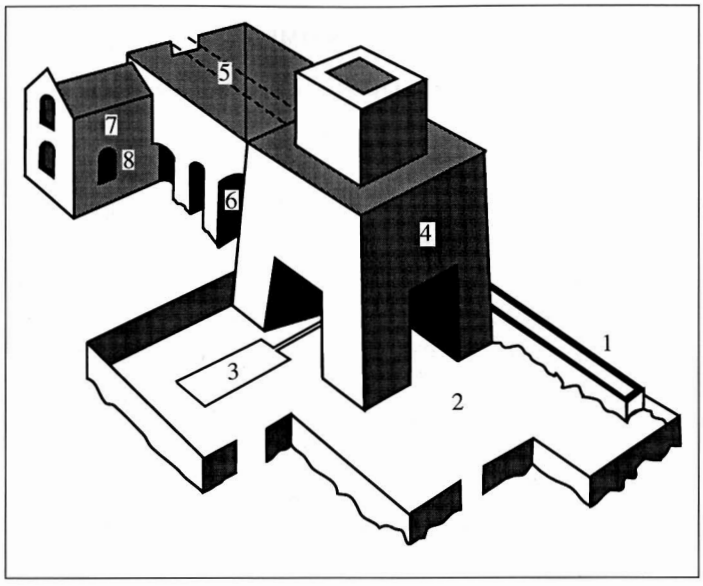

Figure 27 Diagrammatic sketch of Duddon Furnace in Cumbria. 1 – Waterwheel pit, 2 – Bellows room, 3 – Casting floor, 4 – Blast furnace, 5 – Charging bridge, 6 – Store, 7 – Office, 8 – Smithy.

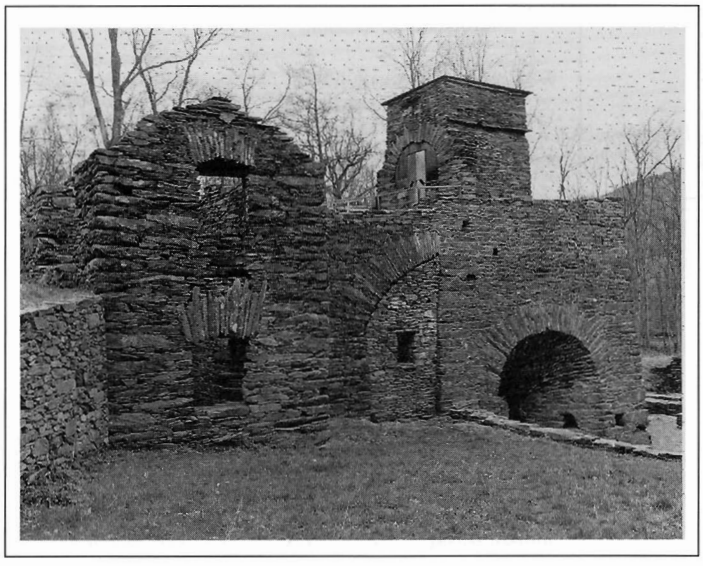

Plate 35 The stone-built charcoal iron furnace near Duddon Bridge in Cumbria.

Reproduced by courtesy of Andrew Lowe, Lake District National Park.

RCHME LEVELS OF RECORDING FOR BUILDINGS

WRITTEN ACCOUNT	DRAWINGS	PHOTOGRAPHY
1. Location of buildings, NGR and status	1. Sketch plan, roughly dimensioned	1. External view or views
2. Date record made, names of recorders	2. Plans of principal floors, showing features of historic significance	2. Overall interiors of principal rooms
3. Statement of building's type, purpose, materials, date	3. Drawings of other significant structural detail	3. All exteriors
4. Fuller account of development sequence, plan, form and function	4. Sections to illustrate vertical relationships	4. External details, relevant to design, development and use
5. As 4, with evidence for analysis	5. Drawings of details, eg. doorcases, mullions	5. Relationship of building to setting
6. Description of past and present uses, including machinery etc	6. Measured elevations	6. Interior detail, structural and decorative
7. Evidence for former existence of demolished structures etc.	7. Site plan relating building to other structures etc	
8. Copies of previous records or information on location	8. Copies of earlier plans	
9. Relevant information from readily available sources	9. Three-dimensional projections	
10. Past and present relationship of building to setting	10. Reconstruction drawings or phased drawings	
11. Potential for existence of below ground evidence		
12. Significance of building locally, regionally or nationally		
13. Other historical research, oral information and bibliography		

	Level One	Level Two	Level Three	Level Four
Written record	1-3	1-2, 4	1-2, 4-9	1-2, 4-13
Drawn record	1	1, normally 2	2-4 or 5	2-10
Photography	1, perhaps 2	2-3	3-6	3-6

Figure 28 A simplified table showing the four levels of recording for standing structures adopted by the Royal Commission on the Historical Monuments of England

maximum dimension was about 20 metres [22 yards]. Although inevitably there was a small degree of inaccuracy, no archaeological detail was lost. The technique involves only one operator, yet has enabled numerous unmapped features to be located, their extents established, condition assessed and their principal management needs determined.

Level 2 recording applied to buildings involves a full description and photographic record of both the interior and exterior of the building. Roughly dimensioned sketch plans are made, and the written record should include a summary of the building's plan, form, function and phasing but without a full analysis of the evidence on which this summary is based. Most of the building recording undertaken by local voluntary groups is of this level, particularly of buildings under threat of demolition or conversion. Examples include the survey carried out by Somerset Industrial Archaeology Society of a malthouse at Halse before conversion to dwellings (Miles 1989) and that under-

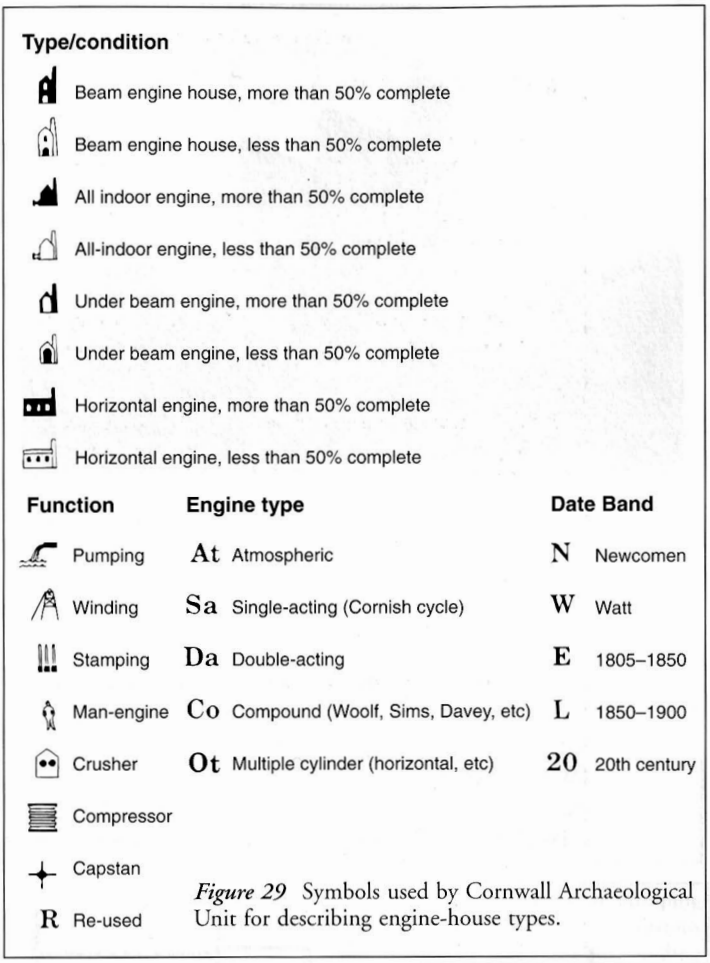

Figure 29 Symbols used by Cornwall Archaeological Unit for describing engine-house types.

MINE NAME: **Grenville United** PRN: **35302.03**
HOUSE NAME: **New Stamps** CONSTRUCTION DATE: **1891**
FUNCTION: **Stamping (aux. pumping)** ENGINE SIZE: **30" cylinder.** BEDSTONE: **In Situ.**
KB REF NO: **E300** NGR: **SW 6665 3860** PROTECTION: **Scheduled, Listed Grade 2.**
OWNER: **Not identified**
FOUNDRY: **Not Known**

MIV	SMAV	MIV + SMAV	Comments
42	29	71	Also associated structures downslope.

Type	Func	Func	Age	Op
			L	Da

Figure 30 Part of a report completed by Cornwall Archaeological Unit for Wheal Grenville New Stamps.
Key: MIV = Monument Importance Value, an assessment of the importance of individual structures as examples of their class.
SMAV = Site Management Appraisal Value, an assessment of the condition of the structures.
Reproduced by permission of the Cornwall Archaeological Unit.

Plate 36 Wheal Grenville New Stamps, in Cornwall, in 1987.

taken by Leicestershire Industrial History Society of the model farm attached to Carlton Hayes hospital, demolition of which was imminent (Palmer and Neaverson 1990–1). Level 2 surveys can also be applied to sites, again often by local groups, as in the work undertaken by Derbyshire Archaeological Society on the remains of coke ovens (Reedman and Sissons 1985; Battye *et al.* 1991). These sites included ruinous structures once related to both railways and coal mines. The basic plans for these were taken from early editions of large-scale OS maps and supplemented by schematic plans of selected surviving structures.

Level 3 recording includes measured plans and elevations, together with dimensioned sketches of details. It is an analytical record, incorporating an account of the origins and development of the site or structure based on an examination of the building itself together with readily available sources. Many of the surveys carried out by RCHME following the initial survey of textile mills come into this category, such as that of Havelock Mill in Manchester (Williams 1993). This survey paid particular attention to the development of the power transmission system within the mill (Figure 31) and the phasing of the buildings. An example of a Level 3 recording on a site basis is the survey of the Gawton Mine and Arsenic Works near Tavistock, carried out by the Exeter Museums Archaeological Field Unit. The survey team based their work on a wide range of maps and published material and carried out a complete site and building survey. Using documentary sources, as well as field evidence, the unit was able to relate the remains to the largely unrecorded process of arsenic calcining (Pye and Weddell 1992).

Figure 31 A section through Havelock cotton mill, Manchester, showing the remains of the power transmission system.
RCHME, © Crown Copyright

The fourth level of recording is employed only for buildings of especial importance and draws on the full range of sources of information. The report will include a discussion of the building's significance in terms of architectural, social, regional or economic history. A good example of Level 4 record-

ing applied to buildings was the survey of the eastern terminus of Britain's first passenger railway from Liverpool to Manchester (Fitzgerald 1980): this report includes drawn plans, elevations and sections of the buildings together with details of interior goods-handling fitments. The survey is set in the context of the development of the railway, particularly its approach to a built-up area involving the construction of numerous bridges. A less ambitious Level 4 survey, undertaken by the authors, was of Glyn Pits Colliery near Pontypool, the only coal mine in Britain to retain steam-powered pumping and winding engines of mid-nineteenth-century origin. Careful analysis of the remaining structures, together with extensive use of documentary sources, has enabled an interpretation of the changes in pumping and winding systems on the mine (Figure 32) which could serve as a model for similar work on other sites (Palmer and Neaverson 1990). Similarly, at the site of the Royal Gunpowder Factory at Waltham Abbey in Essex, RCHME recorded the complex field remains and conducted extensive research into the history of explosives manufacture from black powder to tetryl in order to set this important site into its technological context (RCHME 1994a).

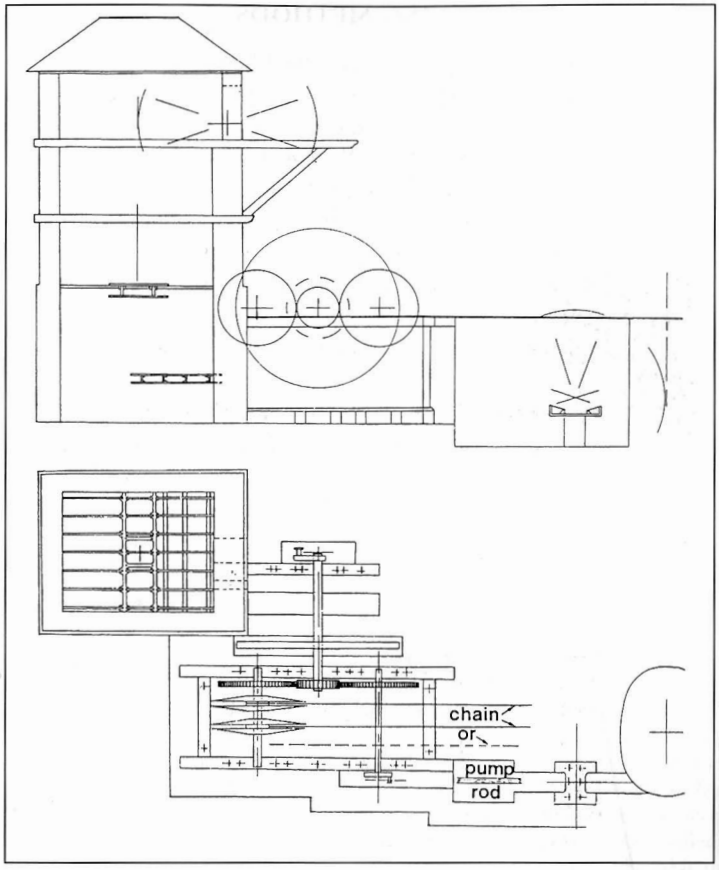

Figure 32 Simplified elevation and plan of the rotative beam pumping and winding engine at Glyn Pits, near Pontypool, Gwent. The obvious field remains indicated only the pumping function: the previous winding arrangement by means of chain reels in a pit adjacent to the engine house was deduced from fragmentary remains supported by documentary sources.

These four levels of recording are useful not only in defining what kind of data is to be collected, but also in enabling the resources available to be matched to the task to be undertaken. Clearly, the use of sophisticated equipment reduces the manpower requirement but it is possible for a local group who have sufficient numbers and time available to work to Level 4 standards with basic equipment. The levels need to be flexible since close examination of a structure may reveal important features which demand a higher level of recording than that originally anticipated. Indeed, the authors' work at Glyn Pits began as a Level 2 project, but the anomalies observed during the recording process prompted detailed documentary work which resulted in a Level 4 record.

SITE-SURVEYING METHODS

Since surveying is a largely field-based operation and the techniques involved cannot easily be learnt from using a text, this section will discuss the survey methods appropriate to a variety of situations but will not deal with the techniques in detail. Industrial archaeologists have a wide range of tools available to them today ranging from the very basic to highly sophisticated electronic instruments incorporating computers. Great flexibility is therefore possible in their adoption and use dependent upon the number of people available, the size and topography of the site and the presence of standing buildings or surface features. A preliminary reconnaissance of the site is essential so that reference points and scales can be agreed upon if several teams are involved in the survey.

Briefly summarised the tools available for site survey are as follows:

- Horizontal distance measurement: rods, chains and tapes; optical tacheometry (theodolite or microptic alidade) and EDM (electronic distance measurement)
- Angle measurement: prismatic compass (horizontal angles) for magnetic bearings; Abney level or clinometer (for vertical angles); theodolite (for horizontal and vertical angles); cross staff and optical square (for setting out right angles); EDM
- Height measurement: folding rods, 5-metre telescopic rods; Abney level or clinometer; theodolite (and use of trigonometry); dumpy, quick-set and automatic levels; total station incorporating EDM and electronic theodolite
- Mapping: plane table with plain or microptic alidade; EDM

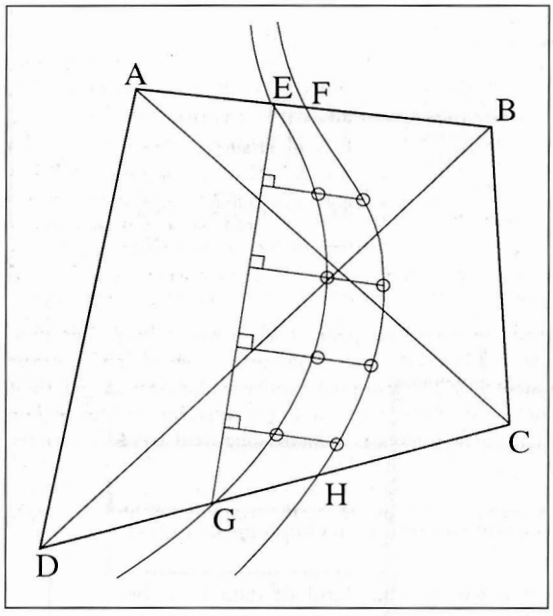

Figure 33 Diagram to show a survey by means of triangulation and offset measurement. An irregular and level area *ABCD* is crossed by a stream in a curved channel. A plan of area *ABCD* may be made by a chain survey, measuring *AB*, *BC*, *CD* and *DA*, using the diagonals *AC* and *BD* as check measurements. The position of the stream bed may be determined where it crosses *AB* and *CD* by direct measurements. The rest of the stream may be determined within the area by laying out a line *EG* and using the offset method of measurement. At various known points along *EG*, perpendiculars are set and the position of the stream boundary noted in each case.

As noted previously, many sites of the industrial period will appear on the first edition, 25-inch-to-1-mile OS maps or the even larger-scale town plans created in the late nineteenth century, which therefore provide a useful starting-point. However, uncultivated areas of waste and mountain were not mapped on the 25-inch scale, only at 6-inch, and consequently many upland mining sites, for example, have to be surveyed to provide a detailed site plan. Modern large-scale maps can be used as a basis for placing unrecorded features in context, although a copyright fee must be paid if the drawing is published (there is a good account of the use of OS maps in Anthony Brown 1987: 49). The National Grid Reference enables a site to be accurately located and the bench marks provide a means of tying in heights to a national reference point.

To produce a site plan for a more or less level site of limited area, say up to 150 metres [180 yards] in maximum dimension, with no or few upstanding structures, an adequate survey may be made by

means of setting up a base line or a grid of lines, visually or by means of a theodolite. The origin of the base line or grid should be at a known position in relation to the OS map if possible. The distances of features from the base line(s) are then recorded by means of measuring offsets or by triangulation from points along the base line(s) (Figure 33). These techniques are described by Brown (1987: 49–54).

For larger, more or less level areas, an adequate plan can be produced by means of a series of base lines as a traverse or grid or by the use of the plane table, or by a combination of both systems (Figure 34). This method is also suitable where there are upstanding buildings. Problems of visibility of points required to be mapped may be overcome by measuring distances by radiation, using tacheometry with a microptic alidade or with a theodolite (see Bettess 1984: 69–77).

Clearly, where the ground is not level there are restrictions on visibility with the above methods, although a telescopic measuring rod is useful for extending the range for plane tabling. With hilly ground it is necessary to use a larger number of base lines from which offsets or sightings are taken. In addition a site profile along the base lines must be made or a full contour survey carried out by means of levelling and if possible linked to a bench mark (Figure 35). Levelling may be done using a Sopwith staff and a level (a technique dealt with by Bettess [1984: 40–53]) or by the use of the theodolite (see Leach 1988: 31–5). Site profiles are important in water-power sites and mining landscapes, particularly ore-dressing floors which rely heavily on gravitation for their flow systems (Figure 36).

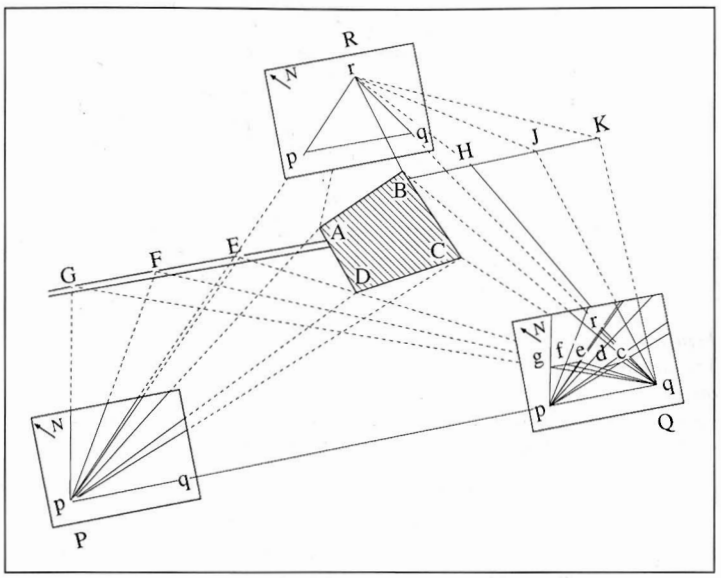

Figure 34 Diagram to show site survey using the plane table.
The irregular watermill building *ABCD* is supplied with water by a pipe, supported on uprights at *HJK*, and water discharges through a tailrace *EFG*. It is required to map the building outline and the features *E–K*. Two points *P* and *Q* are selected west and east of the building from which most of the points to be mapped can be seen. The plane table is set up and levelled at point *P* and by means of an alidade, from a point *p* on the drawing sheet a line is drawn aligned with *PQ* and the point *q* is marked at a suitable scale. Without moving the table, rays are drawn on the drawing sheet to intersect points *GFE*, *A*, *D* and *C*. The plane table is then moved to point *Q*, levelled and the ray *qp* aligned with *QP* with point *q* over the *Q* marker. The table is then kept fixed and the alidade used to draw rays to the visible points *BCD* and *E–K*; some of the rays will intersect and these points represent points *C–G*. In order to map the remaining points by means of intersections a third station *R* is selected north of the building from which the rest of the points may be seen. The distance *QR* is measured and scaled off along the ray *qr*. The plane table is then moved to point *R*, levelled and the ray *rq* lined up with *RQ* and a check sight made upon point *P*. Rays are then drawn to produce the intersections *AB* and *H–K*. If a point is visible from only one station, the alidade may be aligned and the distance measured by tacheometry.

These relatively simple procedures have in many cases, where financial resources permit, been superseded by the use of the total station EDM and theodolite which will furnish information in three dimensions. This instrument requires careful setting up at each station, preferably one from which a lot of readings can be taken. The EDM produces indirect linear measurements of great accuracy and has a range of over 1 kilometre [0.6 mile] (see Leach 1988: 36–41). The data

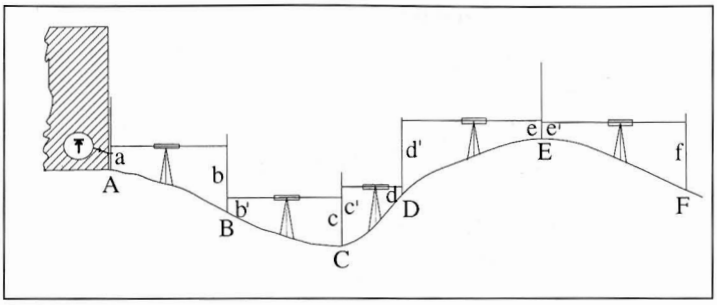

Figure 35 Diagram showing the use of a simple level.
The difference in heights between the ground levels at points *A* and *B* can be obtained by measuring the heights *a* and *b* by means of a level placed at a station between them and taking a foresight and a backsight to a levelling staff. The building has an Ordnance Survey Bench Mark (OBM) upon it, a distance x above the ground level at *A*, so the actual ground level with respect to Ordnance Datum of *A* can be calculated at *OBM* minus *x*. In this example, the difference in level between the two points *A* and *F* cannot be found from one station and so it is necessary to repeat the process between points *BC*, *CD*, *DE* and *EF*, taking backsights and foresights between each point and calculating the reduced levels at points *B–E* so that the height of point *F*, relative to point *A*, and the Ordnance Datum can be calculated.

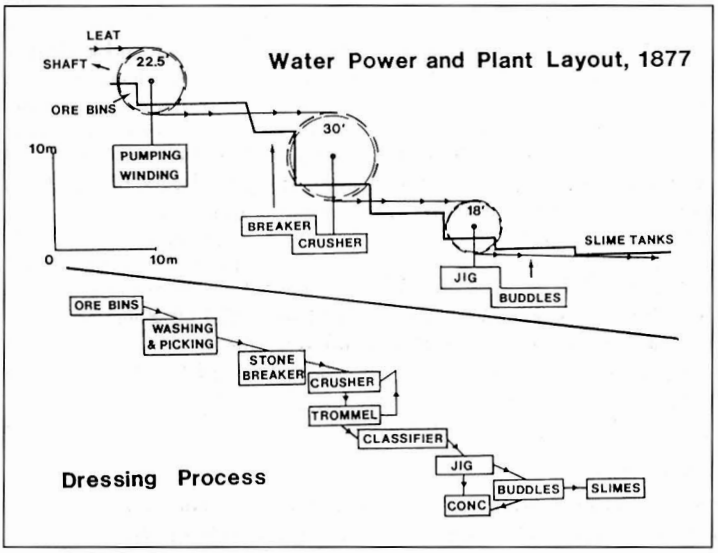

Figure 36 A schematic diagram of the lead-dressing floor at Ystrad Einion mine in Dyfed, Wales. The water supplied by leat was utilised by three separate wheels, while the lead ore was successively reduced in size. The slope of the land was essential for the gravitational reduction and concentration process.

is down-loaded into a data logger and then plotted through an office computer system.

Building recording methods

The recording of buildings, through the production of drawn plans, elevations and sections, will sometimes form part of a site survey or more commonly be carried out where outline site plans are already available. The techniques of producing measured drawings of industrial buildings using readily obtainable equipment have been fully described by Major (1975). A complete photographic record is also essential for elevations and details of a building or structure (Terry Buchanan 1983). In the case of large sites, oblique aerial photographs which record both block plan and elevation are useful for assessing and planning the recording strategy. In cases of immediate threat or limited manpower, only a photographic record may be possible, although, in suitable cases, elevations can be produced by means of rectified photography. As with site survey, several methods of measurement are possible, including the total station electronic system. If several groups are working on one building it is advisable for one person from each group to make a full reconnaissance of it, as with site survey, so that collectively various points of reference and scales can be agreed. The ground-floor plan of a building, although often indicated on a large-scale map, requires the addition of detail such as door apertures and window frames. In all cases a preliminary sketch of the floor plan should be made to which measured dimensions are subsequently added. Since it cannot be assumed that the walls of a building are regular,

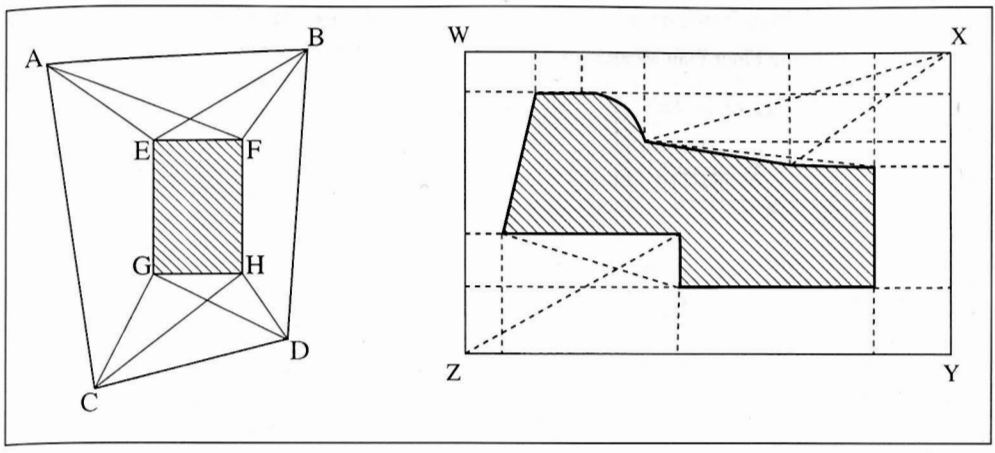

Figure 37 Methods of determining ground plans of buildings.

LH. A plan of the regular-shaped building *EFGH* within the plot *ABCD* can be prepared by means of triangulation from the corners of the plot *A–D*, and using measured distances *EF*, *FH*, *HG* and *GE* as cross-checks.

RH. If the building to be measured is of an irregular shape, a rectangle *WXYZ* (marked by a measuring tape or string) can be set up around it. The positions of corners of the building and other features can be ascertained by measuring the offset from the side of the rectangle to those points at a known distance along the side of the rectangle. Linear measurements of the straight walls will serve as a cross-check whilst re-entrant angles can be positioned by means of triangulation from the corners of the rectangle *WXYZ*.

the exterior plan is obtained by placing a grid around the building, set visually for small buildings and by optical square or theodolite for larger ones. Measurements are taken from the grid to the walls as offsets or by triangulation (Figure 37). It is usual to show the windows and door apertures on the plan and these verticals should be taken by running measurements along the walls to minimise error. The respective wall thicknesses should be measured at each aperture. Diagonal measurements should be taken within the building as cross-checks and shown on the field sketch in coloured pencil to avoid confusion. The internal walls and any floor-level features are then measured, again using running measurements where possible. For multi-storey buildings, changes in wall thickness in the height of the walls should be measured and separate floor plans made at the same scale for each floor level showing the window and aperture positions.

Preliminary sketches must also be made for each elevation of the building and of any sections which are required, e.g. doors or window-sill and lintel details. As on the ground plan, running dimensions must be taken of the window and door-frame apertures and checks made of the alignment of upper-storey windows in relation to the ground floor (see Hutton 1986: 6–7). Before commencing height measurements, a datum line should be established on the exterior of the building so that account may be taken of changes in ground level. The same datum line should where possible be used for the interior elevations or the distance between the two lines accurately known. Heights are measured either above or below the datum. Measurement of upper-storey apertures may well be possible only from the interior of the building but their vertical positions must still be related to the datum line. Whilst a 5-metre telescopic rod is useful for some height measurements, on tall structures some ingenuity must be employed: for example, where the construction is of uniform-sized ashlar stone or brick, the number of courses can be

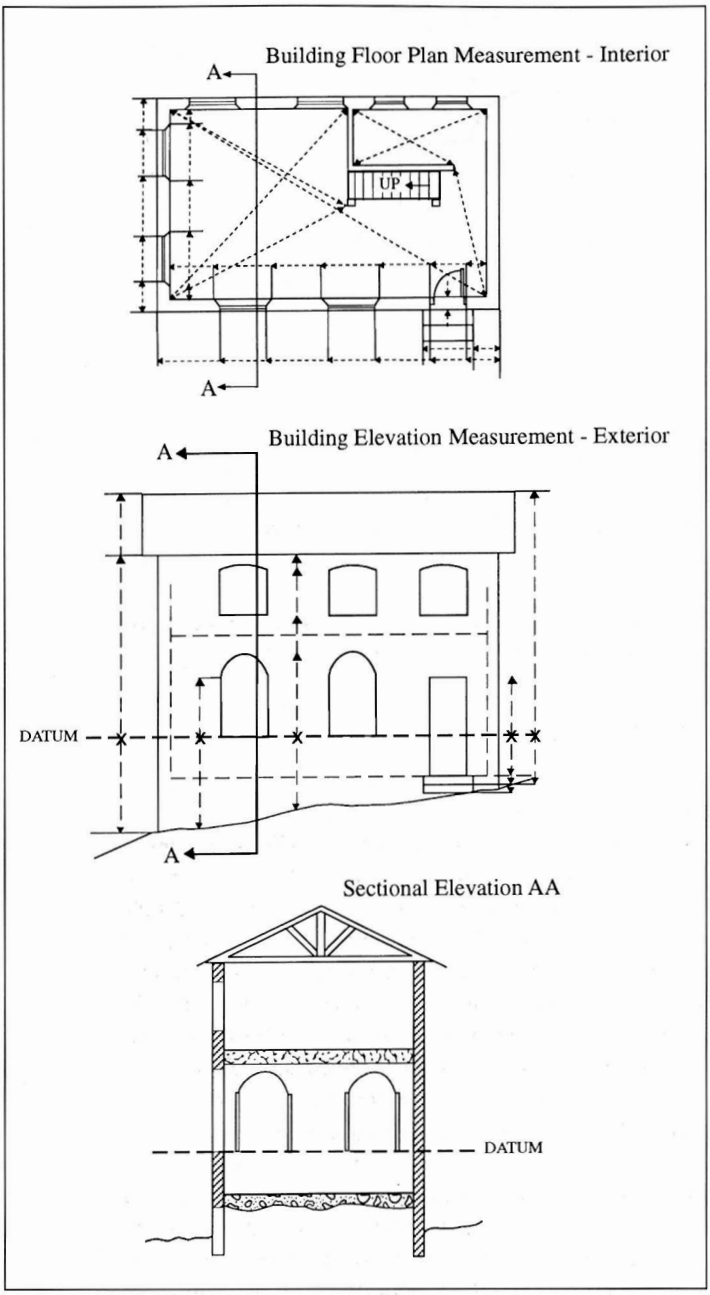

Figure 38 Methods of determining interiors and elevations of buildings.

Top: a preliminary sketch is made of the floor plan of a building, noting the features to be shown on the plan. Linear measurements are taken along the walls, noting the positions of door and window apertures, etc. Running measurements are taken from each corner, to minimise possible error. Check diagonal measurements are taken between corners and to position other features to be shown. The wall thicknesses should be measured at door or window apertures to enable the interior and exterior plans to be linked together.

Centre: in order to take account of undulating ground surfaces it is necessary to mark out a horizontal datum line around the building: the window-sills may be suitable. If more than one datum is necessary to enable the measurements to be made, it is vital to note the differences in height between them. Once again a detailed sketch should be made showing all the details to be measured. Heights of features on the building are then measured either above or below datum. Horizontal distances and heights of features such as door and window apertures should be made with running measurements to minimise errors. Horizontal distances along the exterior of upper-floor features such as windows may be measured by means of plumb lines hung from them.

This process has to be repeated for all the building elevations. Detailed drawings of window-frames, doors, etc. should be made separately and usually drawn at a larger scale.

Bottom: a sectional elevation at a desired vertical transverse plane within the building is often essential to show its construction. This section is through AA of the building shown in the previous example.

counted and the height estimated by calculation. In other cases a theodolite must be used and the height established by calculation (Figure 38).

When preparing the final drawings a suitable scale must be chosen by reference to the largest length dimension. There are accepted conventions for the layout of the respective plans and sections and also for the depiction of details and building materials; these are summarised in the RCHME building recording specification (RCHME 1996).

Another tool available to the industrial archaeologist for the preparation of building elevations is photogrammetry or measurement by photography. There are several methods of an increasing sophistication, the simplest of which is rectified photography. This can produce elevations of reasonable accuracy providing there are no substantial recesses in the building elevation and its height is not excessive. Essentially a photograph of an elevation is taken with the camera film plane vertical and parallel to a wall, or in the case of a long building, a series of photographs is taken from positions along a previously laid-out base line parallel to the wall. Both vertical and horizontal dimensions between features of the elevation must be taken so that a scale may be established. The negatives should be enlarged to a specified scale and for preference printed on transparent film. The series of prints may then be easily overlapped as a photo-montage and a tracing prepared of the whole elevation. Greater accuracy can be achieved by the use of a monorail camera with rising front and side movements to the lens or of a 35mm SLR camera with shift lens and grid focusing, particularly in the case of taller buildings. Rectified photography is well described by Dallas (1980b). A more complex but accurate process for producing elevations using stereo photography is stereo-photogrammetry wherein pairs of photographs taken with a metric camera of the required elevation are scanned in a stereo plotter and the scale drawing produced on a plotting table (see Dallas 1980a). More recently computer-aided mono-photogrammetry has been introduced. This process obtains data from a single photographic image, using computer-aided design (CAD) facilities to produce the final drawing; it is described briefly by Swallow *et al.* (1993). In recent years techniques have also been perfected for the recording of building elevations electronically by means of the total station EDM.

Recording machinery and processes

The industrial archaeologist is sometimes required to record machinery which may be either part of a building or free-standing. In general, the problems of congestion and complication of components of machinery such as a steam engine, for example, mean that only a limited number of elevations may be possible. If actual physical access to the machine can be obtained then the layout and physical dimensions can be measured. When carrying out measurements, the details which it is desired to show on a sectional elevation must be borne in mind when selecting the plane of section, since many components will be concealed. A series of reference surfaces on the machine must be selected from which dimensions are measured. Many of the details will have to be recorded as annotations to sketches (e.g. numbers and profiles of gear teeth, wall brackets, column profiles) and separate drawings prepared of detail components (Figure 39). Where possible, photographs should be taken of the same plans and elevations for cross-reference. Care must be taken to relate items of machinery and shafting dimensionally to the building structure.

Given that recording machinery is a highly specialised activity for which a training in technical drawing is desirable to produce effective results, a specialist draughtsperson may well have to be employed. Documentary research into machine manufacturers' archives, such as the Boulton and Watt collection in Birmingham Reference Library, may well be productive, offering original or similar drawings of machines and their components. In many cases, however, the position of machinery relative to a building or structure is more important than the details of the machines themselves, and recording this is well within the capacity of most fieldworkers.

This section has been dealing with recording the remains of past industry. But, as Hayman (1997) has said: 'Opportunities to make first-hand records of industry should be grasped wholeheartedly by archaeologists.' It is impossible for field recorders to have a work-ing knowledge of the whole range of industrial processes, but the creation of a film archive of working industry is a

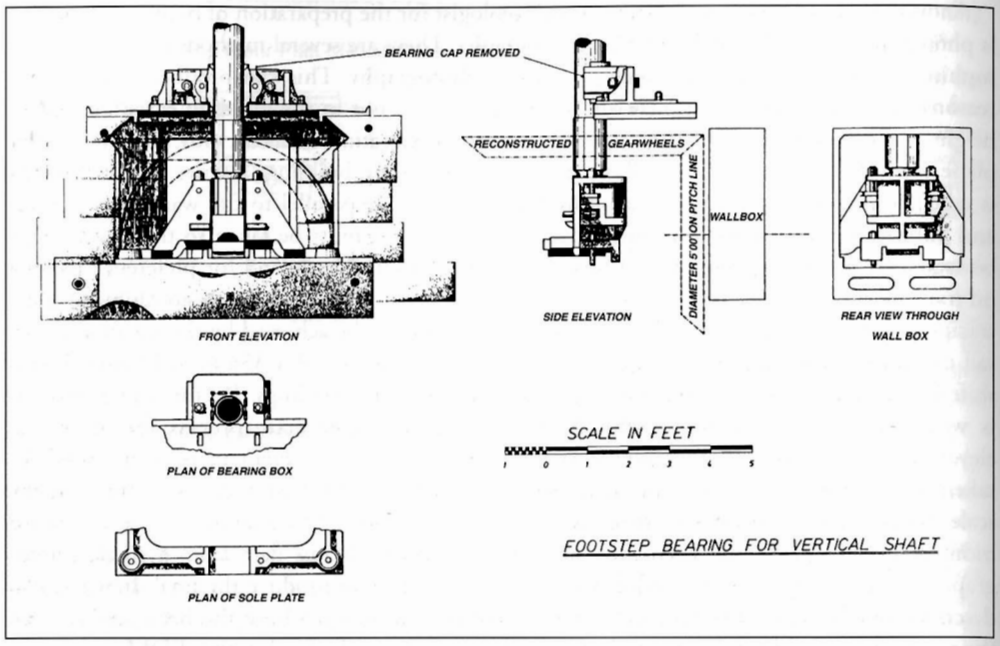

Figure 39 Elevations and drawings of details of the footstep bearing for the vertical power transmission shaft in Albion Mill, Manchester.

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valuable tool for the future. We already have a valuable resource in the films made, for example, of working canals and railways, textile processes, glass manufacture, etc. (Grant and Ballantyne 1985). This work has been continued through the use of video by, for example, IA Recordings, a group who have concentrated on filming the last days of certain industries, particularly coal-mining. The sudden demise of the latter also prompted the various Royal Commissions on Historical Monuments, Cadw and English Heritage to make visual records, not only of buildings, but also of both surface and underground activity (Thornes 1994; Hughes *et al.* n.d.; Gould and Ayris 1995; Malaws 1997). Much of their work was done as part of emergency recording, but these agencies, as well as others, need to be proactive as well as reactive. The problems in recording working processes should not be under-estimated: they can include the dangers of moving machinery, contamination, difficulties of access and the attitudes of a demoralised workforce about to face redundancy. All these problems were encountered by the Scottish Royal Commission on Historical Monuments in their work on the Ardeer explosives works in Ayrshire (Dolan and Oglethorpe 1996). Records of process can therefore be difficult and time-consuming to make, as well as demanding specialist equipment, but they create an archive of past and present industrial activity which is second to none.

The written report

Every site, building or machine survey should be accompanied by a comprehensive descriptive written report supported by a systematic photographic record (Terry Buchanan 1983). Site reports need to include details of location, and ownership where known, as well as information about soil type, geology and general topography. In the case of a building, the number of bays

and storeys should be noted, together with details of the fabric. Changes in building materials, in particular, may help with the phasing of the structure.

It is often useful to treat an elevation of a building in the same way as a section of an archaeological excavation, assigning context numbers to different features. The problem is, what actually is a 'context' on a standing structure? In excavation, 'contexts' are discrete units related stratigraphically to each other and ultimately to unconsolidated natural strata. Generally, below = earlier and above = later. On standing buildings, this does not apply: because one is dealing with a rigid structure, alterations can be made to one area without affecting the rest. Harris's Laws of Original Horizontality and Original Continuity are inapplicable to standing structures. Nevertheless, the technique is a useful one in trying to be as objective as possible in the analysis of a building but a new definition has to be found for a 'context' or 'stratigraphic unit'. Wrathmell (1990: 38) argues that a context is a unit of observation whose identity and significance are widely agreed upon, and therefore a context is defined by the research agenda decided on for recording any particular structure. Only rarely is a stone-by-stone record needed for large industrial structures as it would be for medieval buildings: more often, the 'units of significance' are identifiable objects like windows, numbers of bays, addition of staircase towers on mills, roof-lines, etc. Returning to the discussion at the beginning of this chapter, these units represent deliberate human decisions to alter a building, and therefore assist not only the description of the building but its interpretation in a social as well as structural sense. Separate sequences of numbers can be allocated to each elevation or, in a complex building, to each individual phase of construction. It is then possible to summarise the different features in a schedule of context numbers, each of which is related to the appropriate survey drawing. The use of context numbers in some form does ensure that all features are given equal weight in the description, not just the outstanding features, thereby permitting an archaeological rather than a purely architectural interpretation.

Excavation

Excavation, unlike the other methods of field recording discussed above, is a destructive act which cannot be repeated: the deposits removed cannot be replaced and the information they might yield can be permanently lost. For pre-industrial-period sites, excavation may be the only method of obtaining information about the function and date of a particular site. But in the industrial period, field survey allied with other forms of evidence such as maps and documents may yield the same information without destroying the stratigraphy. For example, by using a combination of survey and documentary research the authors were able to show that a tin dressing floor at Carnkie in Cornwall had gone through three reconstructions in three decades (Palmer and Neaverson 1987). This is further discussed in Chapter Six.

Excavation is therefore a last resort. If it is undertaken, it must be as part of a defined research agenda. For industrial-period sites, excavation has normally been carried out for one of three reasons: rescue, site display or research. Rescue digs have multiplied in the last decade because of the environmental concern with contaminated and derelict land. The funding which has been made available for this purpose has often included an element for archaeological evaluation, but the conditions under which such evaluation has been carried out have often been far from ideal, the archaeologist barely keeping up with the earth-moving equipment. The information retrieved has often therefore been very fragmentary and has not formed part of a total site record. This kind of rescue excavation has been largely confined to mining sites, which have themselves created the contamination, and considerable information has been recovered concerning mining methods and ore-dressing techniques. Similar rescue digs have taken place in areas of early shaft

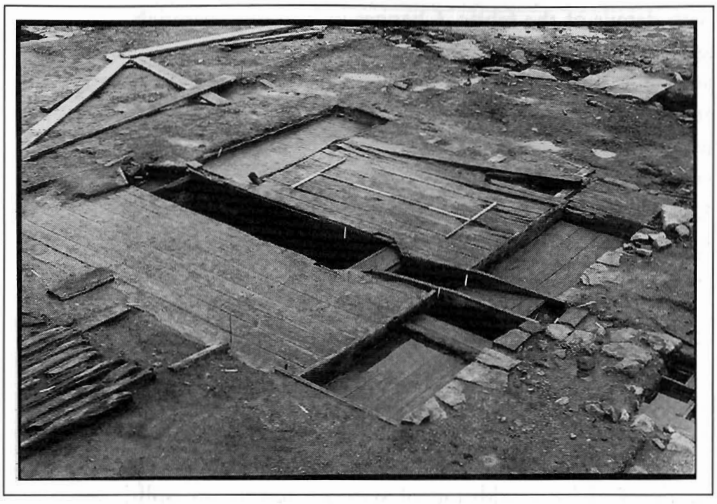

Plate 37 Part of the final phase of the lead-dressing floors at Killhope in County Durham, showing a rectangular buddle of wood and stone construction for separating the ore from the gangue material. This structure has been conserved for display purposes but may well conceal an earlier phase.

By permission of P. Craxford.

mining in conjunction with modern open-cast coal-mining. Careful observation of features in exposed faces has led to limited excavation of old shafts and underground mining features. In Leicestershire, for example, excavations of this kind have exposed timber-lined shafts and systematic pillar and stall working which have been dated by dendrochronology to the fifteenth century (York and Warburton 1991).

It has rarely proved possible for sites revealed by rescue excavation to be conserved *in situ*, but funding has occasionally been made available by local authorities and museums to undertake excavation for the purpose of display. The problem with this kind of excavation is its limited extent, since features which are to be permanently conserved may overlie evidence for earlier periods of working. This was the case with the Killhope lead ore-dressing mill in Weardale, where the final phase of the washing floor was conserved for display purposes (Plate 37), greatly limiting the opportunity to excavate below this level (Cranstone 1989: 44). Only in research excavations can the upper layers be removed to examine the earliest phases, and these have been rare for the industrial period. They have, however, proved invaluable in providing information about processes such as lime-burning and ore-dressing for which little documentary evidence exists.

Few industrial sites are devoid of upstanding structures, and there is always a temptation to carry out the clearance of these without attention to detailed stratigraphy. In some cases, clearance is justified; for example, where the infill is clearly the result of deliberate demolition or tipping – the sort of treatment being received on modern collieries following closure. Thus a test trench may reveal the junction between deliberate infill and stratified deposits. On many industrial sites, there has not always been time for layers to accumulate, and so the careful recording generally carried out on archaeological sites is not always appropriate. Clearance can also be undertaken for specific purposes, as, for example, to reveal the foundations of machinery known to have been present from documentary evidence. At Higher Woodhill Mill, a demolished cotton-spinning factory near Bury in Lancashire, documentary evidence indicated that the original water-power system was supplemented by steam in the 1850s and limited excavation has indicated that this was a house-built engine (Fletcher 1994). In rare cases, the machine itself may survive elsewhere and the excavation is undertaken to examine its previous context. A good example is the 1779 Boulton and Watt beam engine now in the Birmingham Museum of Science and Industry: only in 1982 did the pump-house site at Smethwick, from which the engine was removed in 1897, become available for excavation, the purpose of which was to determine the original layout of the engine and any subsequent modifications (Andrew 1985).

In research excavations, the relationship of one context to another is as important for the industrial period as for earlier periods of archaeology, even though the length of time over which

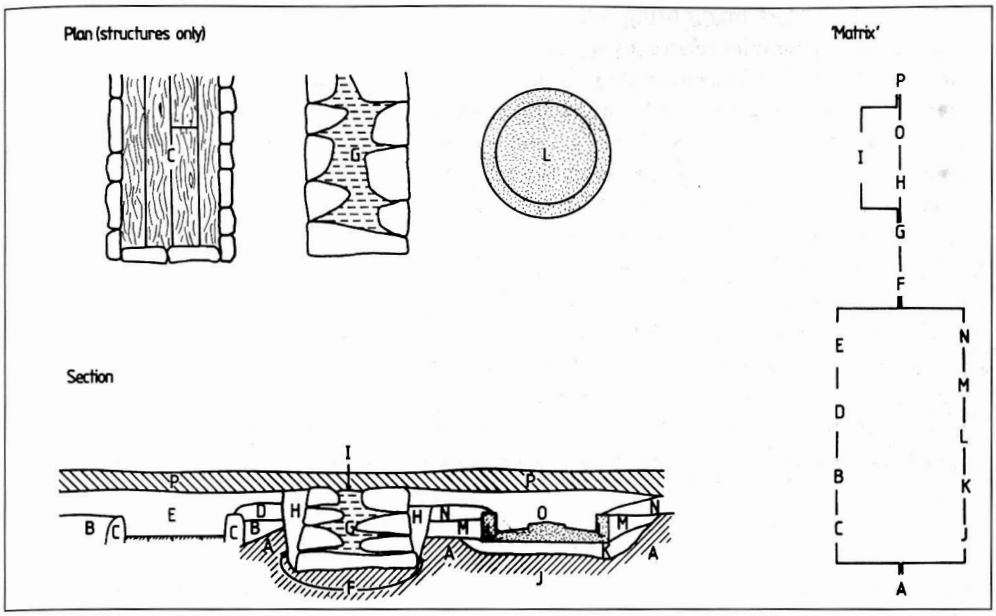

Figure 40 Plan, section and matrix of part of a hypothetical mine washing floor: see text for detailed description.

By permission of David Cranstone and Matthew Watson.

the layers were deposited may be very short indeed. Figure 40 shows the plan, section and matrix of part of a hypothetical mine washing floor. The plan shows the stone and timber structures only, as they would be revealed by clearance of soil layers without stratigraphic recording. The impression derived from the plan alone is that the three structures were contemporary. The section, however, indicates that the central wall *G* was built later, at a time when the jigger *C* was disused and infilled, since the infill *H* of its construction trench cuts the infill E of the jigger. The buddle *L* remained open (and perhaps in use) after the construction of the wall *G*, since its infill *O* overlies the top of the construction trench and abuts the face of the wall. The stratigraphic matrix defines the relationship of these structures (after Cranstone 1992). Normally, the excavated sections are first described as objectively as possible without reference to any other evidence, so that the description is separate from any interpretation of the sections.

The stratification of process residues is also important on industrial sites. For example, on the complex site at Aberdulais in West Glamorgan, the existence of mill scale overlying a cobbled floor in part of the working area indicated that the latter was associated with the iron-working rather than the tinplate period of the site (Hayman 1986). The presence of slag and charcoal fragments may be the only evidence for a vanished bloomery or bole hill site. Different grades of residue may also indicate the function of the structures in which they are contained. This is particularly the case on ore-dressing floors where a gradual comminution of particle size took place through a variety of equipment, the ephemeral nature of which makes their remains otherwise difficult to identify (Palmer and Neaverson, 1989).

The post-excavation treatment of finds from industrial sites has been sadly neglected. This is partly because there are no reference collections of ceramics, glassware, etc. for this period against which finds can be matched, with the honourable exceptions of the clay pipe data collated by David Higgins at Liverpool University (1989), that on Scottish brickmarks (Douglas *et al.* 1985)

and the data on cutlers' marks being collated at Sheffield University. Valuable information can be derived from slag samples related to specific contexts. The metallurgical report on finds at the Moira blast furnace in Leicestershire indicated that the raw materials had a very high sulphur content which was counteracted by an unusually heavy addition of limestone flux. The furnace was abandoned with its charge intact, showing that the final blowing-out was abrupt and unplanned. The presence of quantities of melted brick in the charge suggested that the furnace chimney had collapsed due to overheating in a final disastrous campaign (Cranstone 1985). This archaeological evidence filled a void in the documentary record, which nowhere accounted for the demise of this short-lived operation. None the less, the analysis of residues is not always conclusive, as has been shown at Bersham in Clwyd. Here, analysis of the residues in a structure identified as a lime-kiln indicated far higher temperatures than those expected for lime-burning, and the structure may well have been used for smelting iron ore (Grenter 1992).

The industrial archaeologist is fortunate in often being able to relate the phases derived from excavation to documentary evidence which allows for absolute rather than relative dates to be assigned. At Aberdulais, for example, the excavation indicated six phases in the working area which were refined from the documentary evidence into eight phases ranging from the earliest copper-smelting period through corn milling, iron-working and tinplate manufacture to abandonment *circa* 1890 (Hayman 1986). At the Clydach ironworks in the Brecon Beacons National Park, the combination of findings from excavation and documentary sources has enabled a chronology of furnace construction to be established (Wilson 1988). It is important, however, that consideration of the archaeological evidence should take precedence in phasing a site, since all changes may not have been recorded in the documentary sources.

Dating

It is, therefore, sometimes possible to obtain absolute dates for the various features on a site. However, documentary evidence must be treated with caution: on mining sites, for example, where the mine manager's report is often the only available source, the changes he might propose in writing were not always carried out and so need to be verified in the field. Relative dating can be achieved on industrial sites by assigning context numbers to the different features. These can then be organised in a stratigraphic matrix similar to that discussed above for excavated structures, which clarifies their relationship to each other in both space and time. This is a complex operation, but can be useful for multi-phase sites for which little documentary evidence is available. It has been used, for example, to phase the numerous limestone quarries and access routes at Benthall Edge in the Ironbridge Gorge (Alfrey and Clark 1993: 5, 38–9). Construction of stratigraphic matrices for such extensive areas is, however, a lengthy procedure and generally a series of sketch plans showing the different phases of working are more effective.

The construction of a stratigraphic matrix for a standing building is an equally complex operation and depends, as discussed earlier, on what stratigraphic units have been decided on in a particular recording exercise. Understanding their relationship to one another depends on an awareness of how buildings are put together and on what changes the human beings responsible for the building are likely to have made. These are usually physically revealed by anomalies in the structure such as changes in the roof-line, changes in building materials, blocked-in or inserted windows and doors and straight or bonded joints indicating extensions or alterations. The context numbers assigned to each feature can then be organised in the form of a stratigraphic matrix to determine the relative sequence of construction. Figure 41 illustrates this process for the east elevation of a textile mill. The written description assigns context numbers to the elevation from south to north, and notes anomalies such as straight joints

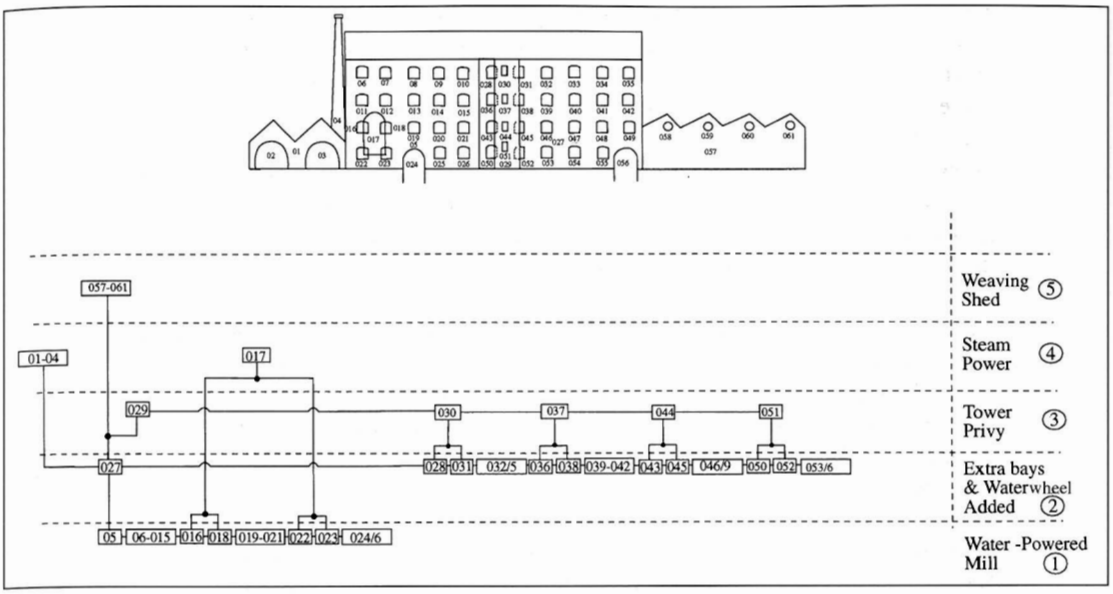

Figure 41 The use of context numbers and a stratigraphic matrix to determine the phases of one elevation of a textile mill (east wall). *PHASE 1* WATER-POWERED MILL, *PHASE 2* ADDITIONAL WATER-POWERED MILL ADJOINING, *PHASE 3* PRIVY TOWER ADDED, *PHASE 4* STEAM ENGINE AND BOILER HOUSE ADDED, *PHASE 5* WEAVING SHED ADDED.

CONTEXT NO.	*PHASE*	*DESCRIPTION*
001	4	BOILER HOUSE EAST WALL
002	4	BOILER HOUSE DOOR
003	4	DITTO
004	4	CHIMNEY STACK
005	1	1ST MILL EAST WALL
006–016	1	WINDOWS
017	4	ENGINE-HOUSE WINDOW
018–023	1	WINDOWS
024	1	WATERWHEEL APERTURE
025–026	1	WINDOWS
027	2	2ND MILL EAST WALL
028	2	WINDOW
029	3	PRIVY TOWER EAST WALL
030	3	PRIVY WINDOW
031–036	2	WINDOWS
037	3	PRIVY WINDOW
038–043	2	WINDOWS
044	3	PRIVY WINDOW
045–050	2	WINDOWS
051	3	PRIVY WINDOW
052–055	2	WINDOWS
056	2	WATERWHEEL APERTURE
057	5	WEAVING SHED EAST WALL
058–061	5	VENTILATION GRILLES

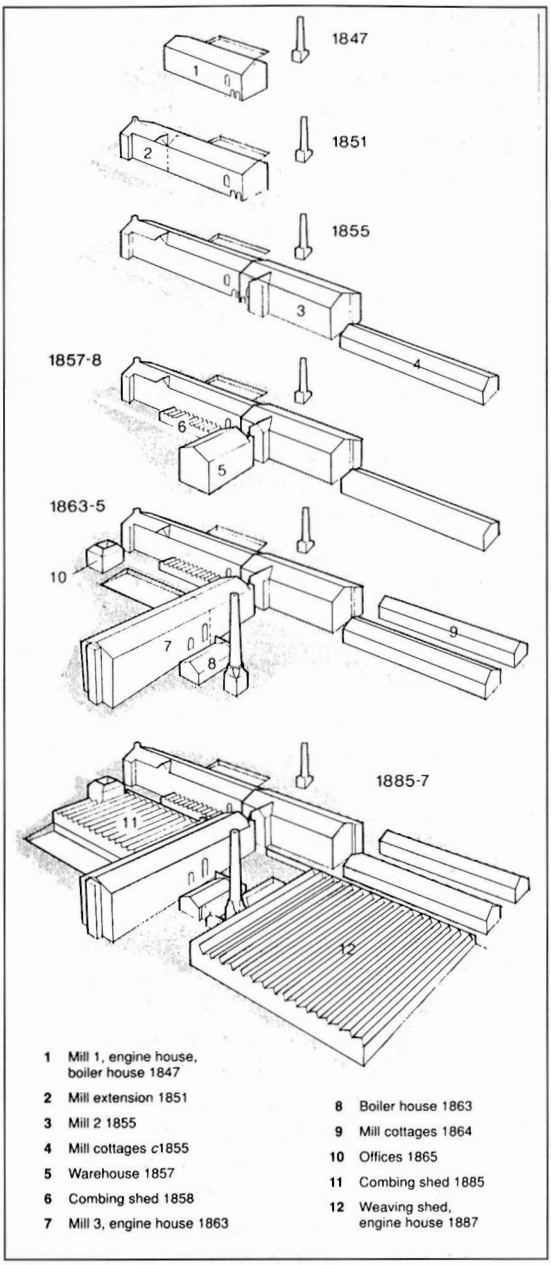

Figure 42 Diagram showing the phased development over forty years of Oats Royds Mill, Midgeley, West Yorkshire. RCHME, © Crown Copyright.

between various sections, the addition of a boiler house and chimney and changes in window patterns. The numbers can then be organised as a matrix, which suggests at least five phases of development. The building began as a small water-powered spinning mill which was expanded with the addition of a second mill adjoining, to which a privy tower was added. Water power was then replaced or supplemented by steam power for spinning and finally a single-storey weaving shed was added. The use of a matrix ensures that every observed feature is given equal weight in the interpretation. It might then be possible to confirm these relative phases and assign them absolute dates from map evidence or other documentary sources. The initial phasing, however, as in an excavated section, is arrived at through observation and meticulous recording which must precede any attempt at interpretation, although inevitably prior knowledge of particular types of building affects the observations which are made. Despite the problems of utilising archaeological methods in building recording, it is worth doing because it charts the process of human intervention in building construction to a far greater extent than purely architectural description.

The information gathered for each elevation of a building complex can then be combined to enable three-dimensional reconstructions to be drawn showing the evolution of the complex. This is most efficiently achieved using a CAD system. The value of such phased reconstructions is demonstrated by the work of RCHME on textile mills, as in Figure 42. A refinement, namely the use of a CAD system linked to a database, makes it possible to superimpose a series of matrices, together with the description of each context, on to a three-dimensional reconstruction; this enables all the available information about the building to be interrogated simultaneously. The reconstruction, therefore, remains a tool to be manipulated rather than an image which controls perception. The technique is a complex one which demands considerable familiarity with computer operation and the CAD system (Boast and Chapman 1991; Dobson 1994).

The use of matrices assists in the phasing of individual buildings, but if an absolute date is not known from other sources, the relative position of a building in a sequence of similar types of structure can be achieved by means of typology. This concept has long played an important part in the relative dating of artefacts and is only now being supplanted by more scientific

methods. Any type of artefact, such as clay pipes, can be placed in a logical series according to a progression of changes in their shape or differences in their ornamentation. This can provide both a means of classification and a relative dating sequence. Accordingly it is also possible to utilise a typological sequence as a means of classifying examples of a particular type of structure, such as lime-kilns or pottery kilns. Once the general development of a type of structure is understood, the position of a specific example within that sequence can be determined. However, the evolution of most industrial structures took a relatively short period of time compared with the prehistoric artefacts to which the typological method was first applied. As a result, there can be no single chronological sequence for a type of industrial structure because the rate of adoption of new building methods or new technology varied from region to region according to economic circumstances. For example, technical literature reveals that the devices utilised for the gravitational separation of metallic ores from gangue minerals, known as buddles, evolved from the manually worked rectangular type to the water-powered circular type. The field evidence, however, shows that the buddle adopted depended partly on the mineral being treated, but even within the lead industry the Derbyshire miners were using the rectangular type at the same time as those in Cardiganshire had adopted the circular type (Palmer and Neaverson 1989). Typology can therefore be utilised to recognise sequences of structures, and so understand their development, but is not generally valid as a means of dating. Only on a single site or on related sites within a region, which possess a group of structures of the same type, can the method be used for dating with any degree of reliability.

Archaeological fieldwork, whether the recording of buildings or the survey and excavation of sites, demands considerable resources of both manpower and equipment. Since the site remains of the industrial period are more numerous than for earlier periods of archaeology, only selected sites can be accorded full treatment. Determining these priorities has been the stimulus for the various rapid recording methods developed over the last decade, from the RCHME surveys through the AIA IRIS project to the MPP. If we can establish what exists for a particular industry, and make some value judgements about the relative importance of the remains, then limited resources can be deployed to their best advantage.

The first stage, then, is to set the research agenda. This determines what data are necessary for recording particular sites and structures. The four levels of building recording devised by RCHME – which in this chapter have also been applied to sites – provide useful guidelines for the type of fieldwork appropriate to a particular site or structure once its position within the hierarchy has been determined. In many instances, of course, rescue surveys take priority and are generally recorded at Levels 1 and 2: very few sites and structures can be given Level 4 treatment. The recording process, followed by deposition in the public archive, is as important to industrial archaeology as excavation is to other periods of archaeology. Standing structures and site remains disappear all too quickly in a dynamic landscape, and preservation by record is frequently the only option.

The higher levels of recording require some analysis of the development of a building or site. This chapter has suggested that the system of context numbers normally utilised for determining the stratigraphy of an archaeological section can usefully be applied to buildings, once the definition of a stratigraphic unit for a particular recording exercise has been agreed upon. The technique ensures that all features of a building are given equal weight so that it is treated archaeologically rather than architecturally, and therefore the process of human intervention is established. The context numbers can be organised into a matrix to provide a framework for the relative dating of different phases of a building, while the concept of typology has a limited but still important role to play in the relative dating of many industrial structures.

Relative dating can often be transmuted into absolute dating by recourse to documents. But apart from the use of map evidence for the discovery of sites, buildings and sites should normally be considered carefully in the field before much work is undertaken on the documentary sources. This is to ensure that the building or site is recorded as found. Although any recorder will approach a site with prior ideas and theories, some degree of objectivity can be achieved by the use of pro-forma context sheets and other archaeological methods considered in this chapter. Too much prior information carries with it the danger of finding only what one is looking for, ignoring the anomalies which may not appear in the documentary evidence. The relationship between field and documentary evidence is crucial for the methodology of industrial archaeology, and will be further considered in the next chapter.

Chapter Five

Documentary research

The nature of documentary evidence

The essence of industrial archaeology is the interrelationship between the field evidence discussed in the previous chapter and the evidence from written sources. The student of the modern period is fortunate in the quantity of written material produced not just for governmental and ecclesiastical purposes, but also in connection with economic activities. Paper was more readily available than it had been in earlier periods and printing was more commonly practised. From the middle of the seventeenth century, Latin ceased to be the language used for official purposes and so working with documents for the modern period does not demand the same specialist skills of palaeography and translation required for students of the medieval period.

This is not to say that documentary research for the industrial period is totally straightforward. Literacy was largely confined to the upper and middle classes until the end of the nineteenth century, so that many of the sources concerning working-class life were written by those not directly involved in it. The surviving records often tell us what employers thought that their workforce experienced; the views of the latter are rarely heard. Government reports about working conditions were often commissioned in response to a particular problem, such as the poverty of the handloom weavers or the employment of women and children in mines, and are not therefore an unbiased account of practices in specific industries. Many accounts were written to reinforce what amounted to foregone conclusions by their authors, who had a particular philosophy to put across. Even technical literature can be misleading, since it tends to concentrate on the innovative and ignores the continuity of tried and tested methods or machines. Consequently, documents of the industrial period, including maps, must be treated with as much caution as those of any other period, establishing reliability, authenticity and intent before their evidence is accepted.

First, the status and capabilities of the author of a particular source must be examined to provide a guide as to the accuracy or otherwise of the evidence. William Cobbett, for example, gives a highly biased account of working-class life because of his political outlook when compared with more objective travellers such as Daniel Defoe or Arthur Young. The latter was the secretary to the newly formed Board of Agriculture, which commissioned a number of 'General Views' of the state of the countryside *circa* 1800. Its reporters understandably concentrated on the new and innovative, as did the industrial spies from Europe who came to discover the secrets of Britain's progress in industry and transport. These spies may not have penetrated everywhere but their reports give considerable technical detail on the sites that they did visit (Henderson 1954; J. R. Harris 1985). Taken in isolation, however, such reports give a misleading impression of the extent of technological innovation in late eighteenth-century Britain and ignore the continuity of established practices.

It is equally important to discover the identity and reliability of early map-makers and their purpose in compiling a particular map. In the second half of the eighteenth century, the Society of Arts awarded premiums for developments in cartography which encouraged the production of many county maps. A map of Leicestershire, for example, published in 1777, was compiled by John Prior and dedicated to the Earl of Huntingdon (Figure 43). Research has shown that Prior himself was a schoolmaster and clergyman with antiquarian interests, who employed a professional surveyor, Joseph Whyman, to make the map which bears his own name. Whyman had served an apprenticeship with P. P. Burdett, whose Derbyshire map had been the recipient of a society premium in 1767 (Welding 1984). Both these maps give considerable detail of the locations of coal-pits, limestone quarries, water- and windmills, etc. but cannot be relied upon for complete coverage. The same limitation applies to special classes of map, such as tithe, lease, enclosure and mining maps, which were compiled for particular purposes.

The historian or archaeologist also needs to understand the original intent of any piece of written evidence. For example, the regularly published reports of metalliferous mining companies were intended to impress and possibly to elicit further financial support from shareholders. They may well refer to new discoveries or to new installations of plant that more objective sources, such as financial records, together with the archaeological evidence, often show were never made. Equally, documents not obviously relevant to a site may well reveal incidental information of interest to the archaeologist. Nineteenth-century geological surveys may include descriptions of the plant used by extractive industries, while official reports on accidents in collieries and gunpowder mills often contain considerable detail of their working methods. The industrial archaeologist is therefore making use of a wide range of sources for purposes other than those for which they were originally intended and cannot expect consistency of information. The inclusion of an item within a document may be entirely coincidental to its original purpose and it must not therefore be assumed that all such items would be included in every document of the same type. For example, some fire insurance policies, such as those for early textile mills, provide considerable detail not only about the buildings but also about the working practices carried on within them, whereas others have only minimal value as a source.

Large collections of documents, like fire insurance policies and local authority building control plans, pose another problem to the researcher, that of locating those concerned with a specific name or site. Although registers may exist, they are often chronologically arranged and not indexed, therefore requiring considerable searching. There was also little consistency in the way in which buildings were referred to; some may have to be tracked down by means of the names of owners, tenants, architects or builders rather than by site name. A particular problem arises with collections of technical drawings, such as those made by the suppliers of steam engines to mills and mines. The same component drawing may have been utilised for several customers and annotated accordingly, making it difficult to relate to a particular site or name. Documentary research is analogous to archaeological excavation in the patience required to piece the evidence together.

Although the survival rate of written sources for the industrial period is clearly far better than that for earlier periods, it is by no means complete. There has been no consistent policy towards the preservation of company archives, which may often have been destroyed through mergers or relocation. The most likely category of documents to survive is those which were required for legal purposes following moves towards limited liability in the middle of the nineteenth century: once put aside, they were frequently overlooked and escaped destruction. Documents relating to the day-to-day operation of a manufacturing concern had a limited life and were often destroyed once their immediate commercial value had passed. These have potentially greater value for interpreting a particular site or structure than the company reports issued for public consumption

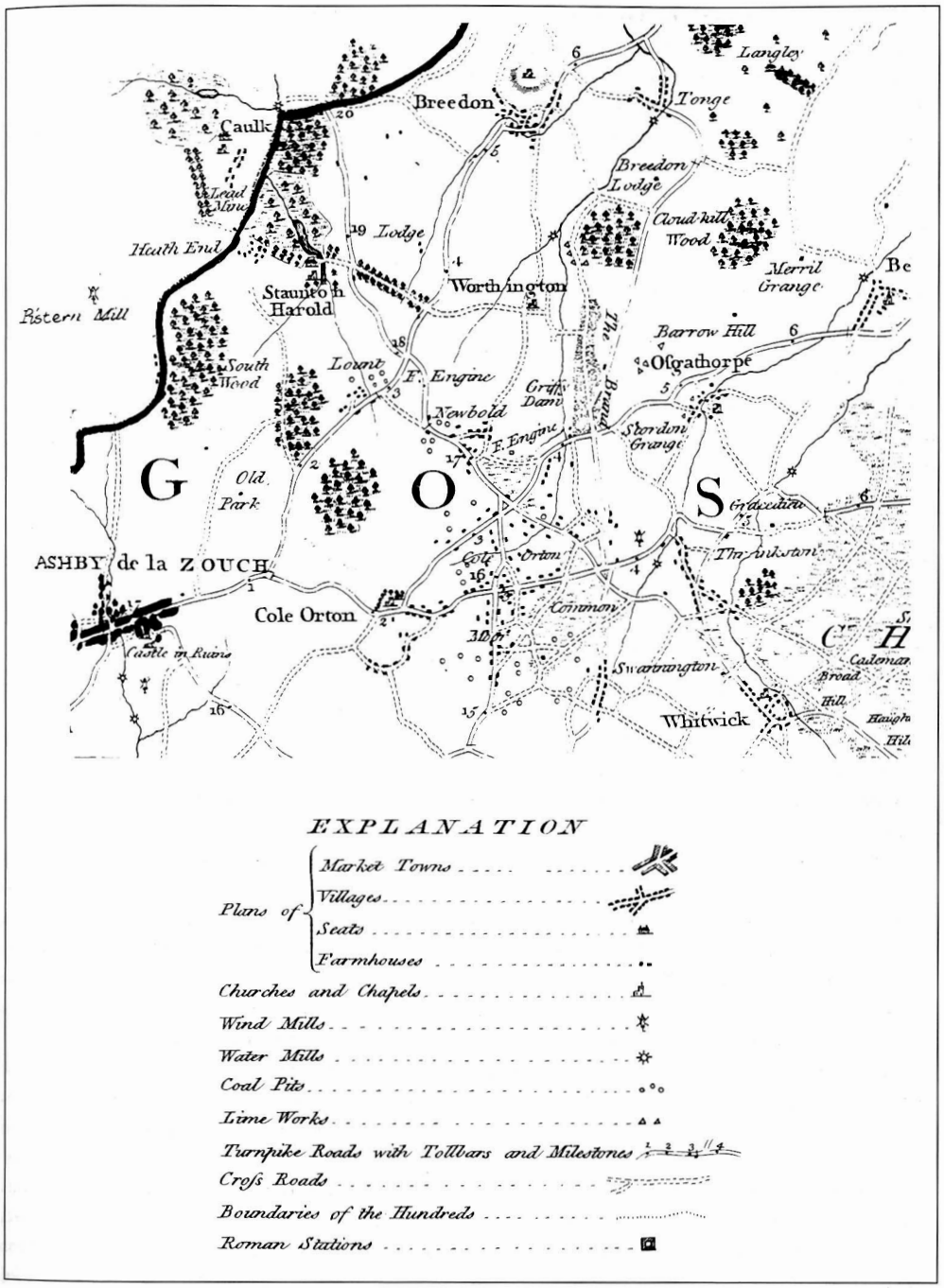

Figure 43 An example of one of the privately produced 1 inch to 1 mile maps of the late eighteenth century. John Prior's map of north-west Leicestershire, published in 1777, gives considerable detail of industrial activity in the area.

Leicestershire Record Office.

and therefore subject to bias. The records of undertakings which required official sanction, such as canals, railways and public utilities, had a better chance of survival since they had to be deposited with either Parliament or the local authority. The process of nationalisation in the mid-twentieth century brought together the records of many previously privately owned companies: the National Coal Board, for example, took over archives relating to small mining concerns which could date back several centuries. Industrial decline, combined with recent privatisation, threatens the survival of this class of document and once again only those records with legal significance are likely to be retained.

Locating written sources

The obvious starting-point for any documentary research is the local library. This may well have a local studies section containing some of the numerous pamphlets and books which are published locally and often difficult to track down. The material in the local studies collection may be indexed by personal or place names, although seldom under subject, which can make researching a specific industry rather difficult. The central reference library for a particular area usually has an extensive local studies section including a range of trade directories, illustrated town and county guides and other standard local publications. It may also contain a collection of local newspapers, occasionally going back to the eighteenth century and now often on microfiche.

Once the local printed material has been searched, the next port of call is the county or city record office. There are several publications listing these, giving their locations, opening hours and telephone numbers (Royal Commission on Historical Manuscripts 1992; Gibson and Peskett 1988). *A Guide to Archive Sources in the United Kingdom* (Foster and Sheppard 1995) is an invaluable directory of archive repositories and archive-holding bodies. Although its stated policy is to exclude businesses, in practice it contains much information on business records. Collections of documents may also exist elsewhere in a locality, such as the archives of landed families and those remaining in museums, private businesses, transport undertakings, etc. In the case of record offices, it is always wise to telephone in advance of a visit, since many have limited space and operate an appointment system, particularly for the use of maps and microfiche readers. Proof of identity is usually required before a reader's ticket is issued, although some offices operate jointly within the County Archive Research Network. Because county record offices have evolved independently of each other, there is no common indexing system to the material they contain. Most operate a card index of place and personal names, together with a limited subject index, which refer to more detailed schedules of individual collections of records. In some instances, however, collections may not have been calendared and are not yet on public access: details of these and new additions to the record offices can be found in their annual reports. Some papers may have been deposited with limited access and the permission of the donor has to be sought before research can take place. Most offices contain records of local government, parish affairs, municipal undertakings and population: some are also diocesan repositories and include tithe material, wills and inventories. Their collections of family and business papers vary enormously, some being of more than local significance. For example, West Glamorgan Record Office houses the extensive collection from the Neath Abbey Ironworks whose heavy engineering products had a world-wide market.

The most reliable means of locating these important collections of documents is through the National Register of Archives, which is housed in the London search room of the Royal Commission on Historical Manuscripts (RCHM). This was established in 1869 to identify documentary sources in private hands and to make these accessible through its *Reports and*

Calendars series. From 1945 onwards, the scope of the Commission was widened to include many important business and industrial collections as well as those in the newly established county record offices. The National Register of Archives includes name and place indices which can be invaluable for tracking down information in a wide variety of repositories. The *Reports and Calendars* series has been succeeded by *Guides to Sources for British History*, which is being extended to cover *Records of British Business and Industry, 1760–1914*: published volumes include those on textiles and leather, metal processing and engineering (Royal Commission on Historical Manuscripts 1990; 1994). RCHM also published until recently annual *Accessions to Repositories and Reports added to the National Register of Archives*, which have enabled the searcher to identify new material. A visit to the Commission's offices at Quality House, Quality Court, Chancery Lane, London WC2A 1HP can save hours of travelling time (James 1992). A similar facility exists for Scotland in West Register House, Edinburgh. Both England and Scotland also have Business Archives Councils, organisations which seek to encourage the preservation of business records. *Business Archives*, the journal of the English Business Archives Council, has published many relevant articles for those seeking to familiarise themselves with such records. The councils undertake surveys and produce thematic lists, such as those on brewing and shipbuilding published by the English Council. Their *Directory of Corporate Archives* describes the formal archive facilities provided by many of the corporate members of the council and its use can again save time. The University of Warwick houses the Modern Records Centre, which contains much of interest relating to trade union activities and social conditions within industry.

The Public Record Office (PRO) was founded in 1838 to conserve the archives of state departments and the central courts of law for both England and Wales. The increase in the number of government departments and the transfer of important collections of records such as those of the British Transport Commission resulted in overcrowding in the Chancery Lane premises and the construction of a purpose-built repository at Kew. The three-volume *Guide to the contents of the Public Record Office* was compiled before the move to Kew, but is still valuable for understanding the structure of the public records. The *Public Record Office Current Guide* is a regularly updated microfiche. There are also numerous finding aids published by the List and Index Society which was founded by the readers themselves. Similar national collections exist in the Scottish Record Office, founded in 1787 and based in Register House in Edinburgh, and the Public Record Office of Northern Ireland founded in 1923 in Belfast. For the industrial archaeologist, the Public Record Office at Kew is particularly useful for early transport records and, in some cases, records of nationalised industries.

The national libraries in London, Edinburgh and Aberystwyth all have departments of manuscripts as well as comprehensive book collections. The British Library is responsible for the national newspaper collection housed at Colindale which also contains runs of periodicals, including important sources for industrial history such as the *Mining Journal*, *The Engineer* and *The Illustrated London News* (Figure 44). The Official Publications Department of the British Library contains a comprehensive collection of Ordnance Survey (OS) maps, together with abandoned mine plans, etc. The national technical museums have specialist libraries and archive collections related to their subject: these include the National Railway Museum in York, the National Maritime Museum at Greenwich and the National Museum of Science and Industry in London. Many learned societies in both London and the provinces were founded in the nineteenth century and have collections of specialist material. The London-based societies include the Institutions of Civil, Mechanical and Electrical Engineers, the Royal Institute of British Architects and the Institution of Mining and Metallurgy, together with a whole range of specialist institutes established from the 1880s onwards. Many county towns had their own

learned societies which still maintain collections, a good example being the Royal Institution of Cornwall in Truro. The Guildhall Library in London holds the major collection of fire insurance registers, since these were generally City companies. Many provincial libraries also have major specialist holdings as a result of their location; for example, the Boulton and Watt collection in Birmingham Reference Library. Some university libraries also maintain an archive collection; for example, Nottingham, Birmingham and the John Rylands Library attached to Manchester University.

The three Royal Commissions on Historical Monuments have built up considerable photographic collections, including aerial surveys: the English Commission at Swindon, for example, curates the important Watkins Collection of photographs of stationary steam engines. Their archives also include plans, architectural drawings and reports on sites recorded: these should be checked before research or recording is commenced to avoid duplication of effort. English Heritage's ongoing Monuments Protection Programme is generating a considerable archive on industrial sites in England, full copies of which have been deposited with RCHME in Swindon, the Council for British Archaeology in York and the Association for Industrial Archaeology in the library of the Ironbridge Gorge Museum Trust. This material may eventually find its way into county Sites and Monuments Records, whose coverage of industrial sites varies considerably but which should be consulted.

The British Isles therefore have rich collections of documentary sources at both the national and local level, but discovering the location and content of a particular set of records requires both time and patience. The primary task of an archivist is the preservation of records, not making them available to the public, and there have been increasing restrictions on both the use and reproduction of documents in recent years. On the other hand, the finding aids have widened in their scope and more material, particularly OS maps, is available on microfiche with facilities for its reproduction. For all original research the recommended route is to begin with the local library and record office, followed by a visit to the National Register of Archives which will open doors to national avenues of research. It is, however, a time-consumingalthough rewarding process.

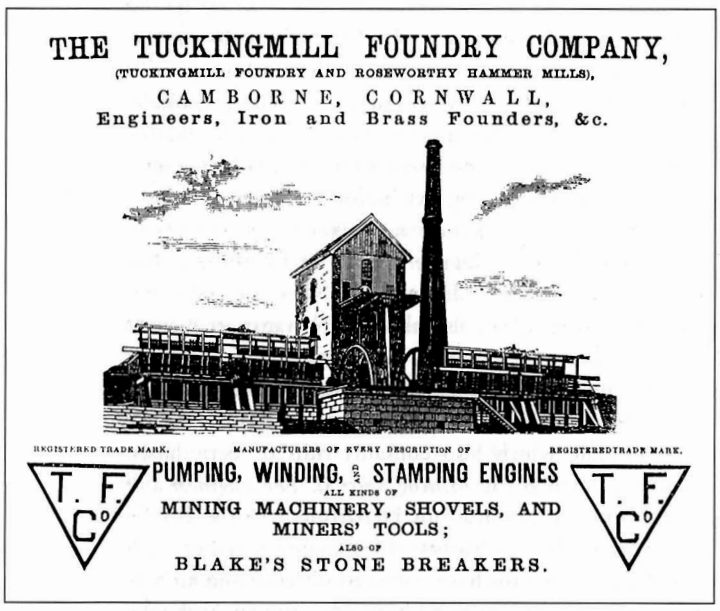

Figure 44 An advertisement for a Cornish foundry company, published in the *Mining Journal* in 1880. It gives considerable detail of a steam-driven stamps battery, probably that at West Basset New Stamps installed in 1875 by that company. (See Chapter 6.) On that site, only the engine house and the supports for the stamps axles survive, and consequently the illustration allows a fuller interpretation of the more ephemeral structures in wood and iron.

SECONDARY SOURCES

The starting-point for local research is still probably the relevant volumes of the *Victoria County History* series, which has not yet been completed for some counties of England and Wales. The introductory volumes

give general accounts of the development of industry and transport, together with invaluable tabulations of population statistics. Their footnotes provide an introduction to local documentary and newspaper sources. For many counties, a multi-volume history was compiled in the late eighteenth or early nineteenth centuries. The bias of these is understandably towards landed estates and ecclesiastical matters, but they often include transcriptions of original documents and detailed accounts of individual parishes. Nichols's four-volume *The History and Antiquities of the County of Leicester*, for example, published between 1795 and 1811, describes the industries being carried on in various villages, including framework-knitting and coal-mining, and cites population figures from the first census.

Industrial topics receive some treatment within modern county history series. Inspired by the work of W. G. Hoskins, the *Making of the English Landscape* series usually includes chapters on the industrial landscape and the pattern of communications, although the amount of space devoted to these topics depends on the interests of the author. The first volume was *Cornwall: an Illustrated Essay on the History of the Landscape* published in 1955 and later reissued in revised form with a picture of an engine house on the dust jacket (Balchin 1983). The *West Riding of Yorkshire* volume was written by Arthur Raistrick, who contributed so much to the early development of industrial archaeology (Raistrick 1970). The *Darwen County History* series, published by Phillimore, now covers most counties, but their industrial references are again dependent on the authors' specialisms. The meetings of the British Association for the Advancement of Science often result in a comprehensive volume on the county in which they were held, usually including sections on the economic structure of the county. Longman are contributing their *Regional History of England* series, producing two volumes for each region, one pre- and the other post- AD 1000. A particularly good volume in this series for the industrial archaeologist is that on *The West Midlands from AD 1000*, with the Gladstone Pottery Museum on the dust jacket (Rowlands 1987). Finally, many collections of old photographs have been published, notably by Alan Sutton, which include many of industrial interest.

The CBA's Industrial Monuments Survey inspired some publishers to initiate county gazetteers of industrial sites. In the 1960s, David & Charles began publishing their invaluable series of regional industrial archaeology studies, which regrettably never covered the entire country. Each volume contains an analysis of the industrial development of a region, followed by a detailed gazetteer which is still a useful starting-point. Batsford were later into the field with a series of *Guides to the Industrial Archaeology of the British Isles*, which achieved only six volumes and a useful introductory volume (Falconer 1980). Examples of all these are included in the Bibliography.

Local research on industrial history and archaeology has resulted in a plethora of articles in a great variety of journals which are often very difficult to track down. A series of invaluable bibliographies has been produced by John Greenwood, the Liaison Librarian at the Open University, covering northern England, the Midlands and south-eastern England (Greenwood 1985, 1987, 1990). The University of Exeter has published a useful bibliography on British metal-mining jointly with the National Association of Mining History Organisations (Burt and Waite 1988), while an annual bibliography, *British Mining History*, on a similar theme is produced by the Peak District Mines Historical Society based in Matlock Bath. National and regional journals, such as *The Local Historian*, *East Midland Historian* and *Northern History*, include bibliographies of recently published work on a regular basis. Regular series of abstracts of articles of industrial archaeological interest are included in *Industrial Archaeology Review* and *British and Irish Archaeological Bibliography*, the latter published by the CBA.

PRINTED PRIMARY SOURCES

The publication of newspapers grew apace in the course of the eighteenth century, few major provincial towns lacking a weekly newspaper by the time of the War of American Independence (1775–83). These report, for example, on new transport developments, such as the letting of toll gates and the meetings of proprietors of canals, together with new mines and quarries being opened. Their advertisements often reveal the products of manufacturing industry, while invaluable detail concerning buildings and plant can be gleaned from notices of sale. The *Macclesfield Courier and Herald* for 20 April 1811, for example, advertised Little Street Mill for sale:

> The factory is three storeys high, thirty yards long and nine yards wide, or thereabouts, and full of silk machinery, the most part whereof is new and which the tenant may be accommodated with. . . . The machinery has hitherto been turned by horses, but a steam engine may be erected at a trifling expense.
>
> (Calladine and Fricker 1993: 57)

Magazines also came into existence in this period, notably the *Gentleman's Magazine*, which ran from 1731 to 1922, and the *Penny Magazine*, started in 1832, both of which can be surprising sources of industrial information and illustration. The following century saw the growth of the specialist technical journals, such as the *Mechanic's Magazine* from 1823, the *Mining Journal* from 1835, *The Builder* from 1843, *The Engineer* from 1856 and the *Colliery Guardian* from 1860. Several major technical encyclopaedias were published in the first half of the nineteenth century, following on from Diderot's great *Encyclopédie* published between 1751 and 1765, which is in itself an important source for industrial developments. The British publications include W. H. Pyne's *Microcosm*, Rees's *Cyclopaedia, or Universal Dictionary of Arts and Sciences*, Tomlinson's *Cyclopaedia of Useful Arts*, Andrew Ure's *Dictionary of Arts, Manufactures and Mines* and J. Loudon's *Encyclopaedia of Cottage, Farm and Villa Architecture and Furniture etc.*; many of these appeared in parts or volumes over a number of years. They furnish not only technical descriptions of processes but also engravings of buildings and machines and useful information on building materials. Contemporary developments and new inventions were also described in the transactions of learned societies, beginning with the *Philosophical Transactions* of the Royal Society in 1665. It must not, however, be assumed that the new technology described in these publications was immediately and universally adopted.

The records of the proceedings and debates of Parliament were published as *Parliamentary Papers*; these can be useful, for example, in tracing the progress of a canal or railway proposal through the committee stages in Parliament. *A Guide to Parliamentary Papers* gives some preliminary guidance to the use of this vast source (Ford and Ford 1972). Even more valuable are the reports of Royal Commissions on various industries, particularly those with labour problems such as handloom-weaving, framework-knitting and coal-mining. These include not only the reports of the commissioners but also transcripts of the oral evidence provided by both employers and workers. For example, one of the commissioners looking into the declining handloom-weaving industry in 1840 reported that:

> I have seen them working in cellars dug out of an undrained swamp: the streets formed by their houses without sewers, and flooded with rain: the water therefore running down the bare walls of the cellars and rendering them unfit for the abode of dogs or rats

but he also found

> streets of small, modern-built houses, in which the cellars occupied by the cotton weavers

were light and convenient apartments, and in many towns the cotton weavers worked not in cellars but in an unboarded room on the ground floor.

(Report of the Commissioners on the Hand-Loom Weavers of the United Kingdom, 1840 [Irish University Press, *Industrial Revolution: Textiles*, Vol. 10, Shannon: IUP, 1970: 657])

These descriptions accord well with fieldwork carried out on cotton-weaving workshops in central Lancashire (Timmins 1977).

The reports of commissioners' enquiries into Children's Employment, the Condition of Framework Knitters and the routine Factories and Mines Inspectors' reports also are valuable sources of information on workshop and factory layouts and their contents. In the 1870s, for example, the statistical returns of the factory inspectorate enable the researcher to assess the impact of steam power on manufacturing industry. These Commission Reports can be located in Parliamentary Papers, but have been collected together by the Irish University Press in a series of thematic volumes such as *Children's Employment, Textiles, Industrial Relations, Factories, Transport, Water Supply, Sanitation* and *Agriculture.*

The growth of trade and industry in the second half of the eighteenth century prompted the publication of provincial as well as London trade directories. These are invaluable for assessing the range of industries in particular towns and the firms operating therein. Most of the directories give a short account of the history, industries and communications of towns and villages, followed by a list of gentry, manufacturers and tradesmen although this may not be complete as a charge was often levied for inclusion. The earlier directories often provide classified lists of manufacturers, Bailey's and *The Universal British Directory* being the only country-wide volumes. From the early nineteenth century, the Post Office produced directories which included full address information to ensure the delivery of mail, a service later undertaken by Kelly. These directories enable particular premises to be identified and can usefully be compared with large-scale OS maps and town plans. A sequence of directories can be used to construct a chronological development of industry for a specific locality, often revealing the decline of some classes of manufacture and the rise of others. This can be invaluable in identifying the use and re-use of particular buildings. The Royal Historical Society has published a guide to the directories for England and Wales issued before 1856, which discusses their limitations as a source as well as listing those available (Norton 1984).

Improved roads led to increasing mobility during the eighteenth century, and travellers' diaries are another important contemporary source. The earliest traveller to comment on industry was the intrepid horsewoman Celia Fiennes who traversed the land in the last decades of the seventeenth century. A more detailed account was given by Daniel Defoe in his *A Tour Through the Whole Island of Great Britain*, 1724–6, which indicates how much of the country was already sending manufactured goods to London for the domestic market or for export. Later in the eighteenth century, the Romantic movement inspired a generation of travellers who lamented the desecration wrought on the landscape by industrial development, but provided useful information at the same time. Among these were Viscount Torrington, William Cobbett and several antiquarian clergymen, notably Richard Warner and James Plumptre (Moir 1964). More objective information was provided by the so-called industrial spies from Europe, who came to discover the secrets of Britain's early industrialisation. Their numbers included men with specialist knowledge of the metallurgical industries, like the Swedish travellers Svedenstierna, Schröderstierna and Triewald and the Frenchmen Gabriel Jars and Moissenet (J. R. Harris 1985): the latter two made meticulous drawings of the machinery they saw (Figure 45). A fascinating account of the landscape of the Black Country was provided in 1868 by the American diplomat

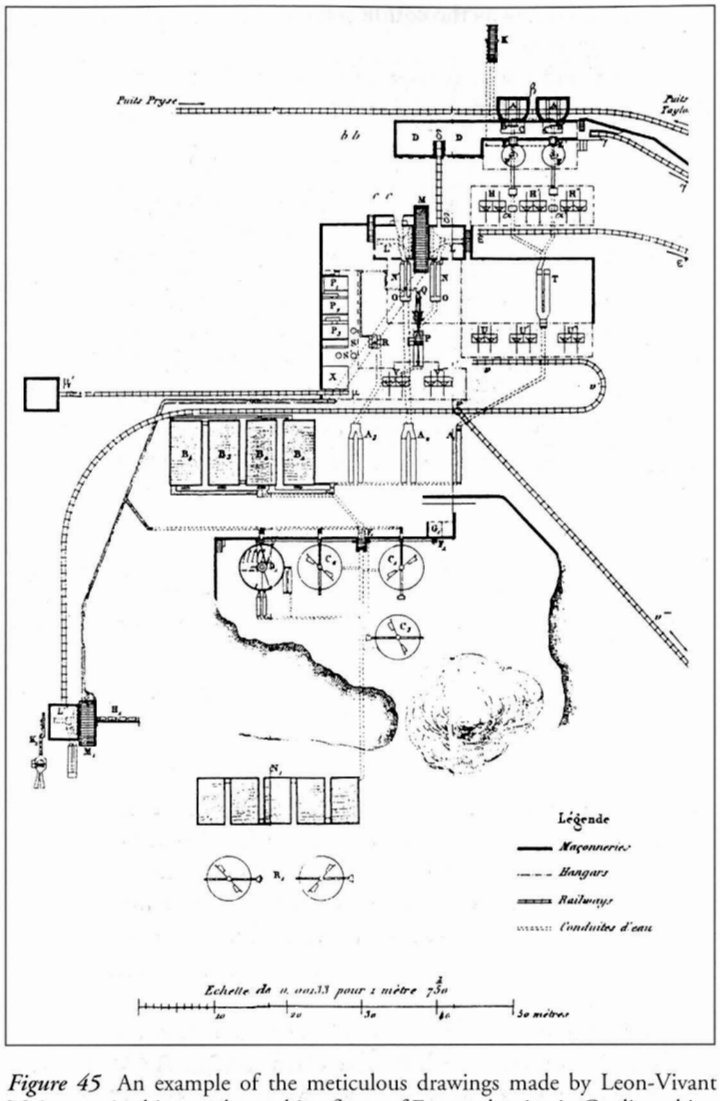

Figure 45 An example of the meticulous drawings made by Leon-Vivant Moissenet, in this case the washing floors of Frongoch mine in Cardiganshire. Plate II from 'Préparation Mecanique du Minerai de Plomb aux Mines de Lisburne, Cardiganshire, Pays de Galles', *Annales de Mines*, sér. 6, tôme ix [1866]: 1–137.

Elihu Burritt who, unlike the earlier industrial spies, was well aware of the persistence of hand technology in this seemingly industrialised area (Burritt 1868).

The foundation of the Board of Agriculture in 1793 led, as has been seen, to a valuable series of reports on the British landscape in a period of transition. These so-called *General Views* were published for most counties between 1800 and 1822. Although their remit was to consider the state of agriculture, the reporters took note of related occupations such as lime-burning and extractive industries which were often carried on as an adjunct to farming. In Leicestershire, for example, William Pitt noted that 'the Earl of Moira has erected an iron foundry at great expense, by the side of the Ashby Canal, where the ore has been smelted and cast into pigs, as well as utensils for various purposes' (Pitt 1809: 8). The most valuable of the *General Views* for industrial content is that for Derbyshire by John Farey, who was commissioned at the same time by the Royal Society to examine the mineral wealth of the county (Farey 1811–13). Arthur Young, the first Secretary of the Board of Agriculture, who wrote six of the county volumes, was himself an inveterate traveller and has left published accounts of his journeys through the regions of England: although largely concerned with innovations in farming, he noted the existence of manufacturing industry such as stocking-weaving in Kendal and lace manufacture in Bedfordshire (Young 1771).

The increasing interest in the landscape at the time of the Romantic movement led to the publication of topographical works, such as Britton and Brayley's eighteen-volume *The Beauties of England and Wales* which appeared between 1801 and 1815 and Samuel Lewis's *Topographical Dictionary* (fifth edition 1844). As a source, these include town plans and, surprisingly, much information on contemporary economic conditions. The growth of the tourist industry, promoted by railway development, initiated a new range of guide books; for example, Black's

Picturesque Tourist and Road and Railway Guide through England and Wales (1850). The railway companies themselves produced illustrated commentaries for those who travelled on their routes, describing not only the engineering marvels on the line but also the views from it, including those of industrial landscapes. Numerous local guidebooks were also published, directing people to beauty spots in the vicinity but often also including engravings and descriptions of buildings which have since vanished. For example, Robinson, Son & Pike produced *Loughborough: its History, Manufactures, Trade* in 1892, detailing the history of individual firms in the town and providing engravings of their premises and products (Figure 46).

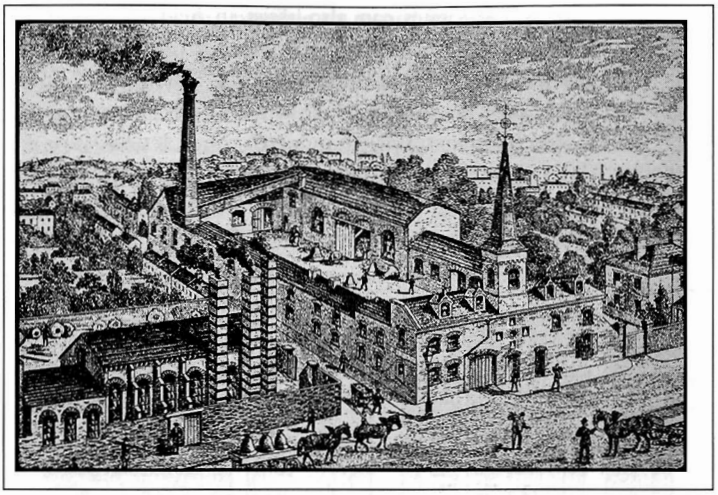

Figure 46 An engraving of the Taylor's Bell foundry in Loughborough, Leicestershire. On the left is the new foundry block of 1875; the right-hand frontage had been destroyed by fire in 1891 and was being rebuilt at date of publication.

From *Loughborough: its History, Manufactures, Trade* (Robinson, Son & Pike, 1892).

PICTORIAL SOURCES

Much of the printed matter referred to above is also a rich source of illustrative material, both deliberately included in the text and incidentally derived from the advertisements therein. These engravings often enable subsequent alterations and additions to buildings to be identified but they need to be treated with caution since the artist frequently exaggerated the scale of individual buildings to make them appear more impressive, particularly in advertisements and letterheads (Figure 47). Early technical illustrations are often highly stylised but those in Agricola's *De Re Metallica* (1556), for example, assist in the interpretation of mining landscapes since the basic technology survived in many areas well into the nineteenth century (Figure 48). These illustrations enable the archaeologist to interpret the often enigmatic remains of wooden structures which were the foundations of very primitive water-powered technology; they also indicate the extent of manual labour required on such sites. Illustrations of machines in later technical magazines and

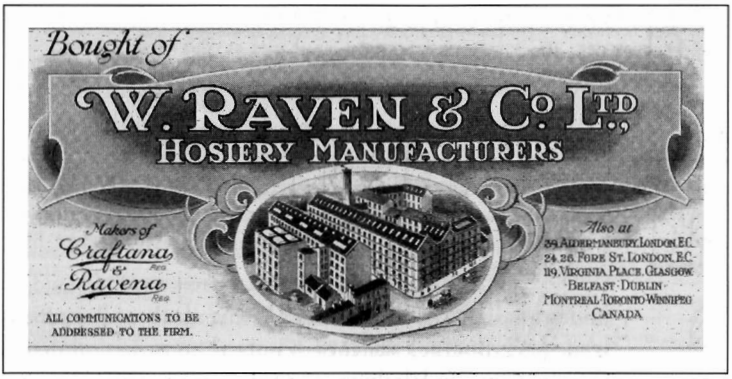

Figure 47 Letter and document headings, calendars and other publicity material were often used to show the extent of business premises. Raven's factory, which is still extant, is typical of the multi-storey hosiery mills which came to dominate the streets of Leicester in the last quarter of the nineteenth century.

Leicestershire Record Office.

makers' catalogues can also assist in field identification. Greens of Aberystwyth, for example, provided lead-dressing apparatus whose foundations can frequently be traced on late nineteenth-century sites such as Frongoch and Killhope, while illustrations of Blake's stone crushers in the *Mining Journal* can be linked to site evidence on numerous mine and quarry sites.

Processes involved in industrial production were also the subject of engravings. Many of those for the textile industry are well known; for example, the depiction of a child piecer underneath a spinning mule, the introduction of Cartwright's power loom and William Hincks's portrayal of the Irish linen industry. Other engravings show, for example, the processes of gunpowder production, the working of a large iron foundry or the interior of a glass-house (see Chaloner and Musson 1963). These illustrations are valuable not only in determining the processes of production in a particular complex of buildings but in understanding the gender and spatial distribution of the workforce within them. Such sources do, however, have to be looked at critically since they may be highly selective in their treatment of the human aspect of past industry.

A—Box laid flat on the ground. B—Its bottom which is made of iron wire. C—Box inverted. D—Iron rods. E—Box suspended from a beam, the inside being visible. F—Box suspended from a beam, the outside being visible.

Figure 48 Agricola's illustration of a battery of water-powered ore stamps. He shows that the broken ore is passed through a series of sieves and the coarser material returned to the stamps for further reduction. The remains of similar boxes and sieves have been found on excavations of nineteenth-century metallic ore-processing sites, showing their continued use long after his sixteenth-century drawing.

The novelty of industrial landscapes attracted the attention of artists, whose paintings need to be treated as images of industry rather than as factual statements. Joseph Wright's painting of Cromford Mill at night and de Loutherbourg's richly coloured impression of the Bedlam and Madeley furnaces in the Ironbridge Gorge re-create the impact of new industrial processes on the contemporary consciousness, which is difficult for us to imagine from the empty shells of the buildings which remain in the twentieth-century landscape. The drawings of Thomas Hair are now often the only source for understanding the landscapes of the north-east coalfield in the nineteenth century (1844), while J. C. Bourne's sketches of railway construction demonstrate the human effort required for these massive undertakings (1839). A surprising number of industrial structures were included in paintings, ranging from lime-kilns to glass cones and iron forges as well as the better-known river navigation features which appear in several of Constable's paintings, such as Dedham Lock. There is no comprehensive thematic index for industrial scenes, although the Elton Collection of the Ironbridge Gorge Museum Trust has brought many of these together, as has Francis D. Klingender's *Art and the Industrial Revolution* (1947).

By the last quarter of the nineteenth century, it became possible to record in photographic form the kind of scenes which Bourne had captured in pen and wash. S. W. A. Newton travelled the length of the Great Central Railway during its construction in the 1890s and his photographs depict not only the railway structures but the towns in which many of them were built. These are now housed in the Leicestershire Record Office, while many other record offices, libraries and institutions have accessioned similar collections, such as the photographs of Cornish mining taken by J. C. Burrow. Those of national importance have generally found their way into the National Monuments Records, like the Rev. Denis Rokeby's photographs of railway stations, many of which have now been altered beyond recognition or demolished, or George Watkins's invaluable record of stationary steam engines. The photographs taken by the three Commissions as part of their own recording programmes since 1908 are in themselves an invaluable resource, although their interest in industrial buildings is comparatively recent (see RCHME 1985). The Commissions' work has also included aerial surveys of industrial landscapes and building complexes, whilst historic collections of aerial photographs are also held by the Cambridge Committee for Aerial Photography (see Hudson 1984) and by the commercial company Aerofilms Ltd which was established in 1919.

Pictorial sources, therefore, put the flesh on the bare bones of the archaeological evidence: they reveal long-vanished superstructures and often provide some indication of the nature of the labour force. They do, however, need to be treated with caution. Paintings and engravings are often selective in content and need careful analysis, as has been shown by comparing a sequence of artists' impressions of the industrial complex at Aberdulais Falls in the Vale of Neath (Hayman 1987). The industrial content of photographs was often incidental, and so illustrations of specific sites or structures can be difficult to track down from indexes. Nevertheless, these sources bring alive past landscapes in a way peculiar to the industrial period, since it is rarely possible for earlier archaeology.

Maps and plans

Maps and plans are the richest source of information generally available to the industrial archaeologist, and a thorough search should be made for them before fieldwork is commenced. As a rule of thumb, the topographical information shown on plans is usually all to scale, whereas on the smaller-scale maps features such as roads and railways are generally exaggerated for clarity. Large-scale OS maps can be used as base plans for field surveys, whereas the other classes of map dealt with below furnish only historical information.

Estate maps are the largest category of unpublished cartographic material and tend to be scattered throughout collections of family papers, which can make them difficult to locate. Some date back to the sixteenth century (Fowkes 1992), but the majority are seventeenth- to nineteenth-century in date. Many estates were sold or leased for urban development and so the maps are not purely rural in scope. Since landowners in Britain had the right to exploit the mineral resources on their estates, such maps frequently record industrial as well as agricultural features. As industrial activity increased in the eighteenth century, areas not previously surveyed were often covered for the first time. In central Wales, for example, the Pryce family of Gogerddan extended their mining interests and their archives include 160 late eighteenth- and nineteenth-century maps of Cardiganshire. Estate maps indicate the attempts by landowners to be self-sufficient in activities such as lime-burning and brick-making.

By the nineteenth century, many landowners had abandoned working their own minerals because of the capital costs involved and leased their holdings in return for a royalty on

production. The leases, renewable at regular intervals, usually survive among their papers but the attached maps depicting the landholdings are often missing. Where they do exist, they can provide useful evidence concerning the chronological development of a site if a series can be found. However, lease maps were intended to delineate boundaries, not usually to portray surface features, and it cannot be assumed that because a particular feature is not marked, it did not exist when the map was drawn. In cases of change of leaseholder, it is possible that plant abandoned by the original lessee is indicated on the new lease map since it had reverted to the lessor.

Open fields and common lands were enclosed first by agreement and then from the mid-eighteenth century until the middle of the nineteenth century by Act of Parliament. In England after 1760 some 5,100 Enclosure Acts covered over 6.5 million acres [over 2.6 million hectares] of land, although the maps do not necessarily survive for all of them. Deposited enclosure plans and their books of reference depict the boundaries of the new land allotments in both urban and rural areas. Buildings and other features are not often shown on the maps, although the field names can provide valuable clues to their past or current usage, e.g. 'brick-kiln close', 'slitting mill pasture', 'furnace field' and 'lime yard'. Similar maps, usually depicting boundaries only, and schedules with field names resulted from the Tithe Commutation Act of 1836 which abolished the tithes which were then still payable to the Church of England in some two-thirds of the parishes in England and Wales. By 1886, some 11,800 tithe apportionments had been made under the 1836 Act. The tithe surveys have to be sought in the original church diocesan record offices which may not necessarily be those of the county in which the land is located. Since tithes were usually commuted at the time of Parliamentary Enclosure, it is rare to find both types of map for one parish and therefore changes in land usage cannot be traced.

Many of the original enclosure or tithe apportionment boundaries can usually be related to those on the later large-scale OS maps. The Board of Ordnance began the Primary Triangulation of Britain in 1791, which formed the basis not only for its own maps but also for several privately published county maps which therefore have a greater degree of accuracy than those pre-dating official triangulation. Most of England and Wales was covered at scales of 1 inch or 1.5 inch to the mile in the 1820s and 1830s by the maps of Christopher Greenwood and Andrew Bryant. These have to be treated with caution since they were often reissued without revision and the information shown may relate to the original date of the survey, not that of publication. They do, however, record an important period of industrial development (Smith 1990). The OS 1-inch series was much slower appearing and was not completed until 1870 for England. The David & Charles reprints of the first editions of the 1-inch OS are valuable because they pre-date the later large-scale maps, but many include information from subsequent revisions, such as railways, which can be very misleading if the detailed commentaries are not studied carefully. Surveys at 6 inches to 1 mile commenced in Ireland in 1825 and were extended to the northern counties of England and Scotland by the 1840s. However, projects such as railway construction needed even larger-scale maps and from 1858 the 25 inch to 1 mile scale was adopted as a standard except for uncultivated areas which continued to be mapped on the 6-inch scale. Early large-scale maps for upland mining districts may not therefore exist. The researcher is directed towards several useful guides to early Ordnance Survey maps (Harley and Phillips 1964; Oliver 1991, 1993). An ever-increasing number of 25 inch to 1 mile OS maps, usually editions *circa* 1900–20, are being reproduced in a reduced size format for sale by Alan Godfrey. A sequence of editions of the large-scale 6-inch and 25-inch maps can be used to advantage in determining site development over a period of years and their evidence can be used to confirm other sources.

Whereas the Ordnance Survey is comprehensive in its coverage, many selective maps were produced for specialist purposes. These fall into three main categories: maps for geological and

mineralogical purposes, which include details of mines and quarries; transport maps, including horse-drawn tramways, roads, river navigations, canals and railways; and urban plans dealing with water supply, drainage and public utilities.

The foundation of the Geological Survey coincided with an upturn in the metalliferous mining industry in the 1830s. Its progenitor was Henry de la Beche, who was personally responsible for the surveys of Devon and Cornwall and had considerable expertise in mining. The survey also produced mineral statistics in conjunction with the Mining Record Office, whose first Keeper, Robert Hunt, was himself a cartographer. His maps of Cardiganshire mines, for example, include details of surface features such as wheel pits and pumping systems (Figure 49). In the 1920s, the Geological Survey produced a series of memoirs on the mineral resources of Great Britain which include useful maps showing the major lodes and sites of mines. These are available in the Official Publications Section of the British Library, but many have been republished under the auspices of the Northern Mine Research Society (e.g. O. T. Jones 1922). There are also many mining maps produced by the mining adventurers themselves, often for the mineral lords, which depict surface features as well as underground sections. These need to be treated with caution; first, since they may depict intent rather than actuality, as discussed earlier, and, second, since features were often added to them over a period of years without the original survey date being amended. The same is true of many of the early colliery maps, some of which remain in the possession of British Coal while others have found their way into county record offices since the demise of the Mining Record Office. Abandoned mine plans were an official requirement because of the dangers of flooding and subsidence, and many survive in the British Library.

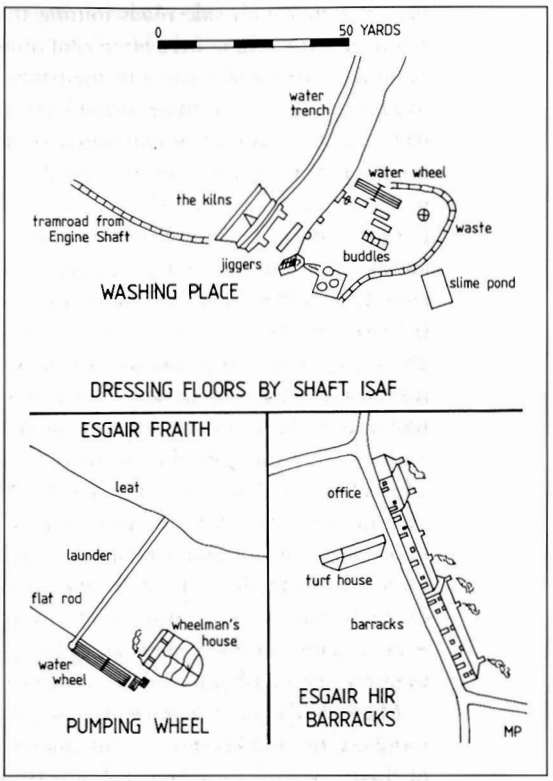

Figure 49 These sketches were drawn in ink on a coloured base map of the Esgair Hir and Esgair Fraith mines in Cardiganshire, signed by Robert Hunt and dated 1837. They were probably added at intervals to show developments on the mining sett and proved invaluable in interpreting fragmentary field remains.

Redrawn from a map in the former Mining Record Office.

The main purpose of many early maps was to indicate roads to assist the traveller. The first road atlas is probably John Ogilby's *Britannia*, first published in 1675 and reprinted several times until 1698. The book contains 100 plates, each with six or seven strip maps showing the road and features alongside. For the industrial archaeologist, windmills, watermills, coal pits and, in some cases, types of bridges are often indicated. For example: 'a Moore with a great many Colepitts' is shown off the Oakham to Richmond road to the north of Mansfield in Nottinghamshire, but in other areas where one might expect to find these shown, as in the Newcastle area, they do not appear: Ogilby was clearly selective about what he recorded. The later county maps nevertheless made use of his information on roads. Eighteenth- and nineteenth-century road development can be traced from enclosure maps, since roads were often replanned in the enclosure process. The records of turnpike trusts have usually found their way into county record offices. These include plans showing the locations of toll houses and

bars, together with side roads joining the turnpike whose destination was usually recorded: in industrial areas, these were often coal mines or limestone quarries, for example, whose traffic was a valuable source of income to the trusts.

Surveyors of river navigations were required to produce large-scale plans of cuts around obstructions such as mills and weirs. These are often the clearest documentary evidence to survive for the layout of leats and mill ponds. It cannot, however, be assumed that what the surveyor intended was always carried out and the documentary evidence needs to be checked in the field. For example, in 1790 William Jessop produced a plan of 'The Intended Navigation in the Rivers Wreake and Eye from the proposed Leicester Navigation to Melton Mowbray'. His papers also include drawings for locks, all of which were to be positioned at the upstream end of the cuts. In the event, however, they were placed at the downstream end of the cuts (Miller and Fletcher 1984: 10). The Syston to Peterborough Railway was built close to the navigation in 1846 and the survey maps for that are in fact the best documentary source for the river navigation as it was actually built. Canal promoters were obliged to provide plans for the entire length of their undertaking, since land had to be purchased for the route. Pre-1795 canal maps are usually on a fairly small scale, but nevertheless usually record the positions of features such as windmills and limestone quarries. Later maps were produced on a scale of at least half an inch to the mile and indicate a strip of land a field wide each side of the proposed route. Since industrial cargoes would be a valuable source of revenue to the company, all potential users such as brickyards, coal-pits and manufacturing concerns are usually shown. The diversity of information which may be gathered from maps and plans of waterways makes these an invaluable source for the industrial archaeologist as well as the transport historian.

Maps also depict the horse-drawn tramroads and waggonways that were constructed in large numbers to connect mines and quarries to navigable waterways. The earliest concentration of these, in north-east England, was shown on Casson's 'Plan of the Rivers Tyne and Wear' of 1804, which also depicts the riverside staithes to which they ran. The waggonways required wayleaves and so the plans usually depict both the fields alongside and the industrial concerns to be served by them. For example, Christopher Staveley's map of 'An Intended Navigation from Loughborough to Leicester' of 1790 shows a network of waggonways at the western end of the Charnwood Forest branch of this, which was intended to open up new coal mines on Swannington Common. For locomotive railways, plans were generally prepared on a much larger scale, particularly when the railway was to penetrate a built-up area, and they usually depict existing developments for some distance on either side of the proposed route. Many of these plans pre-date any available large-scale OS maps and, with the associated books of reference, are valuable sources for urban industrial archaeology even though the actual railway was never built (see Simmons 1953–4, 1957–8, 1961 for lists of deposited plans). The railway mania of the 1840s exhausted the supply of competent surveyors, and the plans of this period cannot always be relied upon for accuracy.

Urban improvements in the late eighteenth and early nineteenth centuries generated a series of town plans which also pre-date the large-scale OS maps. The first were those undertaken by various Improvement Commissions for paving, cleaning and lighting the streets, which resulted in some early town plans, such as that for Rochdale in 1809 on a scale of 24 inches to 1 mile. In the 1840s, the creation of Boards of Health led to numerous town surveys which were necessary to design adequate sewerage and drainage systems as well as clean water supplies. Some of these were undertaken by the Ordnance Survey, which was beginning its own, unfortunately uncompleted, series of town plans, some at the very large scale of 1:500. The existence of these plans has been detailed by Harley and Phillips (1964). Schemes for the provision of public utilities such as gas, electricity and tramways were required by Parliament to include large-scale

plans, many of which have now found their way into county record offices. Finally, the plans prepared for fire insurance purposes by firms such as Chas E. Goad Ltd give an unrivalled amount of information concerning the urban environment. These were to enable insurance underwriters to determine the degree of fire risk, and hence the premiums for a particular building. The plans therefore detail the building materials, power supplies, fire hydrants, and means of access to premises as well as the function of the buildings shown (Figure 50). Since the plans

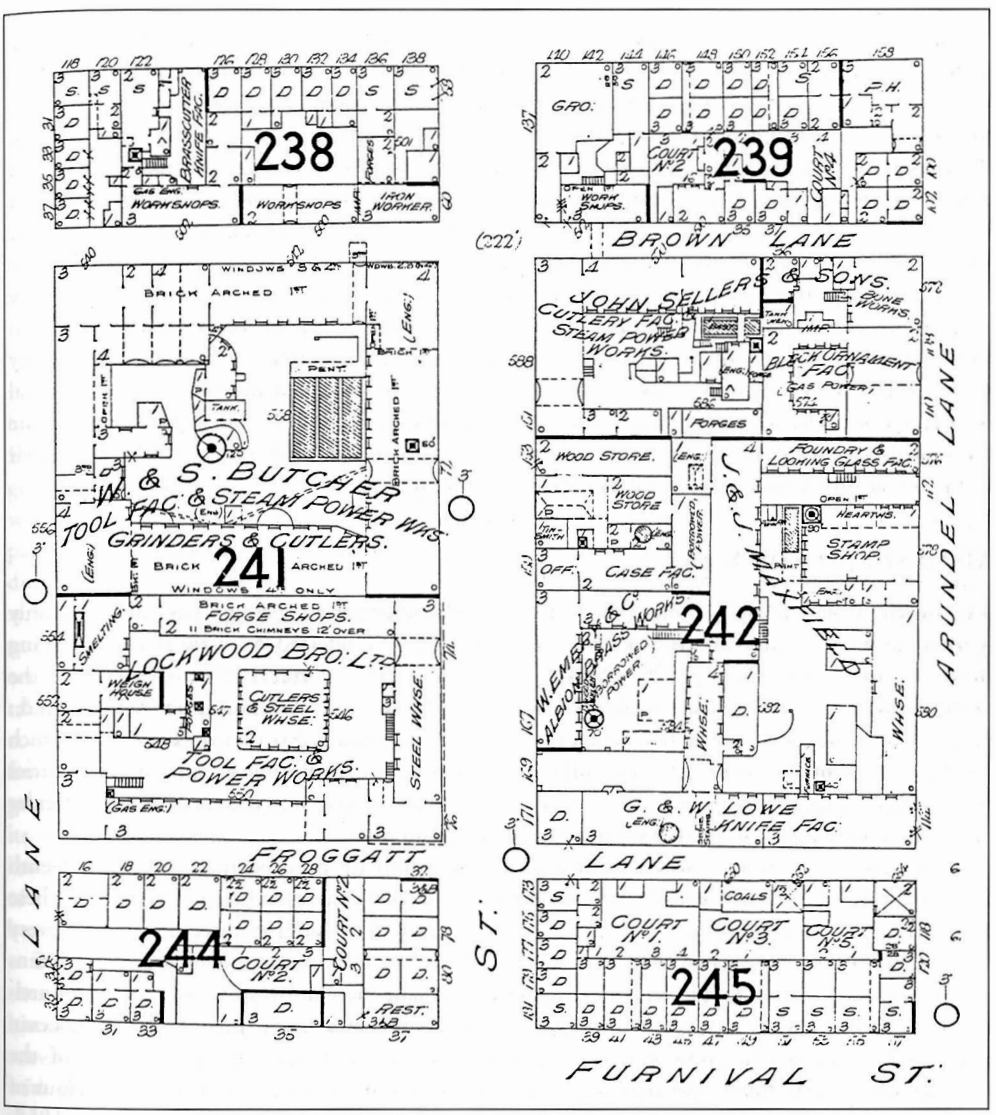

Figure 50 An extract from Goad's Fire Insurance Plans for Sheffield, South Yorkshire, published in 1896. The plan shows the variety of industrial premises each side of Arundel Street, typical of the small-scale cutlery and edge tool works common in the town. It also indicates the provision of both gas and steam power, sometimes shared between production units. The numbers 1, 2, 3, etc. in each block indicate the number of storeys whilst cramped court and back-to-back housing filled available space. A photograph of the premises of W. & S. Butcher is reproduced as Plate 15.

were restricted to commercial and industrial areas of towns, they are of immense value to the industrial archaeologist, especially as they were normally updated at frequent intervals until the 1960s. Goads paid particular attention to warehousing districts in both towns and ports because of the high fire risk of goods in storage, and their plans occasionally incorporated sectioned elevations of warehouses and granaries, etc. (Rowley 1984). Taken altogether, these various urban plans can be used to compile a sequence of site development from the late eighteenth to the mid-twentieth century, which is particularly valuable where archaeological data cannot be obtained.

Plans and elevations of individual buildings were generally restricted to the more prestigious structures until the second half of the nineteenth century, when concern for public health led to the creation of local by-laws for urban development. It became compulsory to submit plans to the new local authorities both for alterations to existing structures and for new buildings to ensure compliance with their regulations. Many hundreds of these building plans survive in record offices, together with the registers which enable particular plans to be traced. This is not always easy as the plans were sometimes submitted in the names of the builder or architect and the exact location of the premises can be found only by reference to map sources, using the dimensions given on the plans. The collections include both plans and elevations of new factories, many of which have disappeared in twentieth-century redevelopment but whose foundations may survive in the archaeological record. Working-class housing, undertaken both by private speculators and the local authorities themselves, can be studied and the plans often reveal the survival of domestic industry at surprisingly late dates. Industrial archaeologists are therefore remarkably fortunate in the variety of maps and plans for their period but, as can be seen, their use is not always as straightforward as might be imagined.

Manuscript sources

The plethora of manuscript sources available to the industrial archaeologist is such that only a small proportion can be considered here. The reader is referred to various aids to using documentary sources (Camp 1963; West 1982; Riden 1987; Porter 1990) together with the useful series of *Short Guides to Records* issued by the Historical Association (Munby n.d.; K. M. Thompson 1994). The first category which will be discussed is that of documents which enable occupations to be identified and therefore the spatial distribution of particular industries to be established. The second category is that of sources identifying and describing particular industrial enterprises, including buildings and their contents.

The detailed inventories which formed part of the probate process from the late sixteenth until the early nineteenth century are invaluable sources for ascertaining occupations. These accompanied wills and listed the contents of a testator's house shortly after death. Not every will had an inventory attached to it, and not all survive, but locating those which do exist means understanding the probate process. In England and Wales, the wills of those of yeoman or artisan status, for example, were proved in archdeaconry courts and found their way into diocesan record offices, which are now generally combined with county record offices. Wills of the wealthy, particularly those with possessions in more than one diocese, or of people conscious of their status, were proved in the Prerogative Courts of York and Canterbury. On 1 January 1858, the ecclesiastical courts lost their jurisdiction over the probate process and since then wills have been proved in the Principal Probate Registry. Inventories are rare after this date, but the wills themselves can indicate occupations, land ownership, family connections, etc. Pre-1858 wills proved in York are now in the Borthwick Institute at York and those proved in Canterbury are in the Public Record Office. Fewer inventories survive from the prerogative courts than the

archdeaconry courts, so county record offices are the best source for them. The complications of the probate process have been made easier through the extensive work of family historians, who have often calendared wills and inventories, which makes individuals simpler to track down. However, the value of inventories to the industrial archaeologist lies in the possibility of analysing the occupational structure of a particular area. The occupation of the deceased is frequently stated, and it is often possible to identify crafts from the equipment listed. For example, in 1756, William Bentley of Shepshed in Leicestershire is identified as a hosier: his house contained a Shop and Warehouse Chamber and eighteen stocking frames were listed among his possessions. The total value of his goods and chattels was £1,281 6*s* 7*d*, and he was clearly an employer of framework knitters. The latter would be unlikely to leave inventories, their estates falling below the normal threshold of 50 shillings in value. This illustrates the limitations of probate inventories as a means of establishing a true occupational structure, but they can give an idea of the spatial distribution of particular crafts and industries. Inventories can also be useful in identifying artefacts associated with particular crafts, although the terms used are often difficult to interpret (Trinder and Cox 1980; Thornes 1981).

Probate inventories can be used in conjunction with other records to amplify the information on the occupational structure of a particular area. Registers of baptisms, marriages and burials frequently record occupations, especially once standard forms of register were introduced after 1812, but exclude Nonconformists who usually made up a substantial proportion of the working population. The latter were included once civil registration was introduced in 1837. Poll books listing the qualifications of those entitled to vote were introduced after the General Election of 1695 and continued until the introduction of the secret ballot in 1872. The lists generally include occupations of the voters, but the use of these is limited as not all elections were contested anyway and the franchise varied from borough to borough. They are, however, particularly useful for the eighteenth century before the widespread introduction of trade directories. Another series of lists which include occupations are those of men liable for militia service, which were required by the Militia Act of 1757. These also have their shortcomings, but can be a valuable source for the occupational structure of the late eighteenth and early nineteenth centuries. The most complete record of occupations is that of the census, begun in 1801 and taken decennially, except for 1941. Detailed census information is embargoed for 100 years but comprehensive details of names and occupations, including women as well as men, are available from 1841 onwards. Since the place of birth is given from 1851, it is possible to identify immigration into a particular locality, which can indicate the growth of new industry there and its decline elsewhere. Depending on the diligence of the enumerator, the place of work of individuals can also be ascertained and the labour force in a particular enterprise estimated. None of these sources is adequate on its own to establish the occupational structure of a specific area, but collectively they can provide the basis for a working hypothesis.

The second category of documents, those identifying industrial enterprises, buildings and their contents, is both more diverse and also difficult to interpret. A source frequently used by historians to study land ownership is the Land Tax returns, which date from 1692 but whose survival is patchy until 1780, from which date until 1832 duplicate returns had to be lodged with the Clerk of the Peace. It is possible to identify land exploited for industrial purposes from these returns, especially where mineral rights for metalliferous or coal-mining were concerned (Unwin 1986). Whereas the Land Tax returns are of most value in rural areas, the rate books giving details of those assessed for various forms of local rates can assist in the identification of property in an urban environment. The comparison of successive rate books can establish building or demolition dates of both houses and commercial buildings, change of use and new developments.

One of the largest classes of document in county record offices is the Quarter Sessions papers. These quarterly meetings of local Justices of the Peace were originally concerned with cases of law and order, but they gradually became the main organ of local government until the Municipal Corporations Act of 1835 and the Local Government Act of 1888 put in place new administrative bodies for towns and counties respectively. Quarter Sessions were therefore in receipt of all acts of central government affecting the localities, such as enclosure, turnpike road, canal and railway proposals, and the plans associated with these, along with explanatory books of reference, had to be deposited with the Clerk of the Peace who maintained the records of Quarter Sessions. It must be borne in mind that abortive as well as successful projects are included in these records and can thus provide incidental information about other aspects of the economy. The importance of these papers was partly responsible for the creation of county record offices, and a search through the schedules will usually prove rewarding. The successors, corporation and council proceedings, provide similar information to the papers of Quarter Sessions but, especially in the case of towns, yield details of municipal schemes concerned with urban development and public utilities. The latter assumed considerable importance following the creation of Boards of Health in 1848, the reports to which provide considerable information on local topography since they are usually well illustrated by maps and plans.

Whilst the Quarter Sessions deposits contain maps and books of reference for canals and railways, the full records of the companies that built and operated them were brought together by the British Transport Commission at the time of nationalisation in 1947. This invaluable collection of material dating back to the eighteenth century was transferred to the Public Record Office at Kew and classified as RAIL (see Hadfield 1955–6; L. C. Johnson 1953–4). The minute books of canal and railway companies provide a detailed account of the motivation behind a particular undertaking, the methods of construction, the problems encountered and modifications adopted, together with requests from potential users for branches to collieries, quarries and brickworks, etc. For example, the Ashby Canal committee ordered that their engineer

> do procure in the cheapest manner, either by canal or land carriage, or partly by one and partly by the other, a boat load of blocks from Little Eaton on the Derby Canal not to exceed 100lbs weight each, to be drilled 1¼in. diameter and 5in. deep, to be not less than 7in. thick or more than 8in. – such blocks to be laid on the [tram] road between Ashby and Willesley.
>
> (PRO RAIL 803/4 7 June 1814)

As the original tram road was laid in 1802, this extract suggests that the stone blocks supporting the plateway had proved unsatisfactory. Benjamin Outram's original specification, of which a copy is also included in PRO RAIL 803, had stated that the blocks were not to be less than 150 lb in weight and that each block was to have

> a hole drilled near the centre one inch and a half wide and six inches deep to receive an octagonal plug of oak five inches long in which a spike or large nail is to be driven to fasten the ends of the two rails which are to be bedded on the blocks.

The blocks were to rest on ground to be 'well stamped so that each block may be firmly bedded and the spaces between and round the blocks to be filled up with small stones or gravel'. This was necessary to prevent the track going out of gauge and the surviving field evidence indicates that Outram's instructions were adhered to.

The huge collections of family papers in county record offices are another important source for illuminating the industrial development of large areas of the country. They have been extensively used by economic historians (see Ward and Wilson 1971) but, because of the lack of a systematic index, have not been sufficiently utilised by industrial archaeologists. It is necessary

to have a good idea of the date and development of a particular site being researched before tackling family papers. They can, however, provide details which can be obtained nowhere else. For example, the extensive archive of Pryce of Gogerddan in the National Library of Wales contains the bargain books detailing the contracts for the construction of an ore-dressing floor and its water supply at Esgair Hir in Cardiganshire. The massive 40-feet [12.1 metres] diameter pumping wheel was constructed in 1840 and its underground tailrace driven by a team of five men on a bargain of 5 shillings a yard, while another team were paid 40 shillings 'to make a pool for the washing place' and 20 shillings 'for making a water course and fixing the launders'. All these features can still be identified on the site (Palmer 1983: 25–7). British landowners did not attempt to hide their interest in their industrial undertakings, and their letters often help in dating sites and structures. On 3 June 1810, the Earl of Moira wrote to his wife: 'We were at the Woulds yesterday to see castings made with the new iron. I saw it taken from the furnace without any intermediate process and cast into articles of the greatest nicety.' He was referring to his new blast furnace, now a scheduled ancient monument in north-west Leicestershire (Cranstone 1985).

The family papers of the Earl of Moira demonstrate the problems of using this type of record. They are split between the collections in the private possession of the Marquis of Bute, the Huntington Library in California and Leicestershire Record Office, where they can be found both in the Hastings family archives and among papers deposited by a local firm of solicitors. The latter class of record represents a huge and largely untapped reserve of information, ranging from legal papers concerning landownership to the formation and activities of industrial concerns. Many solicitors' collections are so vast that they have not been catalogued and are therefore not always on public access; others require permission before use.

Business records are another very diverse source, which either may remain with the original firm or its successor, or may have found their way into various record repositories. Much of the information they contain is of economic interest but material of interest to industrial archaeologists may occasionally be found. As was suggested earlier, it is the larger firms with national or international interests who safeguarded their records. For example, the archives of the Gregs of Quarry Bank Mill in Styal contain maps and plans, together with memoranda which have proved valuable in dating the phases of the mill building. The important textile machine manufacturers Platt Brothers of Oldham have left a considerable archive which includes not only plans of their premises but also drawings of the vast range of machines they produced, together with details of their installation. Such collections also often contain other valuable illustrative material in the form of photographs, catalogues and publicity material. Business records can also provide details of obsolete processes which help with the interpretation of archaeological evidence. For example, the firm of Walkers, Parker & Company of Elswick in Northumberland became the largest lead manufacturer in Britain and managed the shot towers which were once a feature of towns such as Bristol, Chester, Elswick and London. Their records include inventories and valuations of their various premises, together with technical notes on production processes. Smaller firms have, on the whole, not retained such a complete range of records and often only individual account books and ledgers have found their way into public repositories.

The lack of information in business records about the premises in which firms operated can to some extent be compensated for by looking at records specifically concerned with buildings, such as fire insurance policies. Early textile mills, especially those processing cotton, were a particular fire risk and most were therefore insured. The entries in fire insurance policy registers usually refer to the building materials, the source of power and the processes carried out in various sections of the mill. For example, a Royal Exchange policy of 1778 describes the first cotton mill built by the Robinsons in Nottinghamshire as: 'stone built and slated, turn'd by

water'. A sequence of policies can be used to trace the building additions and changes as an enterprise expanded: by 1782, the Robinsons had added another cotton mill and a cotton and worsted mill, together with workers' housing, to their original mill building. Five years later, a further insurance policy records the addition of a steam engine in one of the mills (Greatrex 1986–7). Stanley Chapman has demonstrated the value of fire insurance policies for the study of early Arkwright-type mills (Chapman 1981). These policies can also be used to demonstrate the continuity of domestic production after the introduction of powered spinning. A firm of merchants in Kendal insured their premises as follows in 1802:

> On a house, situate on the West side of Stricklandgate, in Kendal aforesaid £600
> On a warehouse, 2 cottages, stable and outbuildings all adjacent behind £400
> Utensils etc. £400
> On a weaving shop situate at the South end of the croft nearby £100
> Utensils and trade therein £100
> On a weaving shop north of the last, in the same croft £200
> Utensils and trade therein £400
> Memo – there are stoves in the weaving shops for the purpose of heating their irons. Warranted that no parts of the cotton manufacture, except warping, weaving or cutting, be carried out in the premises.
>
> (Guildhall Library, City of London, Royal Exchange 194326, 1802)

Cotton-spinning was clearly regarded as the major fire risk.

Whereas the normal routine of business often creates information of value to the economic historian, it was usually only when things went wrong that descriptions of assets or buildings were drawn up. Such occurrences could be a legal dispute, an arbitration between owner and tenant, disposal of assets by sale, or, at the worst, bankruptcy. The records of the Court of Bankruptcy are held at the Public Record Office, but manuscript copies may well be found in deposits in local record offices. The assets of a company or an individual were also listed when the industrial concern was either sold or let to a new tenant. When the lead mine at Cyffty, near Llanwrst, was sold to a new company in 1899, the plant was as follows:

> No.1 Engine Shaft: One large Cornish Engine with Boiler, 10 to 11 tons in weight, ready to work;
> Wooden Rod with Bob attached; Winding Drum; Pit Head and Pulley with Dividing down the Shaft; Ladders to bottom of Shaft;
> Tramrails and Waggons underground;
> One large Iron Kibble & 18yds. of 9in. lift complete; Dressing Floors with Zinc Roof;
> One Hand Jigger; Round Buddle;
> Crushing Iron Waterwheel 20ft. by 3ft. breast in working condition with 1ft. Crusher Rolls attached in good building with wooden floors, and some dressing tackle inside;
> Smithy & Storeroom with Bellows, Anvil, Steel Tools, Chain & Iron and Office;
> One large Pumping Wheel 35ft. by 3ft. breast with Iron Rods, Travelling Bob Pulleys and Bob on top of Shaft with Rods connected to the Pump;
> Horse Whim with Capstan and Chain;
> Three Iron Kibbles and Lift of 10ins. Pumps complete;
> The bottom Lift of 8ins. Pumps complete;
> Rails & Waggons in the bottom of the Mine.

This description can be related to a water-colour of the mine by H. E. Tidmarsh in 1884 (Plate 38) which shows the steam engine, head gear, crushing house and waterwheel and the single

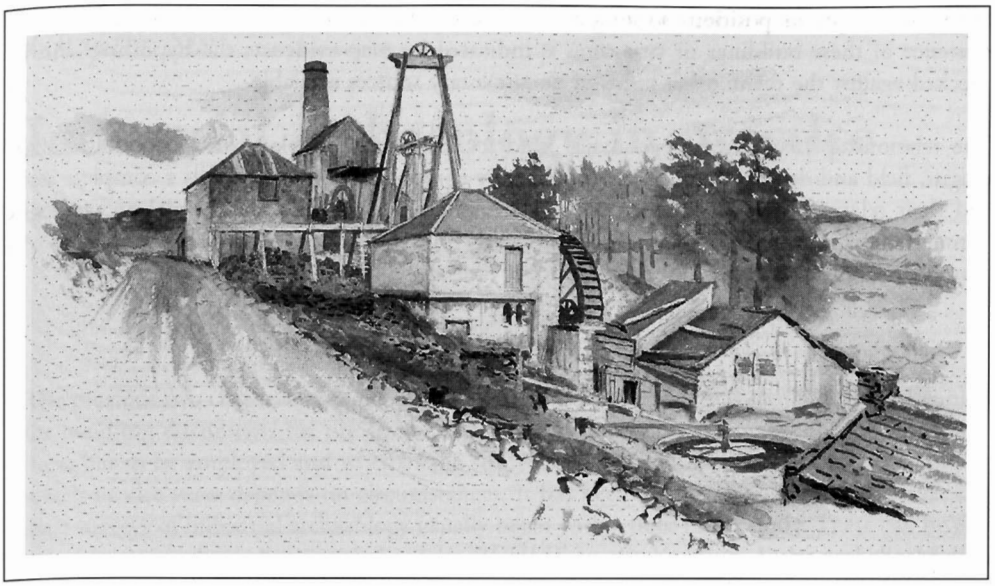

Plate 38 Cyffty mine, then known as the Pencraig mine, as painted by H. E. Tidmarsh in 1884. This view shows the steam winder, the waterwheel which powered crushing rolls in the adjacent square building and the round buddle in the foreground. This water-colour is an important source of evidence as the engine house was needlessly demolished in 1966: the site has since been consolidated and interpreted by Snowdonia National Park.

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round buddle. Together, they enable the industrial archaeologist to reconstruct the site of a small mine which was largely reduced to rubble in the 1960s (Bennett and Vernon 1993: 77).

The last example exemplifies what is perhaps the ultimate use of documentary sources, the re-creation of past landscapes and sites for which the physical evidence has disappeared. This process of re-creation has become increasingly necessary to understand the development not only of previously mined landscapes, but also of whole areas of towns where former industrial concerns have been totally obliterated. Maps provide the basic framework for these reconstructions, supplemented by many other types of evidence including aerial photographs. In order, however, to trace the spatial distribution of earlier industrial premises, the industrial archaeologist needs to understand from surviving examples, or photographic evidence, the physical characteristics of a particular type of building so that it can be recognised on early maps. For example, in Northamptonshire the stitching of leather uppers for boots and shoes was carried out in small workshops set against the back garden or yard walls separating rows of terraced houses, which were themselves spatially related to the small factories which cut out the leather and finished the boot or shoe (Palmer 1994a). These workshops can be recognised on maps because of their location, whereas the workshops of the textile industries, characterised by long windows rather than distinctive ground plans or locations, are not so easily picked out. John Prest traced the previous existence of many of the cottage factories for ribbon-weaving built in Coventry in the 1850s by the appearance on maps of groups of houses in triangles or squares around a central steam engine (Prest 1960): similar spatial relationships have been observed in the Sheffield cutlery industry. Away from towns, many industrial structures such as lime-, pottery- and brick-kilns, engine houses, arsenic calciners and buddles are also recognisable on maps by their

distinctive shapes or positions so long as they are not housed in a roofed building. Once the existence of these buildings or structures is indicated by map evidence, the hypothesis can be checked against the many other kinds of documentary sources available.

The relationship between the two major kinds of evidence available to the industrial archaeologist, field and documentary, is therefore highly complex. Neither kind tells a complete story and their relative importance varies from site to site. The aim of the industrial archaeologist is not the writing of a piece of economic history but the understanding of a landscape. An example of industrial archaeology in practice is the subject of the next chapter.