Trouble at t'mill: industrial archaeology in the 1980s

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Despite the 'archaeology' in its name, industrial archaeology is a world of its own which barely figures in ANTIQUITY *or the other general archaeology journals. A consistent trend in recent archaeology has been an interest in landscapes and the physical contexts of settlement, studies by survey rather than excavation of rich spot sites for their own sake. That landscape is usually rural, and its industry – mills, olive presses, or building-stone quarries – of a pastoral nature. Here, an approach is presented in that same spirit, as the archaeology of a more fully industrial landscape.*

Industrial archaeology has often been the butt of savage criticism by geographers, archaeologists, economic and architectural historians. Even its practitioners have argued endlessly over the definition and proper field of enquiry of the subject. But there are signs of change. The techniques of traditional and landscape archaeology are bringing to the discipline a variety of new approaches, designed to put what has often just been technical history into a wider perspective.

Hitherto the study of industrial remains has been largely undertaken by non-archaeologists, with specialist skills in technical history. Engineers, metallurgists and geologists were among those in the forefront of the field. They founded the Newcomen Society in 1919, the Historical Metallurgy Group in 1962, and today continue a long and honourable tradition of studying the evolution of technology both practically and through surviving documentary evidence.

Some of these studies moved away from machines to looking at the landscape around them. Jespersen's pioneering study of the lades which supplied water to the Great Laxey wheel in the Isle of Man (1954) did much to explain many of the engineering anomalies of the site. This, the largest water wheel in Britain, only ever worked at a capacity of 60 h.p.; its water supply had been diverted elsewhere.

But by concentrating upon technical evolution, a concern for 'firsts' crept into the subject, recognizing innovation but often ignoring utilization. This is reflected in the official definition of an industrial monument – used as a means of identifying buildings for listing and scheduling – as something which 'illustrates or is significantly connected with the beginnings and evolution of industrial or technological process' (Falconer 1981). The literature is scattered with studies of the first beam engines, the first iron bridge, the first locomotive. The significance of a relic becomes suddenly devalued if an earlier example is unearthed, as happened when an iron bridge in Yorkshire was found to be earlier than the famous example in Shropshire – built in 1779 – which had been thought to be the earliest cast iron bridge in the world (Linsley 1980).

A second type of industrial archaeology developed in the 1950s through the efforts of amateur groups, involved in university extramural teaching and the Workers Educational Association. Practical fieldwork experience was needed, and tutors found an ideal source in local industrial remains. The term 'industrial archaeology' was used for these activities by one extra-mural tutor, Michael Rix, in 1955 (Rix 1967: 5). But the claim to have invented the subject was resented by technical historians, who saw nothing new (Hudson 1979: 1). Nonetheless the term caught on, a journal was founded, and a flood of books written. The movement coincided with what has been seen

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as a wave of nostalgia for Britain's industrial traditions in the face of burgeoning new towns (Cossons 1975: 30). Today the decline of Britain's world industrial supremacy gives added poignancy to the subject.

Industrial archaeology: aims and definitions

The 1960s were a period of unprecedented destruction of industrial remains. The demolition of the Euston Arch, the neoclassical portico of the London and North Western Railway's terminus, in 1962 was a watershed, and amateur enthusiasm was now kindled. The Council for British Archaeology set up a working party to co-ordinate the recording efforts initiated by growing numbers of local societies. Groups were sent out with cameras and pro-forma cards to record what was left. Eventually over 30,000 cards were filled in on a site-by-site basis for the National Register of Industrial Monuments, some of which were later used by the Ministry of Works (later the Department of the Environment) for listing and scheduling decisions. But this uncritical enthusiasm, which espoused a philosophy of 'record it, because it is there', led to serious shortcomings. The secretary of the working party himself admitted the very poor quality of the result (Falconer 1981: 2). This may not have been the fault of the amateur, but simply that complex sites cannot be described in terms of the same few questions.

More serious was the absence of an academic framework. Archaeology is little more than antiquarianism when there is no framework – whether behavioral, economic or social – on which to hang the evidence. Throughout the 1960s industrial antiquarianism seems to have been the principal activity of many industrial archaeologists; not a discipline, but an 'agreeable hobby' (Hudson 1963: 34).

The most pertinent illustration of the absence of a framework lies in the argument concerning the meaning of the very term 'industrial archaeology', a term almost unique to Britain. In Australia and America 'historical archaeology' is more generally used. Rix's 1955 definition was, 'recording, preserving in selected cases and interpreting the sites and structures of early industrial activity, particularly the monuments of the Industrial Revolution'. Other early practitioners concurred that the core of the subject was the study of the industrial remains of the Industrial Revolution in Britain, that is the 18th and 19th centuries (Buchanan 1972: 20–21; Rix 1967: 5). The historians of the 'pre-industrial archaeology era' objected to this narrow definition, and proposed the study of industry of all periods from the Neolithic to the Victorian, pushing 'back the starting point of industrial archaeology to the appearance of organized industry with special techniques' (Raistrick 1972: 9). Needless to say, when industry or craft activity are studied in isolation, divorced from the social context, naïve cultural generalizations can occur. Recent attempts, though technically very important, do not apply the same high standards to the interpretation of culture and cannot be called archaeology (Raistrick 1972: 99; Tylecote 1986: 10).

The thematic approach is based on the principle that practitioners of industrial archaeology rely on a 'special range of disciplines, which overlap with conventional archaeology, but which are not and cannot be identical with them' (Hudson 1979: 12). W.G. Hoskins, the founder of English landscape history, was clearly intimidated by the grease and engine-bearings of industrial archaeology, and suggested that it was, 'easier . . . for an engineer to pick up his history . . . than for an historian to acquire a sound knowledge of technology, and without this he cannot hope to write Industrial Archaeology as it needs to be written' (Hoskins 1967: 12). This disregard of industrial archaeology has been continued by his successors in landscape studies (Aston 1985). The result of this technical mystique is an isolation from the wider disciplines of archaeology or economic history. Excavation techniques are rudimentary and the concept of stratigraphy is rare. Rather than asking broad analytical questions there has been a tendency to produce a very specialist form of history.

An alternative definition, put forward by industrial archaeologist and museum director Neil Cossons, considers industrial archaeology to be a period rather than a thematic study (Cossons 1975: 16). The period in question is that of the Industrial Revolution and its aftermath, and the study of it is a logical follow-on from medieval and post-medieval archaeology. The term 'industrial' is used because industry was the prime mover of this period, just as Romans were in the Britain of AD 43 to 410. Of course, as with other archaeological periods, ante- and post-cedents must be carefully

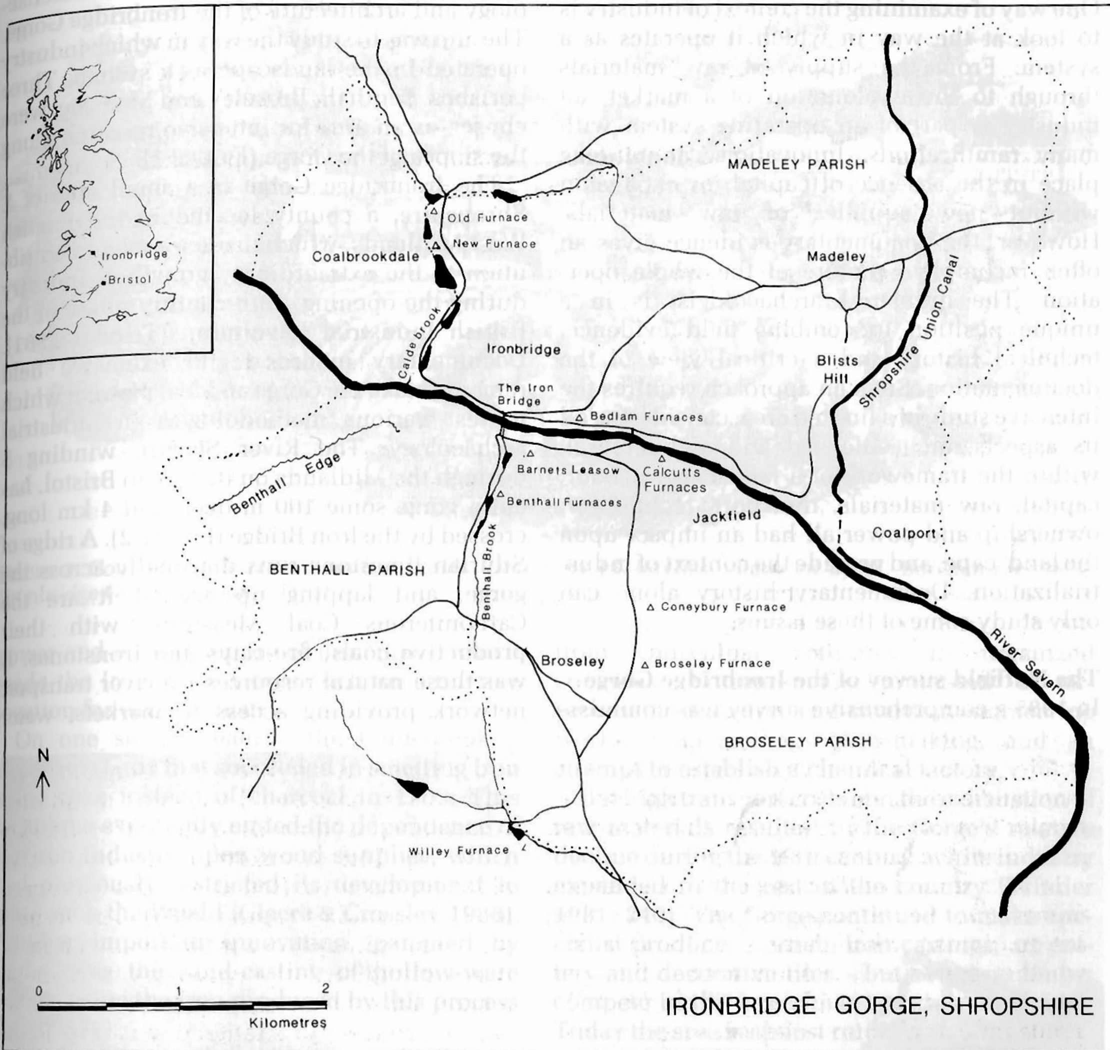

FIGURE 1. *Map of Ironbridge Gorge, Shropshire.*

considered. Period definition allows a much wider field of study: houses as well as factories, footpaths as well as railways, rural as well as urban landscapes. By placing the physical evidence for industrialization within its wider landscape, and its social context, form of serious contribution might be made at last to economic and social history. This definition placed the subject firmly within the canons of more traditional archaeology.

Concern was voiced by the founding fathers that a period definition would exclude the amateurs, who remain the main practitioners: 'industrial archaeology belongs to them, just as much as it does to the economic historians' (Hudson 1979: 6). *Industrial Archaeology Review*, the leading journal, continues to reflect the dedication to plant rather than context – accounts of lime kilns without mention of the limestone quarries which supplied them (Bick 1984), water wheels without their water systems (Moore 1984). But there is a move towards the study of regions (Cleere & Crossley 1986), settlements (Jones 1982), social conditions (Trinder & Cox 1980) and archaeology (Hayman 1986). Even the technically excellent work of the Scottish Royal Commission tends to be oriented towards monument rather than context (Hay & Stell 1986).

Industry and its context as a system

One way of examining the context of industry is to look at the way in which it operates as a system. From the supply of raw materials through to the exploitation of a market, an industry is part of an operating system with many ramifications. Innovation cannot take place in the absence of capital, or expansion without new supplies of raw materials. However, the documentary evidence gives an often incomplete picture of the whole operation. The industrial archaeologist is in a unique position to combine field evidence, technical history and a critical view of the documentation. Such an approach requires the intensive study of a limited area, considering all its aspects, archaeological and architectural, within the framework of a landscape. Labour, capital, raw materials, transport, technology, ownership and power all had an impact upon the landscape, and provide the context of industrialization. Documentary history alone can only study some of these issues.

The Nuffield survey of the Ironbridge Gorge

In 1985 a comprehensive survey was commissioned by the Nuffield Foundation of the archaeology and architecture of the Ironbridge Gorge. The aim was to study the way in which industry operated in the landscape as a system. Three parishes, Benthall, Broseley and Madeley, were chosen as an area for intensive research along the slopes of the Gorge (FIGURE 1).

The Ironbridge Gorge is a small area of E Shropshire, a county located in the English West Midlands, which made a a major contribution to the extraordinary growth of industry during the opening, 18th-century phase of the British Industrial Revolution (Trinder 1981). Documentary evidence and extensive field remains make the Gorge an ideal place in which to test various methodologies in industrial archaeology. The River Severn, winding S through the Midlands on its way to Bristol, has cut a gorge some 100 m deep and 4 km long, crossed by the Iron Bridge (FIGURE 2). A ridge of Silurian limestone runs diagonally across the gorge, and lapping up against it are the Carboniferous Coal Measures, with their productive coals, fire-clays and ironstones. It was these natural resources – a river transport network providing access to markets, water

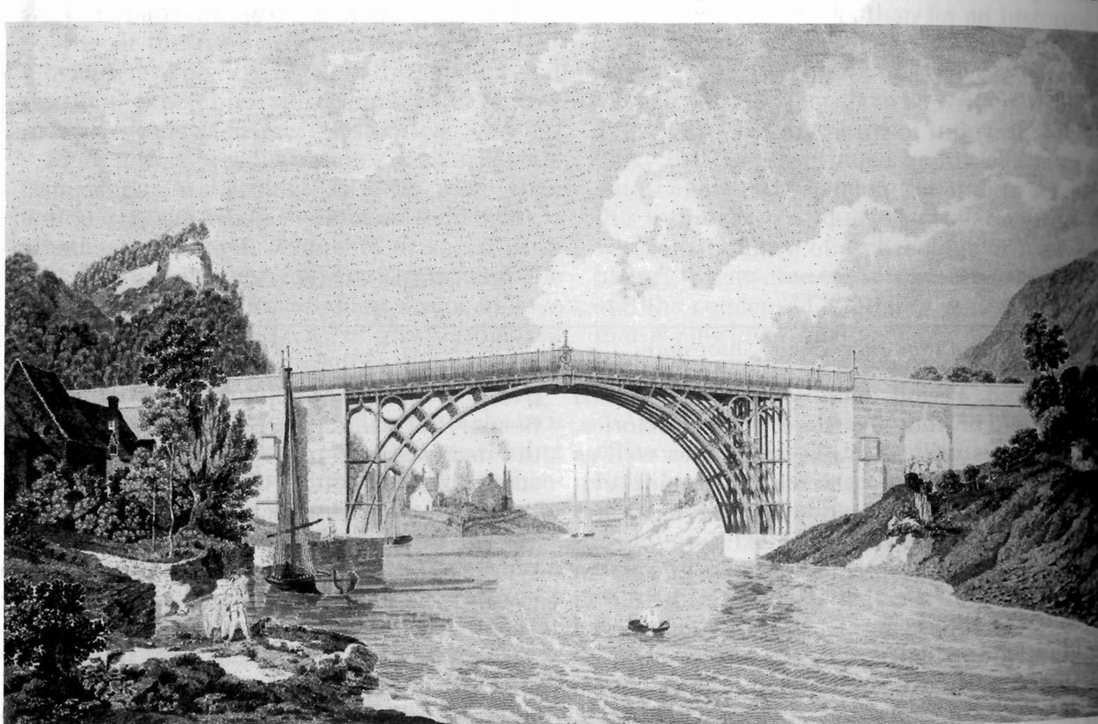

FIGURE 2. *A view of the Cast Iron Bridge near Coalbrookdale, by William Ellis after Michael Angelo Rooker, 1780 , showing Benthall Edge in background). (British Library.)*

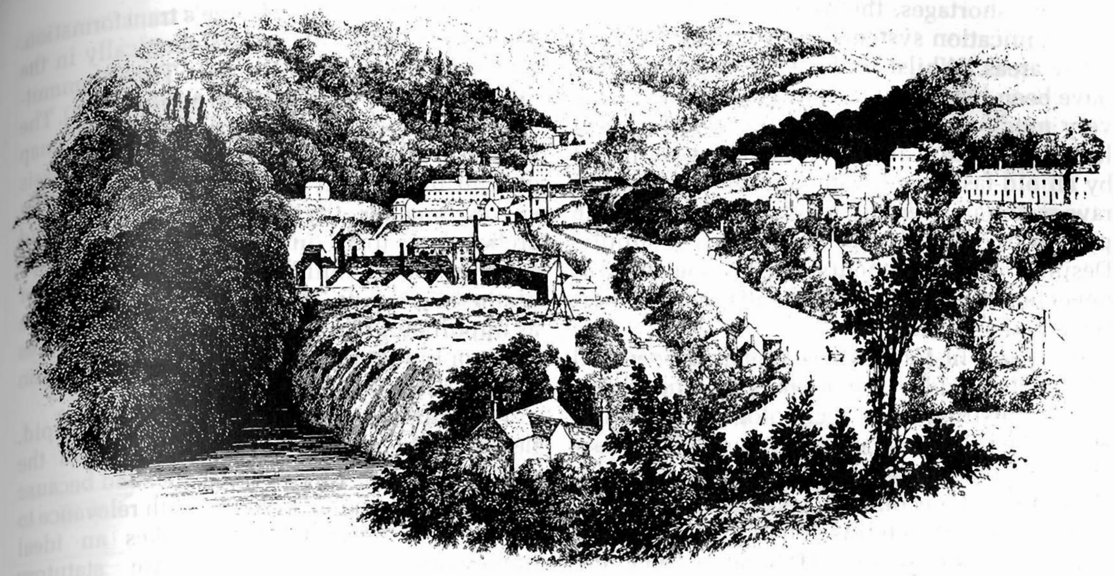

FIGURE 3. *Coalbrookdale from Paradise Fields. Drawn by J.C.Bayliss, engraved by W. Bangham, c. 1856. (Ironbridge Gorge Museums Trust.)*

power and a local supply of minerals – which made the Ironbridge Gorge such an attractive location for early industry.

On one such stream – the Caldebrook – Abraham Darby first succeeded in smelting iron using coke instead of charcoal in 1709. This technique eventually ended the dependence of the iron industry upon wood supplies, which had previously restricted its development to areas such the Weald (Cleere & Crossley 1986). Another important innovation, patented by Darby, was the sand-casting of hollow-ware vessels using the iron produced by this process (Mott 1957).

By the 1750s, Shropshire was the largest producer of iron in Great Britain (Trinder 1981: 21), and in 1800 the Gorge, described by one contemporary traveller as 'the most extraordinary district in the world' (Trinder 1977), contained at least 12 iron furnaces, the largest concentration in Britain. The rapid success of the iron industry led to further innovation and industrialization. The Coalbrookdale company was involved in the early development of atmospheric and steam engines, iron railways, locomotives, iron-framed buildings, bridges and canal aqueducts (FIGURE 3). Local industries expanded during this period. Both pottery-making at Jackfield and the 16th-century clay-pipe industry at Broseley were transformed from individual activities to organized concerns. Entrepreneurs promoted a tar-processing industry, lead-smelting, engineering works, brick-making, glass-making, and an attempt to establish a chemical factory.

But high transport costs and the exhaustion of raw materials resulted in the Gorge's relative decline during the 19th century, while industry expanded in the rest of the country (Trinder 1981: 240). The Gorge continued to make specialist products – ornate iron castings, art pottery and decorative tiles – but could no longer compete in the larger mass-produced markets. Today the area is almost rural again. The artisan settlements of Ironbridge, Coalbrookdale and Broseley remain largely unchanged and their industrial buildings deserted. This preservation of the industrial landscape has enabled a group of museums, using the Iron Bridge as its symbol, to present the industries and way of life of the last two centuries (Cossons 1979).

Various explanations have been put forward for the extraordinary expansion of the Shropshire iron industry in the 18th century. Innovation, a fortuitous supply of suitable coking coal, an ideal location for both transport and raw materials, and the entrepreneurial abilities of the iron-founders themselves, have all been suggested. In turn the equally rapid decline of the area has been attributed to raw material shortages, the distance from the new communication systems and competition from other areas. Whilst each of these factors may have been important, archaeology has shown a very much more complex situation at a local level. Innovation at Coalbrookdale was limited by an old-fashioned water system. Shortage of raw materials were as much a product of the pattern of ownership as exhaustion of supply. Despite the entrepreneurs, the river Severn was never made easily navigable, and river transport remained seasonal.

Economic historians have remained sceptical of the 'Ironbridge' phenomenon. Underlying this is a distrust of the technological determinism which occurs when industrial archaeologists place too much emphasis upon invention. The economic take-off after 1750 is more often seen in terms of national conditions of economy and society (Hobsbawn 1969: 38), than the discovery of the use of coke in iron-smelting or the design of the Spinning Jenny. It is hardly surprising that economic historians have little time for industrial archaeology.

Survey methods

Archaeology has developed a number of techniques for field survey, mainly based on the principle that the archaeological record is the sum of a definable number of individual sites (Mueller 1975). But it became obvious that a site based methodology, as used by the county Sites and Monuments Records for example, was inappropriate to the Ironbridge Gorge. The sheer complexity of the remains means it is not always possible to define where a site begins or ends, or to untangle its links with other landscape features. The method of landscape historians – investigating the landscape as a single site, often concentrating on single periods of activity, and invariably in a rural context (Taylor 1974) – also seemed inappropriate. The density of remains, the standing buildings, the area covered and the need to include much of what most archaeologists would classify as modern material, made it impossible to adopt a single site approach. Some means had to be found to divide up the landscape for study, without recourse to 'spot' sites.

The Nuffield survey chose to cover the whole landscape by examining individual plots of land. These plots are the units in which land has been described, conveyed and occupied since before the period of the Gorge's transformation. They were first mapped systematically in the enclosure awards and the later Tithe Commutation maps of the 1840s (Kain & Price 1985). The 1:2500 first-edition Ordnance Survey map shows in great detail these plots, still the basis of land division in the United Kingdom. Plot survey enables the study of buildings and archaeology to be integrated, and avoids the need to select buildings on architectural or aesthetic grounds. Housing and settlement are as important to the archaeological landscape as fields or industrial areas. Transport systems can also be adequately described.

This intensive treatment has proved a rapid, flexible and effective method. It forces the recording of the whole landscape, and because it uses defined parcels of land with relevance to the growth of settlement, makes an ideal framework on which to base statutory protection.

Two examples of the value of the wider approach can be suggested from the survey of the Gorge. The first concerns the development and the decline of water-powered iron-working in Coalbrookdale; the second, the supply of raw materials from Benthall Edge, on the south side of the river.

Water power in Coalbrookdale

Coalbrookdale provides a case study demonstrating a systemic approach to the industrial landscape (Clark & Alfrey 1986). One of the valleys leading down to the River Severn, it was the site of Darby's experiments in iron production in 1709 using an existing charcoal blast furnace, constructed around 1638. This 'Old Furnace', taken over by Darby, formed the nucleus of the Coalbrookdale Company. A second furnace was added lower down the valley in 1715. Other activities, on sites leased out to individuals, included forging, machine-tool making and puddling wrought iron. The whole complex was initially powered by water. A series of man-made pools was created to control the flow of water and to provide power (FIGURE 4).

The Coalbrookdale company has been well researched from documents, illustrating the operation of a family company as it grew from a small operation smelting iron and casting pots – taken by Darby himself to local markets – to a major producer of iron goods sold throughout

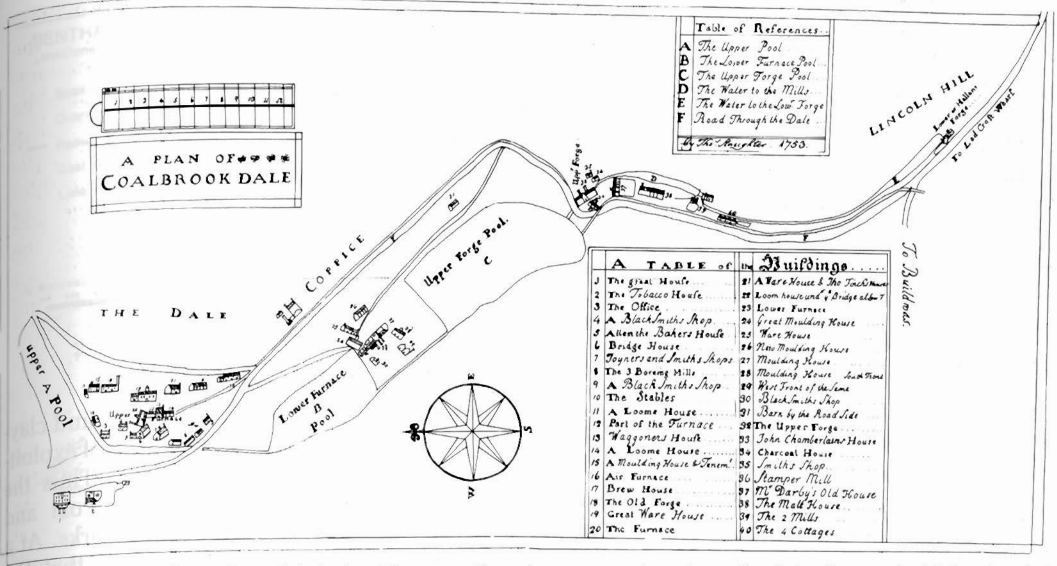

FIGURE 4. *A plan of Coalbrookdale by Thomas Slaughter, 1753 (tracing of original map held by Ironbridge Gorge Museums Trust).*

the world (Raistrick 1953). But the company continued to rely on water-powered equipment well after the invention and use of steam engines, which they themselves helped to pioneer, for blowing the furnaces used for smelting iron. By the early 19th century its furnace operations were so expensive that it ceased smelting. Why did this happen?

Archaeological field survey in the Coalbrookdale valley gives a solution. The system of water power in the valley predates the arrival of Abraham Darby; a water-powered smithy existed in 1536, and iron was smelted before 1645 (VCH 1985: 48). The Upper Furnace pool was driving a large water wheel that provided air blast for the 17th-century 'Old Furnace'. The Upper Forge pool relates to a complex of small industrial buildings dating to the same period, part of which was used for steel-making (Wanklyn 1973). Below this pool the outlet respects Rose cottage – which may also have been an industrial building – dating to 1544. Another 17th-century cottage suggests early occupation at the bottom of the valley, and the dam creating the Lower Forge pool may date to this period.

Thus when Darby took over the Upper Furnace site, he inherited a complex and long-established water power system, dating back to at least the 16th century. His only addition to the system was the Lower Furnace pool in 1715 built to power his new furnace. The expansion of iron production in the 18th century meant there was insufficient water to work the wheel which operated the bellows for the furnaces. This was due to seasonal variation in the flow of the Caldebrook, a small stream with a limited catchment area. During the summer months, the furnaces were often shut down for lack of water (Raistrick 1953: 107). The manager of the works, Richard Ford, installed a 'machine for discharging a part of our water back into ye pool' to get round this problem. A horse-powered lifting pump at the new furnace took water from the Upper Forge pool into the Upper Furnace pool in 1735. This must have proved inadequate, as water shortages continued, and in 1742 the horse gin was replaced by a Newcomen atmospheric engine. Furnace figures show a marked improvement in output (Raistrick 1953: 109).

But even this new engine proved insufficient to recycle water during dry summers, so a drastic scheme was completed in 1781. This involved 'a subterraneous passage about half a mile in length to a pit at the top of the works 120 feet deep' (Anonymous 1801), linked to a new Boulton and Watt engine (called *Resolution*) of 102.6 h.p., the largest steam engine ever built at that time. This massive steam engine was employed in order to recycle water so as to keep old water-powered equipment in operation.

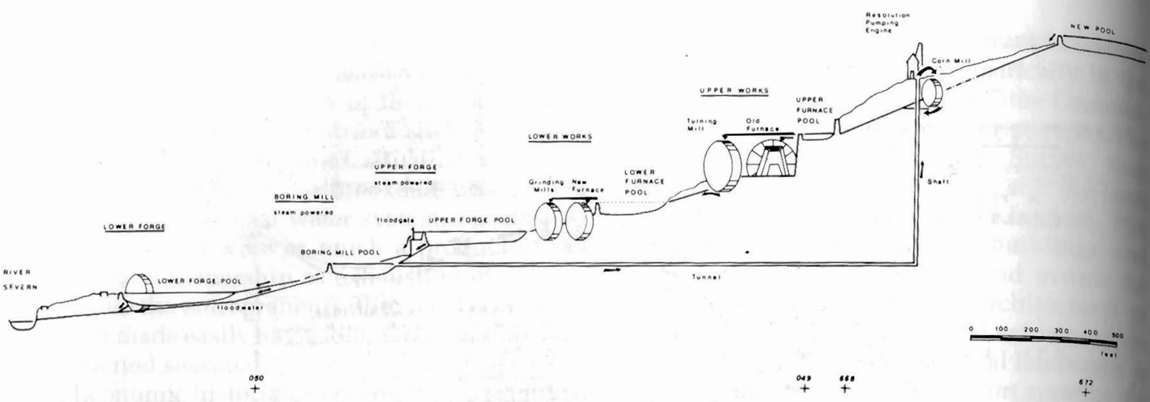

FIGURE 5. *Coalbrookdale – water power 1801–5, schematic section.*

The investment is surprising in view of successful use of a much smaller Boulton and Watt engine directly to blow a furnace in 1776, at Willey on the other side of the Gorge (Trinder 1981: 273).

Clearly it was considered economic to make a large investment in recycling water, and keep old water-powered machinery in operation, than to replace existing plant, which included small and obsolete furnaces. In 1815 an observer remarked that the furnaces were 'blown by a water wheel, all the machinery old and clumsy and all the works seem to be conducted upon the old plans of forty years ago' (Trinder 1977). Soon after 1817, the Coalbrookdale furnaces went out of operation, and the company thereafter concentrated on castings. A company which had been in the forefront of innovation was, by the beginning of the 19th century, hamstrung by the water system that had made its early success possible.

Summer water shortages at Coalbrookdale had been identified through documents (Raistrick 1953), but until detailed field survey was undertaken it was not possible to place this information in the context of its landscape. The height of water head and the diameter of water wheels (calculated, for example, from scratches on the side of the Old Furnace) can be established with precision (FIGURE 5).

Field survey has demonstrated the scale of the system, and explains the company's reluctance to abandon an inefficient but massive investment.

Raw materials on Benthall Edge

The supply of coal, ironstone and limestone was another vital element of iron-smelting, while the clay obtained as a by-product supplied the large brick, tile, pottery and clay-pipe making industries. This pattern of exploitation led to integrated operations. Thus the Madeley Wood Company, mining coal and smelting iron, also operated brickworks. At a very much earlier date, it appears that the making of clay pipes, requiring white clays, was closely linked with the 16th century coal-mining in Benthall and Broseley. Unfortunately almost no documentary evidence survives to explain the mechanics of this local supply network. Here again a systemic approach may be applicable.

Benthall Edge is a 100 m high scarp of limestone on the S bank of the river Severn (FIGURE 2). The cliff is capped with the best-quality limestone which is needed for fluxing. Lower deposits of poorer-quality stone could be burnt for lime and building mortar. At the E end, the Broseley fault upthrows coal measures, containing ironstone, fireclays and good-quality coal (FIGURE 6).

Archaeological survey of the network of limestone quarries, roads and railways along the scarp shows four phases of working.

To the W, medieval quarrying is linked with the very early road to the near-by Cistercian Abbey of Buildwas. The quarries that run along the top of the scarp provided the fluxing stone needed in the smelting of iron. This was removed via a group of roads which converge at a point on the river bank where a wharf was located. None of these quarries have lime kilns. This exploitation represented the transport of fluxing stone by river, probably for the early-18th-century iron industry at Coalbrookdale. Documentary evidence refers to barge owners shipping stone to Ludcroft Wharf, at the foot of Coalbrookdale, shortly after 1718.

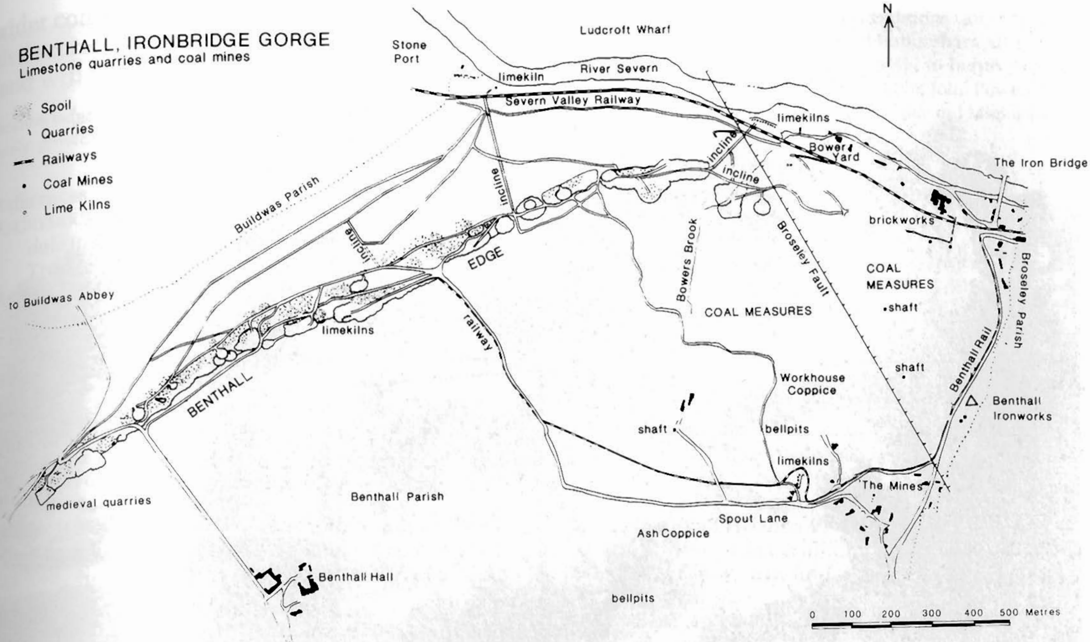

FIGURE 6. *Benthall, Ironbridge Gorge. Map showing limestone quarries and mines.*

Another series of long, open quarries is linked with a railway, leading in the opposite direction, towards Broseley. Twenty kilns are known from map and field evidence, all relating to this railway. Most of this stone was used for agricultural lime. One set of kilns was new in 1800, and the railway was still in use for lime-carrying in 1844. The railway was connected with Benthall Rail, a wooden horse-drawn railway in existence by 1686, which runs down to the river Severn. Finally at the eastern end of the scarp two inclines lead down to 10 lime kilns on the river bank (FIGURE 7). Initially the lime was taken out by river, but when the quarries were reopened c. 1920, another incline, crushing machinery and railway siding were built.

The exploitation of coal and clay followed a similar pattern. Because the coal measures outcrop on the surface, the earliest exploitation was in surface workings. Later, shallow bell-pits and horizontal adits were dug into seams. In the 19th century the easily accessible coal was exhausted, and deeper shafts were dug. The bell-pits of Workhouse and Ash coppices date from the 17th centuries and were linked into the same wooden rail network as the limestone, one of the earliest in the country. Just as the shortage of summer water restricted the activities of the Coalbrookdale company, so the inability to secure adequate supplies of raw materials must have been one factor in the decline of iron-smelting in the Gorge. There seem to be two reasons for this, exhaustion and ownership.

Archaeological evidence suggests that the most easily exploited coal, ironstone and limestone was taken out before 1750s. What little remained was probably used by the Harries family, who owned the mineral rights, for their own iron-smelting operation close to the end of the Benthall Rail. The same railway system linked with the New Willey Furnaces, operated by John Wilkinson from 1757, and the Old Willey furnaces established in the early 17th century and rebuilt in the 1750s.

Benthall Edge was one of the closest sources of limestone for other furnaces of the Gorge, but most of the ironmasters were forced to obtain fluxing stone from more distant sources. The Coalbrookdale Company bought limestone from Much Wenlock and Gleeden Hill, 4 km beyond Benthall Edge. The partners in the railway to the Stone Port at Buildwas (who operated the furnaces at Bedlam, Calcutts and Wrens Nest) obtained stone from Wyke and Tickhill, and not from the near-by Edge. By 1835 the furnaces were using stone carried from Llanymynech on the Welsh border along the Shropshire Union Canal.

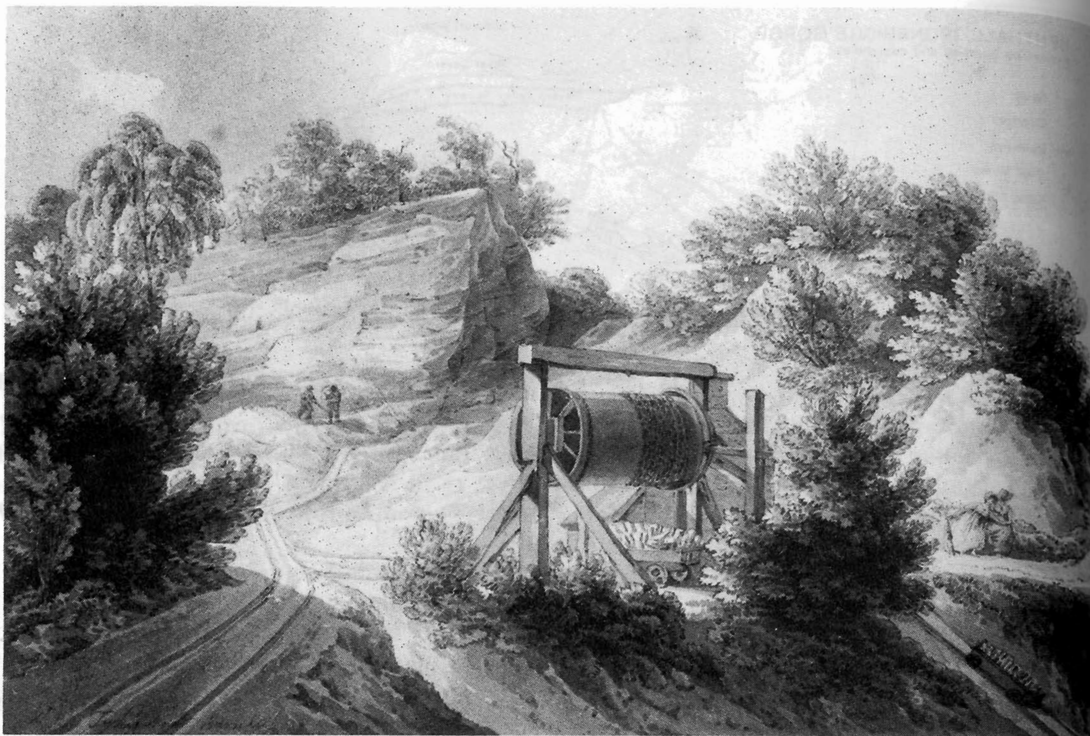

FIGURE 7. *Tykes Nest, Broseley, by Joseph Powell, c. 1816–18, showing limestone workings, railways and winding mechanism for inclined plane. (Reproduced with permission of Trustees of the Victoria and Albert Museum.)*

Although content to allow the quarrying of the poorer-quality shales for lime-burning, which took place on a very large scale in response to agricultural improvements in the late 18th century, it seems that the Harries family did not provide limestone for competing furnace-owners, however profitable this would have been.

Landscapes of industry

The Ironbridge Gorge shows how the development and decline of industry can best be understood within the fuller framework of the physical environment. This environment made possible the initial success of industry, by providing a minerals, water power and transport. In the same way it hamstrung long-term industrial development, through the exhaustion of raw materials and the inaccessibility of the Gorge to later transport networks. The early investment in equipment to harness and exploit this environment was on such a large scale that the operating companies were unwilling to replace it with more efficient manufacting systems. It was the rapid and early success of the Gorge which led to its long-term decline.

The process is very evident in the surviving landscape, which incorporates evidence for different factors of production: natural resources, capital, labour, patterns of ownership and networks of communication. The study of the changes in this landscape over time, using both documentary evidence and traditional methods of archaeological field survey enables long-term processes to be understood. An industrial landscape archaeology provides the overall view of the interaction of a variety of systems through space and time. The approach developed at Ironbridge extends beyond industrial archaeology to suggest a new tool for classical, economic and social historians as well as archaeologists. In history as well as archaeology, wider aspects of ancient society are being incorporated, town as well as countryside (Osborne 1987), the smith as well as the forge (Herbert 1984). Those developments are directly analagous to our approach to industrial archaeology, which considers the machines in a wider context. Perhaps the procedures of intensive survey based on the plot-by-plot analysis of land will be of more general applicability.

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