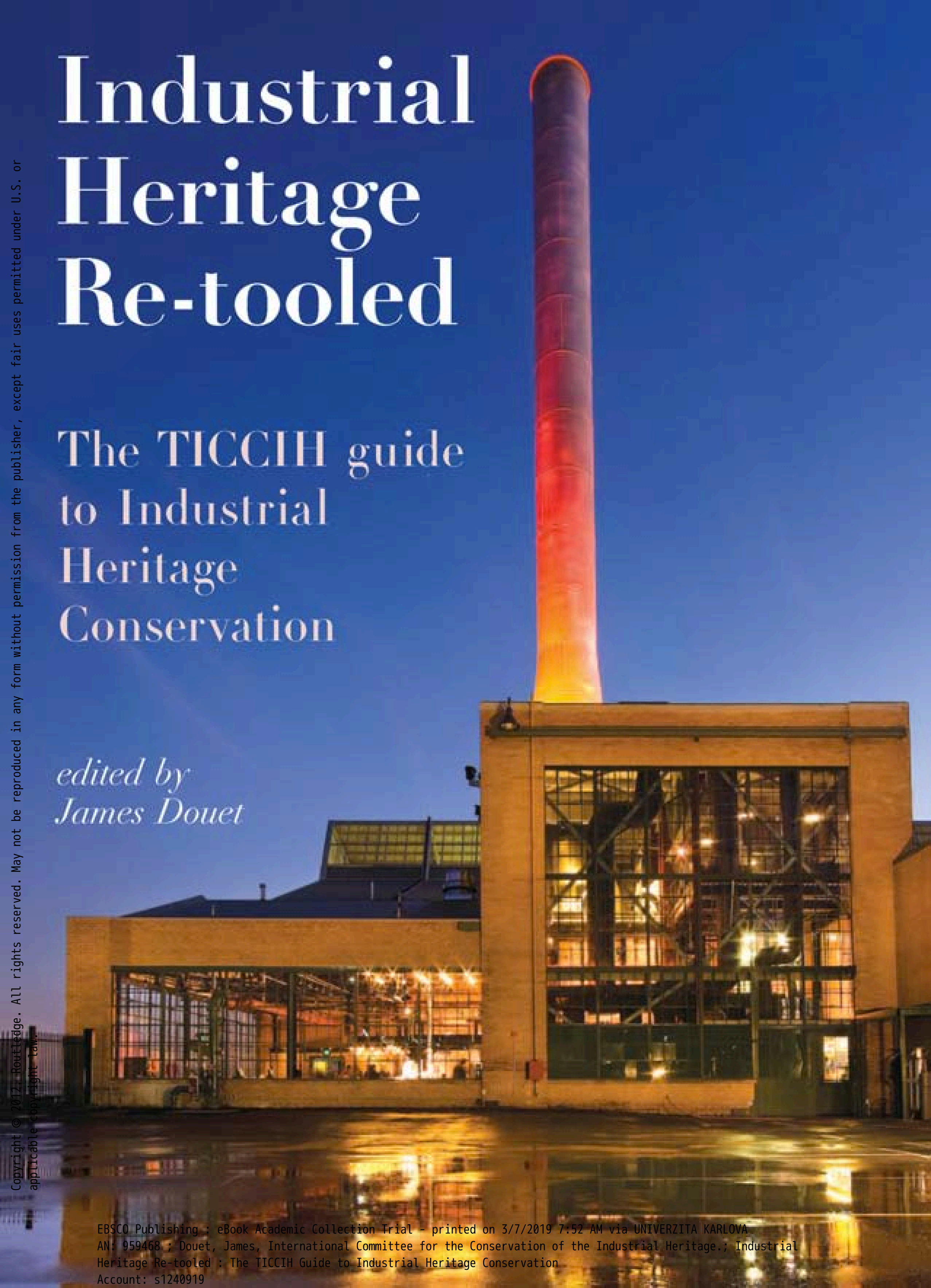
Industrial Heritage Re-tooled

The TICCIH guide to Industrial Heritage Conservation

edited by
James Douet



THE TICCIH GUIDE TO INDUSTRIAL HERITAGE CONSERVATION

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The International Committee for the Conservation of the Industrial Heritage

TICCIH

J.M. KAPLAN FUND

TICCIH – The International Committee for the Conservation of the Industrial Heritage – is the international organisation for industrial archaeology and the industrial heritage. Its aim is to study, protect, conserve and explain the remains of industrialisation. For further information and how to join, see www.ticcih.org

Frontispiece:
The challenge faced by industrial heritage:
empty and maltings in Lincolnshire, UK. (Masaaki Okada)

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Introduction

James Douet

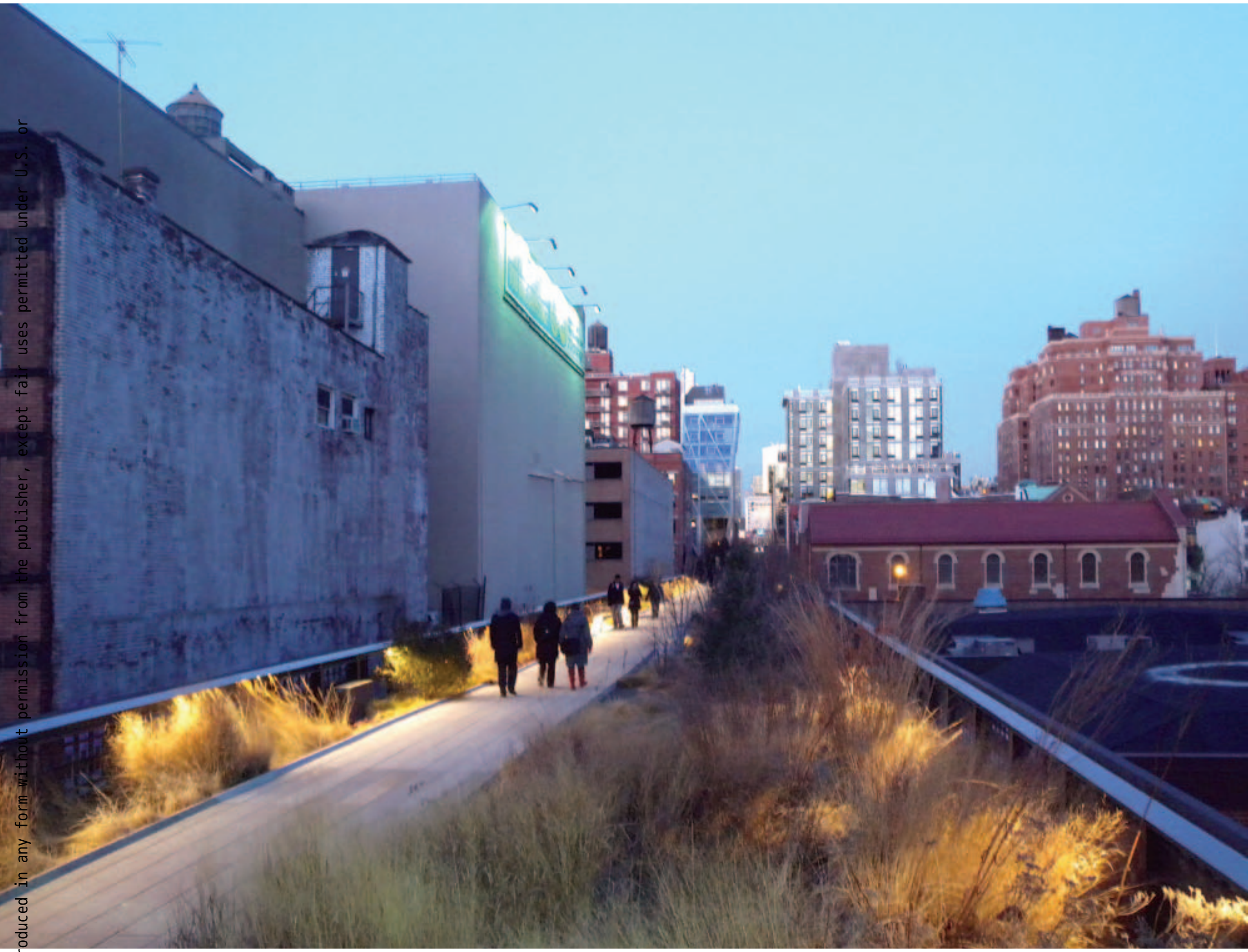
RETOOLING is an industrial engineer's term; it means reequipping a factory with the latest machinery and the most modern methods in order to keep it up to date and competitive. This book aims to perform a similar function for everyone interested in the heritage left by industry, collecting together the most effective techniques and modern practices, tried and tested around the world, for dealing with this singular cultural legacy.

Singular but challenging, too, for its technical complexity, its economic weight, its scale and magnitude, its social consequences as well as the negative perceptions that sometimes hamper its appreciation. What should we make of the industrial heritage, how can we make the most of it, and the best of it?

Consider its scope. Of the 'cultural goods' that modern societies aim to sustain for their future well-being, few are more universal than the industrial heritage. This, therefore, is not a book just for industrial archaeologists and heritage managers. In any part of the world affected by industrialisation, archaeologists are certain to encounter material from the period, while architects and builders have greater opportunities to adapt and re-use old industrial buildings than any other, for their quantity as well as versatility. Their embodied energy helps environmentalists to deliver sustainable development goals. Adapting and repurposing them are now mainstream strategies for urban planners. As tourism becomes central to the economy of many towns, the potential of the industrial heritage is fast becoming apparent. Similarly, the educational possibilities offered by historical industry are a resource of which schools and teachers must be aware. Meanwhile, the 'challenge of the evidence' – the intrinsic evidential value of the places – continues to confront historians and academics wherever industrialisation had, or is having, its transformational consequences.

This phenomenon is not exclusive to the rust belts or ghost towns of post-industrial decline in northern Europe and America. The most striking examples of factory adaptation, urban regeneration or historic interpretation are no longer in the canonical cradles and birthplaces of the Industrial Revolution but likely to be found in Shanghai, New York or Istanbul.

In 2002 The International Committee for the Conservation of the Industrial Heritage, (TICCIH), hammered out a charter, signing it in the great steel-milling and tank-manufacturing town of Nizhny Tagil in the Russian Urals. International charters are a way of formulating key concepts and fundamental methodologies, which the Nizhny Tagil Charter does for industrial archaeology. It proposes some basic definitions



The High Line park in New York is an elevated railway that passes through Manhattan's West Side. It is owned by the City of New York and maintained and operated by a non-profit conservancy, the Friends of the High Line. The linear park is credited with revitalising a swathe of the city, generating $2 billion in private investment alongside the park and contributing to 12,000 jobs in the area. (Jim Henderson – Creative Commons)

for the scope and period of the subject, while advising on the best ways to understand, maintain and share what is especially meaningful about the remains of industrial culture. In 2011 a further framework document was signed, this time by TICCIH and the International Council for Monuments and Sites (ICOMOS), their *Joint Principles for the Conservation of Industrial Heritage Sites, Structures, Areas and Landscapes*. This took place in Dublin, hence the name 'Dublin Charter'.

To get the most from these skeletal 'doctrinal texts' they need to be fleshed out and clothed, which is the idea behind this book. *Industrial Heritage Retooled* started as a 'glossed' version of the Nizhny Tagil Charter. Specialist authors would be invited to elucidate and expand the sparse text of the Charter's main clauses, illustrating them with examples drawn from outstanding heritage sites around the world.

The title of the book comes from a 2010 symposium held in Tarrytown, New York, co-sponsored by the J M Kaplan Fund. The assembled experts explored the present and future of America's industrial heritage, and asked some tough questions about how the heritage of industry gets treated alongside other more familiar or amenable remains of our past, and what sort of tools and resources can and should be applied to keep it in good shape both for now and in the future.

The symposium was intended as a launching pad for new ideas and this is one of them. Patrick Martin forged the link between the symposium and TICCIH, of which he is President. *Industrial Heritage Retooled* – the book – was also made possible by the open-handed financial support of the J M Kaplan Fund, and the backing of a key member of the Fund's staff, Ken Lustbader. It was he who framed the specific goal that it be a definitive international guide to contemporary best practices. The book was to be presented in an accessible and approachable format and written for a wide audience of enthusiasts, preservationists, community-based not-for-profits and private-sector developers, industrial archaeologists, teachers and scholars.

Through TICCIH's international network, more than thirty expert authors were identified and brought together, each kindly agreeing to contribute a chapter on a subject with which they were intimate through many years of research, reflection and professional experience.

The book opens with four reflective essays which set out the essential values and meanings associated with the Industrial Revolution, industrialisation and its material and cultural heritage. Part II examines the methodological and technical options that we have available to interrogate the raw material, the physical evidence for industrialisation and the societies that developed within it: artefacts, structures, sites, processes and landscapes as well as documents and images.

Part III presents the procedures by which the abundant resources of *industrial archaeology* are transformed into the valued but vulnerable material we try to capture and conserve as *industrial heritage*: what is to be selected and why; how to protect and to manage change while ensuring that historic value is sustained; how conservation can also be an economic catalyst; all the modern techniques for adapting or repurposing sites without disproportionate sacrifice; profiting from the in-built energy in existing buildings; letting nature conserve the industrial ruin; the benefits that community participation inspires; and finally the dynamic of World Heritage and the spin-off and trickle-down effects that nomination and designation can prompt.

The industrial heritage identified, understood, protected … Part IV examines how it can be shared and enjoyed. The industrial museums and the conserved production sites which have opened to visitors in recent years have brought a sometimes difficult and unapproachable subject to a wide public, including disproportionate numbers of the young. The success of innovative techniques for preserving and interpreting working machinery and for presenting complex processes is evident in their unprecedented visitor figures, as well as in the growing number of people, loosely categorised as tourists, who set out to discover places once thought inimical to tourism.

The fifth section of the book discusses the part education has to play, not only by traditional methods but also through the internet, in making sure that public heritage agencies, non-profit groups, archaeological contractors, architectural practices, consultancies or owners, are suitably equipped to treat the historic material of industry in an informed way.

This publication is an important step for TICCIH and part of a determined effort to reach beyond the organisation's habitual constituency. Patrick Martin takes much of the credit for giving definitive form to the original idea. Neil Cossons' support and advice contributed greatly to the final shape and style of the book. The Nizhny Tagil Charter around which it is structured is one of Eusebi Casanelles' major achievements. All three, together with Terry Reynolds, Benjamin Fragner, Barry Gamble, Massimo Preite, Iain Stuart and Alison Wain made valuable comments on the texts, and thanks are also due to Myrick Howard, Marie-Noëlle Polino and Hans-Peter Bärtschi. All the photographic credits are in the text, but particular thanks to Billy Hustace for permission to reproduce his photograph on the cover. Finally, special recognition is owed to all the authors, each connected with TICCIH over many years, who have tapped an immense reserve of professional experience and personal enthusiasm to produce perceptive and illuminating chapters.

Part I

Values and meanings

1

Why preserve the industrial heritage?

Neil Cossons

The world order is changing. Inexorably, the economic centre of gravity is moving east. That progression is driven in the main by the industrial revolution taking place in China. For some three centuries industrialisation has been the crucial prime mover of global economic and social change as one country after another has lifted itself from agrarian dependency to some new form of prosperity. Only industrialisation enables nations to make that transition. The effects have been wide-ranging and profound. For some, industrialisation has become the central engine of their economies. For others, moving successively from primary commodity producers to adding value through processing has enabled them to achieve increased economic self-determination.

Historically, the effects of industrialisation have been challenging and far-reaching. The legacy is prolific and overwhelming. In most industrial countries urbanisation has been one of the more significant of the social and economic consequences. Today, for the first time in human history, more people live in towns and cities than in rural environments. Far-reaching improvements in the standard of living and per-capita GDP, and advances in national power and enhanced global status, are all qualities reserved for industrial nations. Capitalism as we know it is also a product of nineteenth-century industrialisation; so too are socialism and communism. And, although globalisation has its roots well before the age of industry, it has been the development of the extraordinary commercial and trading empires of the industrial world that has given real meaning to the term. Out of this has grown the most fundamental change in the human condition and the human habitat.

Today, flourishing trade and industrial investment among emerging countries represents a further dramatic shift in how the world economy has worked for over two hundred years, replacing the traditional flow of natural resources into the industrial West, which in return exported textiles and other factory-made goods to the developing world. The United States is no longer India's largest trading partner; China has assumed that position. And India and Brazil both export more manufactured goods to fellow emerging markets than to the developed world. China is the largest foreign investor in Brazil, challenging the historical dominance of the United States in South America; and, Russia's Rusal, the world's largest aluminium producer, launched its first public offering not in London or New York but on the Hong Kong stock exchange.

There is abundant evidence too that existing industrial nations that neglect their manufacturing capability, and the technological innovation that underscores it, and that fail to adapt to these seismic global transmutations, will fall back in terms of national and per-capita GDP and long-term economic sustainability. As new nations industrialise so older ones have to consider their position in the changing world order. Where does their future lie? And what, if anything, do they do with their past?

In the second half of the eighteenth century, the early stirrings of what by the 1840s had come to be called the 'Industrial Revolution' could be found, first in Great Britain and increasingly across Western Europe; new technologies, new methods of organising labour, new means of applying the power of water or steam to manufacture, in new forms of buildings that we now call mills or factories and, crucially, new models of settlement. And in these new industrial communities grew up a new industrial culture with patterns and conditions of work that were novel, replacing the thousand-year traditions of seasonality and uncertainty that had characterised pre-industrial agricultural economies. The industrial heritage is a complex amalgam of places and people, processes and practices, which continues to defy explanation of its origins and astounds in the effects of its subsequent development and decay.

Values

All this raises the question of whether, given the overwhelming magnitude of the three hundred-year-old industrial experience, it has a history and heritage that matters and, if so, why and to whom? It is only in the last fifty years or so that industrial heritage – recognition and valuing of the material evidence of industrialisation – has begun to figure in our consciousness. There are several reasons for this. Most of the initial interest

Ditherington Flax Mill, Shrewsbury, England, built in 1796/97, is the world's first iron-framed building. It was converted to a maltings in the 1880s. This *c.*1970 photograph shows one of the malt floors shortly before closure. Now empty, it is in the ownership of English Heritage but its future remains uncertain. Too precious to lose, too fragile to use, the flax mill illustrates the dilemma of buildings of high evidential value but low utility. (Brian Bracegirdle/Ironbridge Gorge Museum Trust) in what is today called heritage grew out of curiosity about and study of the history and archaeology of the medieval age and earlier. Indeed, in Europe the desire to preserve the past was in some senses a consequence of industrialisation and its cataclysmic effects on pre-industrial communities and landscapes.

So, when we contemplate the values attaching to the industrial heritage we need to understand that, despite the overwhelming impact of industrialisation on the lives of us all – and in part because of it – the public's perceptions of heritage derive from roots, sentiments and attitudes that lie elsewhere, in an earlier age and a different aesthetic. Industrial heritage is a new, novel and challenging arrival in the heritage arena. Defining why it matters is important not just for the public at large but for many heritage organisations and professionals. For these reasons it is crucial to understand what we mean by value and importance and, at the same time, recognise that the techniques of preservation and conservation built up over many years in the wider historic environment sector do not necessarily meet the demands of industrial heritage. Just as industrialisation has been a new and unique economic and social phenomenon, so too the challenges posed by the conservation of its remains require innovative new approaches. Often, legislation defined for one purpose may not fit the new demands posed by the industrial heritage. All these factors impact on the approach to determining value. Indeed, having a clear understanding of value is the more important in an environment where levels of understanding and acceptability may be low. The context – social, economic, environmental and political – all need to be taken into account. So too do the skills and predilections of those who have a stake in the future, as public or practitioners, developers or heritage professionals. Industrial heritage is, arguably, a unique cultural discourse; it brings challenges found nowhere else in the heritage sector and requires new answers, for there are few precedents. It is not for the faint-hearted.

Dramatic as the arrival of industrialisation may have been, as the most significant engine of change in human history, the effects of its decline have often been equally cataclysmic, reflected in decay, dereliction and despair. Here again, the heritage of the post-industrial poses unique challenges; to find a future for industrial places in the context of economic fragility and the social issues that so frequently stem from it. To advocate preservation of a redundant industrial site, basing the arguments on traditional heritage values, does not always look attractive to a community afflicted by economic collapse or high levels of unemployment. Or, alternatively, while the community may find the notion appealing, offering as it might the chance of capturing something of their former spirit and pride, harsh economic circumstances make realisation by conventional means an impossibility. It is in these contexts that one might legitimately ask, 'why preserve the industrial heritage?' Finding answers often poses challenges beyond the ordinary.

Consider some of the basic principles. First, the material heritage has intrinsic value as evidence of a past. This evidential value may derive from its archaeology; the remains are the means of our understanding a past and a people. In this respect industrial remains enjoy common currency with other archaeological verification. Often, documentary evidence, unavailable to those who study earlier periods of history, can provide additional – and sometimes the most substantive – information. But it is rare that documentary sources can wholly replace the physical. Increasingly, as industrial studies have matured over recent years, the real contribution that material evidence can make to understanding has become apparent. This evidential value reflects activities that had and continue to have profound historical consequences, and the motives for protecting the industrial heritage are based on the universal value of this evidence.

But evidential importance in the archaeological sense is not the only value attaching to industrial sites and landscapes, nor is it necessarily the most significant. The industrial heritage is of wider social and cultural significance as part of the record of people's lives, and as such provides an important sense of history and identity. That may relate to an industry, a specific company, an industrial community, or a particular trade or skill. Or, the industrial heritage may have technological and scientific value in the history of manufacturing, engineering and construction, or have aesthetic qualities deriving from its architecture, design or planning. These values are intrinsic to the site itself, its fabric, components, machinery and setting in the industrial landscape, in written documentation, and also in the intangible records of industry contained in human memories, traditions and customs. Industrial heritage may offer identity for a community or provide the signature for a place, recognised externally.

Evidential value can extend further, to embrace places where significant innovations took place. Care needs to be exercised here as technological innovation, even more than pioneering entrepreneurial enterprise, can rarely be ascribed to one place or person. 'World firsts' are temptingly attractive but often raise more questions than they answer. But taking a less deterministic view there are undoubtedly places that for legitimate historical reasons have taken on a primary significance in terms of scholarly acceptance and public perception that justifies their veneration – for the purposes of history. Some are World Heritage Sites and, as such, they have had to meet UNESCO's criteria of Outstanding Universal Value.

The Ironbridge Gorge in England was one of the first, inscribed as a World Heritage Site in 1987. Here was a landscape rich in the remains of early industry, ranging from icons such as the Old Furnace where in 1709 iron was first smelted with coke instead of charcoal, to the 1779 Iron Bridge across the River Severn, and set in a river valley that both defined context and offered prolific evidence of an evolving community, from pre-industrial roots to post-industrial decay. Significant in realising the intrinsic heritage value of the Ironbridge Gorge was the impact of prolonged economic decline. This had two effects; first, to slow the rate of change, as new investment was largely absent. This is the ossification factor so frequently encountered in areas of industrial relapse; survival through benign decay. Second, conditions had become bad enough to prompt outside intervention in the form of a government-funded regeneration agency – Telford Development Corporation – with a remit to revive the economic and social fortunes of the wider East Shropshire coalfield area. The Corporation saw Ironbridge as an asset and an opportunity, with history and conservation as the keys to reviving its fortunes. Out of this grew a not-for-profit management body, the Ironbridge Gorge Museum Trust, which since 1968 has managed the key sites.

In ascribing value to historic industrial environments it is easy to forget that these were places of work. Empty mills once contained manufacturing machinery and the prime movers that powered it. Almost invariably, both will have disappeared soon after closure. Most of the industrial buildings that feature in the heritage debate on value, and subsequent discussions on their future, are thus empty husks, devoid of the life and activity that went on in them and which were the reasons for their existence. The consequence is that the perpetuation of machinery *in situ*, and especially in working

Queen Street Mill, Burnley, England. This once-typical weaving shed from 1894, its looms powered by a Lancashire steam mill engine through line-shafting and belt-wheels, is now unique and preserved as a working cotton mill. The accident of survival has made this a site of outstanding importance. (Neil Cossons)

condition, is a rare attribute that can confer exceptional value simply by virtue of the accident of survival.

In 1900 there were some 100,000 looms in and around Burnley in Lancashire, England. The town was the world's largest single manufacturer of cotton cloth; the industry is today extinct there. But one mill survives substantially intact, Queen Street Mill, Harle Syke, opened in 1894 for the manufacture of grey cloth, cotton fabric that was bleached and dyed elsewhere (see illustration). The co-operative multiple-ownership financial structure of the company inhibited change, and when the mill closed in 1982 the original looms and steam engine were still in place and in use. It was at this point that its extraordinary importance was recognised, and it reopened in 1986 as a working museum where cotton fabric is still woven on some of the 308 remaining looms. Sale of the cloth makes a modest contribution towards running costs. Here is an example of something typical and commonplace that by virtue of serendipity survived into an era where its extraordinary rarity gave it a value beyond the ordinary. Today, it is thought to be the only steam-powered weaving shed in the world.

Queen Street Mill epitomises the issues faced when ascribing value to industrial sites and landscapes. Value may be sensed and articulated at a very local level, often by people who have no background in heritage or understanding of the methods of protest or advocacy. These are often people with passion but no voice, and time and again the industrial heritage is the subject of their concerns. These are the people directly affected by industrial change. Their arguments may be easily dismissed as emotional attachment to jobs lost or communities destroyed, or simply as fear of the future, whatever that might hold. Here can be found industrial strength dedication combined with an innocence of how to campaign for a different future.

Not far from Burnley, also in Pennine Lancashire, is the Whitefield area of Nelson, another former cotton town where the mills had closed. Demolition of the terraced houses of the former industrial community, still occupied and generally in sound condition, was seen by the local authority as an opportunity for the regeneration of Whitefield's economic fortunes. But the people of Whitefield did not want to move. Nor did they know how to protest. They appealed to the outside world. Help came from English Heritage and other agencies to support them in their cause and today their houses and their futures in them are secure. The lesson here is that national agencies need to be aware of local priorities and be prepared to step in to support them.

The case of Nelson highlights another of the issues presented by the industrial heritage. When the mill has closed or the seam runs out and the mine shuts down, it is communities that survive. Industrial housing represents in many cases the most prolific evidence of former industrialisation. These are the houses that litter the rust-belt landscapes of old industrial regions and that are often all that is left when the rest has gone. But the people are still there, with their memories, their friendships, and what is left of their pride. Time and again the claim is made that these are the people who want to see the back of old industrial plant and the hardship and anguish that attended it. Almost invariably the opposite is the case; some of the greatest commitment to supporting the cause of industrial heritage comes from communities whose history it was. In terms of values, these are some of the most difficult to capture but most powerfully expressed.

An example is the abandoned Chesapeake & Ohio Canal, which was purchased in 1938 by the United States government and placed under the care of the National Park Service to be restored as a recreation area. As a result the lower 35 kilometres (22 miles) of the full 292-kilometre length (182 miles) were repaired and re-watered. After the war the idea of turning the remaining route over to automobiles was vigorously opposed by numerous communities along the route. Their initiative was championed by United States Supreme Court Associate Justice William O. Douglas who in 1954 led an eight-day hike along the full length of the towpath from Cumberland to Washington DC. Popular support was galvanised, and in January 1971 the canal was designated as a National Historic Park. Here national and community interests coalesced around a common cause but the timescale involved – despite the intervention of the Second World War – was not untypical of projects of this nature and magnitude.

Another United States initiative has put community groups in the driving seat of conservation projects, some of great scale and complexity. National Heritage Areas are sites designated by Congress to encourage historic preservation of an area and an appreciation of its heritage. Several have industrial heritage as their central theme. They are not National Park Service sites, nor are they federally owned or managed, but are administered by state governments, not-for-profit organisations or private corporations. There are currently 49 – some using an alternative title, such as National Heritage Corridor. Rivers of Steel Heritage Corporation is one, dedicated to capturing something of the history of south-west Pennsylvania's industrial communities. Another is the Delaware and Lehigh National Heritage Corridor, which stretches 265 kilometres (165 miles) across five counties and some hundred municipalities in eastern Pennsylvania, following the historic routes of the Lehigh & Susquehanna Railroad, the Lehigh Valley Railroad and the Lehigh Navigation, Lehigh Canal and Delaware Canal from Wilkes-Barre to Bristol. Included is the industrial heritage of Bethlehem Steel.

This raises the issue of the relationship between national and local agencies, between academic and community interests, between those who seek certainty based on defined and quantifiable value measures and others driven by more emotional imperatives. It is easy for head and heart to be in conflict when the future of industrial places is in debate. There has to be room for both. Industrial heritage demands knowledge, great judgement and real understanding. From understanding grows valuing; from valuing grows caring; and from caring grows enjoyment and inspiration. Industrial heritage is often a bottom-up business, struggling to survive in a top-down world. The best results come from a symbiotic relationship between the two. But, it is crucial that value is understood and that it is expressed in language that non-believers can understand. One of the weaknesses of the wider heritage community in recent years is that its carefully honed mores mean little to the outside world. Grandiloquence can be a fatal flaw. If this is a public heritage then the public deserves to be accorded the respect of understanding the nature and content of the arguments. Equally, for the heritage sector to indulge in academic casuistry is a recipe for losing the confidence of the people.

The values that underscore these initiatives are complex and multi-layered and do not sit easily with conventional conservation legislation. What the industrial heritage demonstrates repeatedly in many countries is that its values need to be articulated powerfully and forcefully, and that determination is needed to shape the bureaucratic system, and often the legislation, to meet the needs of this new heritage challenge. And industrial heritage often involves the collision of principles on the one hand and the scale and challenge of practicality on the other.

Sustainability

This is manifest in the movement, worldwide, to recycle industrial buildings which, having enjoyed one life, are now redundant. For long seen as liabilities these are increasingly appreciated as assets-in-waiting, ready to be adapted to another perhaps quite alien purpose unconnected with, or quite alien to, their history. Adaptive re-use has blossomed in recent years and is often seen as the only means of retaining old industrial buildings or areas. The roots of this movement can be found in the United States in the 1960s, with celebrated examples in economically buoyant cities such as San Francisco and Boston. The conversion between 1964 and 1968 by architects Wurster, Bernadi and Emmons of the Ghirardelli chocolate factory into shops, restaurants, galleries, and offices at a cost of some US $12 million, followed by the conversion of nearby ice-houses into offices and showrooms, is widely credited with starting the trend for waterfront rehabilitation based on recycled historic buildings. It set a style that has evolved on similar lines worldwide. And it has turned historic industrial waterfronts into hot property. Retail, residential and leisure-based waterfront schemes now abound in, for example, St Katharine Docks, London; Albert Dock, Liverpool; Darling Harbour, Sydney; Victoria & Alfred, Cape Town and Granville Island, Vancouver.

Equally influential has been the transformation of the great textile mill complex of Lowell, Massachusetts, into a National Historical Park. Here one of the largest industrial textile communities in the world was faced with future decay unless a new and radical solution could be found; the result, a combination of federal, state and city investment, in an historic area that has become the engine not only of Lowell's regeneration but hugely influential in shaping attitudes internationally.

Such is the power and attractiveness of the re-use formula and so commercially successful can be the results, that the value and intrinsic importance of the historic buildings themselves can easily be easily overlooked. Here again understanding is the key. It requires good architects and historians with the right level of understanding of intrinsic quality to effect an economically viable transformation that reinforces rather than erodes the fundamental values of the place – the buildings externally and internally, their context and setting. That these are not simply structures with structural and aesthetic qualities that make them attractive for re-use, but places where the memories of the world were formed, is an elusive attribute easily overlooked. Definition of value as a prelude to regeneration is critical.

Regeneration of whole post-industrial regions offers still bigger challenges, driven by different motives. Here the scale of dereliction demands an answer; to do nothing is not an option. The role of public-sector driver as a means of mitigating environmental and social dislocation, and thus creating opportunity for private-sector investment, has been a thread that runs through much of the heritage- and culturally-led industrial regeneration schemes across Europe. A prime example has been Emscher Park, where the vast brownfield landscape of the Ruhr valley in north-west Germany, once the heartland of Europe's coal and steel industries, has been revitalised. Here a top-down and carefully integrated development plan backed with huge funds from the state government of North Rhine-Westphalia, the German Federal Government, European Union and private sector, has enabled nearly 800 square kilometres (more than 300 square miles) of industrial dereliction to be rehabilitated within a carefully defined framework of ecological principles. Within this macro-structure individual sites were then targeted for redevelopment and local private and public initiatives encouraged.

Removal of the polluted remnants of mine tailings, coke ovens, gas and chemical plants, has been followed by landscaping to create linear green spaces interspersed with development areas in which old industrial housing has been renovated and new residential property built. Four fundamental principles characterise the approach at Emscher:

- re-use of brownfield land as a means of making good dereliction and preventing exploitation of previously undeveloped 'greenfields';
- extending the life of existing buildings that can be saved, in preference to building new;
- using ecologically sound building practices for new build and for adaptive re-use;

- transforming the region's production and employment structure towards environmentally friendly methods.

As Emscher's visionary planner, Karl Ganser, states, 'Even the best planned new buildings are no match against the preservation, modernisation, conversion and re-use of existing buildings when it comes down to the consumption of resources'. And re-use makes sense in terms of infrastructure costs, as these sites are usually well endowed with services such as roads and sewers.

One of the striking aspects of Emscher Park is the profusion of mammoth steel plants, gasholders and mine headframes. These have, where possible, been retained, often as monuments in the landscape. The great gasholder in Oberhausen is now a cultural centre for conventions, theatre and concerts, while the celebrated Zollverein pithead frame in Essen, designed in 1928 by Fritz Schupp and Martin Kremer, forms the heart of a cultural complex that is now a World Heritage property. It was designated European Capital of Culture for 2010.

In France some 100 square kilometres (40 square miles) of the Nord-Pas-de-Calais offers an outstanding diversity of coal-mining remains; five generations of winding engines, some 200 waste tips, transport systems, and numerous areas of miners' housing. All this illustrates the impact of a 300-year industry on a huge area, reflecting its vivid industrial culture and traditions. Mining ended in 1990, but since 2000 the Mission Bassin Minier has been promoting the candidacy of the coalfield for World Heritage status.

Similarly, in Kyushu and Yamaguchi, the evidence of the extraordinary transition, from the end of the Tokugawa era through the period of the Meiji restoration, which built the foundation for Japan's industrial revolution, forms the basis for a World Heritage nomination embracing the coal, iron and steel and ship-building industries. Here is first-hand material evidence, captured in sites and landscapes of intrinsic archaeological and historic value, of the birth of a modern nation, the first Asian country to industrialise.

Conclusion

The industrial landscape is a misunderstood heritage, at worst urban rustbelt, dangerous, a toxic wilderness; at best, an outstanding historical resource to be re-used, regenerating communities, offering real richness and opportunity, reinforcing cultural identity and creating new commercial prospects. But it can also be a vivid reminder of how today's world came to be the way it is, when industry employed whole communities and provided the heartbeat for many towns and cities. In this respect these historic industrial landscapes deserve our closest attention.

Today in many post-industrial societies, industrial culture is no longer central to people's lives; ensuring its past matters to new generations poses new dilemmas. The narrow economic arguments – tourism and cultural renaissance, adaptive re-use and expanded retail opportunities – are challenged by the sheer scale of Liverpool's or Detroit's predicament. And yet the fate and future of these places is of interest to us all because as world cities they belong to us all. In a global society this is an even more persuasive argument than we might at first imagine. We have an opportunity to recalibrate our view of the past and the values we place on its heritage by acknowledging

Pithead baths, preserved coal mine, Kladno, Czech Republic. The presence of absence: miners' clothing from the last shift hanging in the pithead baths. (Neil Cossons)

the democracy of the meanings and metaphors that attach to it. These are whole places, and they deserve to be treated as such.

That means ditching some of our heritage predilections and comfortable traditions; move away from individual sites, structures and buildings to see landscapes in the round as places to be re-ordered for people and where an understanding of the past can liberate a resource for the future. The new urbanism, a growing recognition that human habitats and the web of history afford creative synergies, the innovative philosophies of new-generation architect planners, are all responses to the challenge of reviving the fortunes of what for many communities can be a daunting prospect.

And, the world's post-industrial landscapes are littered with outstanding places that have an intrinsic value, in terms of their history and archaeology. This transcends any usefulness that adapting them for new purposes might afford, even supposing that to be possible. Here we need to preserve for history's sake. The origins of the industrial age, the first great global empire, stand with those of ancient Egypt, Athens or Rome. Capturing these industrial landscapes and their futures for posterity is increasingly seen as an obligation by nations proud of their industrial roots and keen to retain symbols of a distinguished past.

The future of these working places is in our hands; to preserve for posterity, to recycle for tomorrow, or here and there to leave alone as unmanaged ruins so that future generations can make choices for themselves based on our prudence and their values and judgements.

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2

What does the Industrial Revolution signify?

Helmuth Albrecht

Introduction

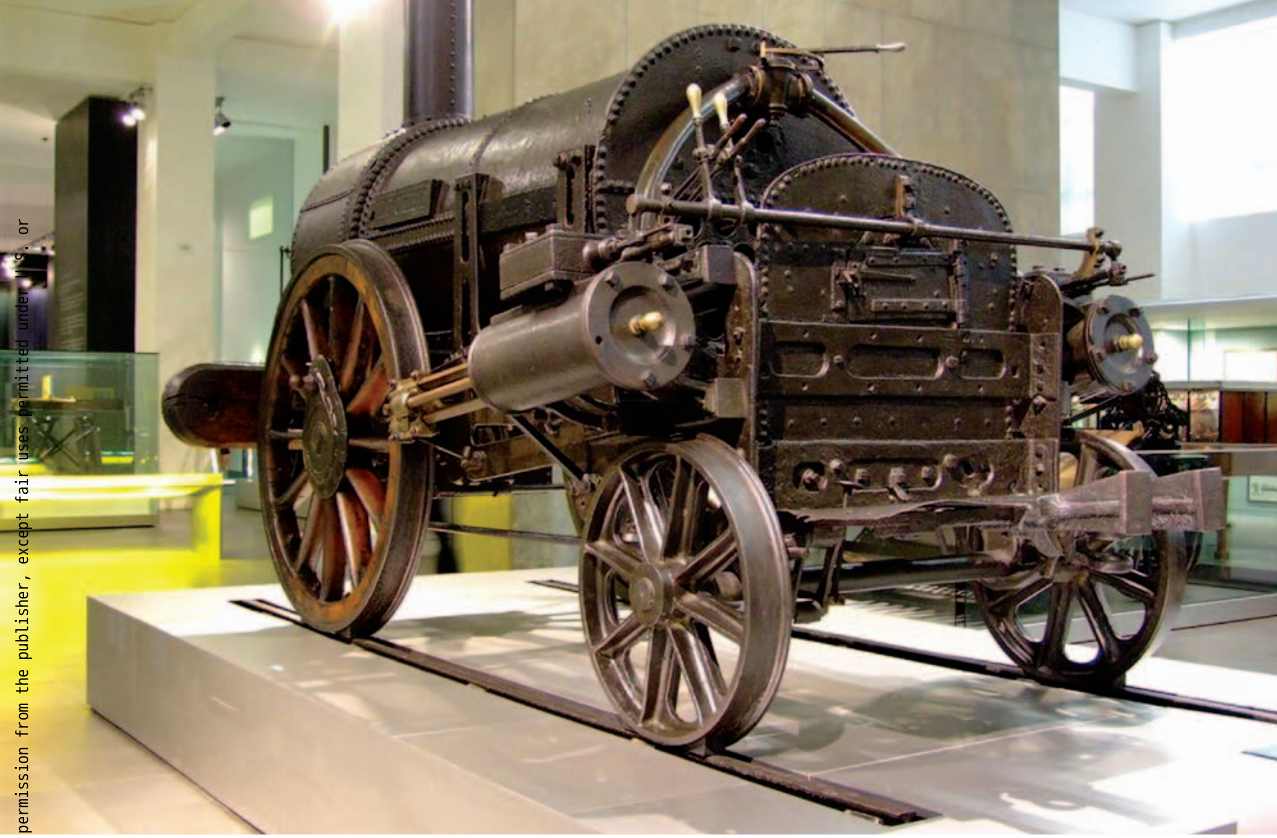
Today, the uses and the meanings of the term 'industrial revolution' are quite diverse. For example, 'industrial revolutions' are postulated for Europe in the Middle Ages, associated with the diffusion of waterwheel technology in the thirteenth century, or for the western world with the introduction of semiconductor technology and the rise of the age of computers in the second half of the twentieth century. Moreover, for the public and most historians the term 'revolution' stands for a radical change within a short time – such as occurred during the French Revolution in 1789, or the Russian in 1918 – and not for long-lasting evolutionary, and still on-going, processes like the industrialization of our world since its beginnings in Great Britain around 1760. On the other hand, no one can deny that exactly the process of industrialization caused, in history and continuing today, one of the most radical changes in human history all over the world: the transformation of an agricultural society into an industrial society with radical changes in all aspects of human, social, political and economic life. Even nature and the global environment have been deeply influenced and changed by this process during the last 250 years.

Without a doubt the industrialization of our world is a revolutionary process, and its 250-year history is a very short time compared to other radical changes in the history of mankind, such as the Neolithic Revolution in food production and settled communities between 7,000 and 10,000 years ago. Today, industrial archaeologists as well as historians of economics or technology use the term 'industrial revolution' within the broader concept of industrialization as a *terminus technicus* for the starting period of the process of industrialization followed by the periods of 'high industrialization' and 'post-industrialization'. Thus the 'industrial revolution' is the take-off phase of industrialization, during which the change from an agricultural society to an industrialized society occurred. In the field of technology and production, this means the change from *hand-tool technology* to *machine-tool technology* with the introduction of machines into manufacturing and the birth of factory production, and is centralization within one building or a central complex of buildings – the so-called *factory*. The systematic adoption of machines in the production process for the generation of operating power and the production of all kinds of goods – last but not least of machines themselves – revolutionized the means of production. It allowed division of labour and with this a radical increase of productivity. Furthermore it allowed mass-production and the development of standardized tools, machine parts, machines and all kinds of goods.

The implementation of the factory system with its machine production led to far-reaching consequences within society. The social structure of traditional rural society changed with the emergence of new social groups such as the industrial bourgeoisie and the industrial proletariat. The rapid growth of population, the migration of people from the countryside into the new industrial regions, and the development of fast-growing urban industrial centres with their new social and infrastructural problems and challenges, led to the birth of the modern industrial society, along with its new social classes, its new political system of parties, parliamentarianism, democracy and communism, and the economic systems of capitalism and socialism. But the process of industrialization did not only change the life of all human beings, of social groups and whole societies. It also changed our environment, the landscape and our whole planet with increasing velocity. Within this on-going process, the 'industrial revolution' was only the starting point and the transition period from the old traditional rural society into the new industrial society.

Despite a widespread, commonly held opinion, the technological activator of the Industrial Revolution was not the invention of the steam engine. The first useful steam engine had been built in 1711 by Thomas Newcomen, years before the process of industrialization started in Great Britain around 1760. The early motivating power of industrialization was the use of water power by waterwheels that were used to drive the first modern production machines for spinning cotton in centralized production sites. Both the first spinning machine, called the *water frame* (patented in 1769), and the first modern factory, the Cromford cotton mill (built 1771) near Derby in England, were built by Richard Arkwright, who became one of the most successful inventors and entrepreneurs at the beginning of the Industrial Revolution in Great Britain. Both as an inventor and as an entrepreneur he opened the way to mass production of textiles by the mechanization of the whole cotton spinning process and by the creation of the prototype of an industrial production site. Other inventors such as Samuel Crompton (*spinning mule*, 1779), Edmond Cartwright (*power loom*, 1785) or Richard Roberts (*self-acting mule*, 1830) followed Arkwright's example and laid the technical foundations for a fully mechanized production process of spinning and weaving. Thus the Industrial Revolution and the process of industrialization in Great Britain started with the mechanization of the spinning process of cotton and the foundation of water-powered spinning mills around 1770. Other and more advanced spinning technologies followed as well as the mechanization of weaving so that by 1830 the whole process of textile production had been mechanized and industrialized.

With the growing number of textile mills the demand for special and more efficient machines for the spinning and weaving process increased. This demand laid the foundation for the development of other industries, including textile machine production, the production of machine tools, or the production of chemicals and dyes for bleaching and colouring of the textiles. Timber as the traditional main construction material of pre-industrial machines, and still used for the construction of the first spinning and weaving machines of Arkwright and Cartwright, was now replaced by cast iron and steel. The development of larger, faster and more efficient machinery advanced



Robert Stephenson's *Rocket* locomotive, built in 1829, is conserved in the Science Museum, London. Railway construction was spurred by industrialisation and fed it with increased consumption of coal and iron while providing tremendous scope for territorial development. *Rocket* is rich evidence for the progress of technology and a museum object of unfading interest. (Les Chatfield – Creative Commons)

the development of iron and steel technology and these technologies in turn fostered the development of machine construction. The mass-production of cast iron was possible since the invention of the coke blast furnace process by Abraham Darby in 1709 in Coalbrookdale, England, and its further development by Darby's son and grandson until its breakthrough as a widely used iron production technology in England in the 1760s. Two decades later, the invention of the puddle-process for refining of pig iron, and the rolling mill in 1783 by the English ironmaster Henry Cort, opened the way for the large-scale production of wrought-iron and its further mechanical processing. The Scottish inventor James Watt developed a new type of steam engine, patented in 1769, which was much more fuel efficient than the Newcomen engine. Together with the entrepreneur Matthew Boulton, Watt founded the company Boulton and Watt in 1775 in Soho near Birmingham which produced and sold steam engines not only in Great Britain but into many parts of the world. Watt's first steam engine was installed in 1776 at the machine-tool factory of John Wilkinson, who had developed a new technology for the precise boring of iron cannon and which now was used for the production of cylinders for Boulton & Watt.

The development of Watt's steam engine made factory production independent from water power. Factories could now be built wherever they were needed and with almost no limit to size and productivity. Moreover, the development of more effective and lighter steam engines led to the construction of steam locomotives. In 1825, the world's first public railway – the *Stockton and Darlington Railway*, with Stephenson's *Locomotion No. 1* – was opened. For Britain, the 1830s and 1840s brought a period of railway mania with its zenith in 1846 when in one year 272 new railway companies were set up.

The development of railway systems in Britain, Europe and North America as well as the invention of Bessemer steel, which made the mass-production of steel possible, led to an acceleration of the process of industrialization from the 1860s – a period sometimes referred to as the Second Industrial Revolution. By the beginning of the twentieth century it led to mass production and production lines and to the birth of new sectors such as the chemical, electrical and automobile industries. It was also the period of accelerated urbanization, of the rise of workers' unions and the fight for better working and living conditions for the working class, of the mechanization of warfare, and of imperialism and colonialism by the leading industrial countries of the time. Britain lost its position as the world's leading industrial nation to Germany which was itself overtaken by the United States of America at the end of the period.

The inventions and innovations of British engineers in the century between 1750 and 1850 formed the technological basis for the rapid development of textile, coal, iron and steel, machine-tool and engine-building industries in Great Britain, which became the first and leading industrialized country in the world.

Why Britain? The answer to this question is as complex as those relating to the technological, economic, political and social background and the outcome of the Industrial Revolution. Factors included the political, economic and social structure of Great Britain in the eighteenth and early nineteenth century, with its parliamentary monarchy and its relatively open social structures; the presence of a politically and economically active middle class as well as a substantial labour force; the British Empire and the possibilities it provided for a world-wide source of raw materials and a market place for British products; the nation's great navy and merchant fleets, as well as the world's financial centre in its capital, London; its national patent law as a strong protection for early nineteenth-century inventors and their inventions; the country's highly developed transportation system of canals, harbours, roads and bridges. All of these aspects together provided a unique set of conditions for the birth of the Industrial Revolution in this country. Britain thus became the first and for many years the leading industrial society in the world. Its transformation process – known as the Industrial Revolution – started around 1750–60 and reached its climax around 1850, represented for the whole world by the first Great Exhibition in London the following year. This exhibition was an imposing expression of the world-wide British leadership in technology and industry. But it also showed that other nations were following the British example. Industrialization had started to become a global phenomenon.

Throughout the nineteenth and twentieth centuries, the Industrial Revolution and the process of industrialization spread all over the world, beginning in each country with a characteristic time-delay to Britain depending upon the political, social, economic and technological conditions of each one. The first impulses for an industrial take-off could be found in Europe and North America around the turn from the eighteenth to the nineteenth century. The process started first in France and in Belgium, followed by Germany and the United States. In all these countries, the transfer of British technology and know-how played a major role for the launch of industrialization. This transfer happened by different ways and means: official visits and spying, copying and reproduction of ideas and technology, legal and illegal export of technology as well as the migration of British experts. The different political, social and economic environment of each country also played a major role for the success and the timing of the process. The political background of the French Revolution and the following Napoleonic wars, with the blockade of all British trade to continental Europe and North America between 1806 and 181, played a crucial role in the growth of factory production in these early industrializing countries: in the wind-shadow of the blockade, without the overwhelming competition of Britain's technology and goods, it was possible to go the first steps towards the development of independent national industries.

Belgium with its provinces of Flanders and Wallonia was the first country on the European continent influenced by the Industrial Revolution coming from Britain. Its long tradition of textile and iron production, its large coal deposits in the north and south as well as its strong and self-confident middle classes with close connections to Britain, formed the basis for an early industrialization. The first Newcomen engine outside Britain was erected in the coal mines of Liège in 1720. In 1799 the British entrepreneur William Cockerill built the first wool spinning machine on the European continent in Verviers, where he set up his own textile factory in 1807. Ten years later he founded the largest European iron foundry and machine workshop near Liège. Cockerill's industrial activities, together with the development of a modern transportation network of canals and from 1830 of a light railway system, led Belgium into the Industrial Revolution and the age of industry.

Two other early examples for the adoption of British technology and industrial proficiency could be found in Germany and the United States. The first cotton spinning mills of Germany in Ratingen/Rhineland (1784) or in Chemnitz-Harthau/Saxony (1798) used British technology and the expertise of British engineers. Both the first steam engine of the Watt type in Germany at the copper mine of Hettstedt/Prussia (1785), and the first German coke blast furnace in Upper Silesia/Prussia (1797), followed the example of British prototypes. Around 1800, regional clusters of early coal, iron and steel in Prussia (Westphalia and Silesia) or textile industry (Saxony) developed. The Ruhr Valley in Westphalia was at that time known as *Miniature England* despite the fact that a lot of influences for the early industrialization of this region came from nearby Belgium.

In the United States, Samuel Slater, an immigrant from Britain and former co-worker of Richard Arkwright, founded the Slater Mill on the Blackstone River in Rhode Island in 1793 and more than ten textile mills were built in the following years. With Slater Mill and numerous other mills, the Blackstone River became the birthplace of the Industrial Revolution in the United States. In 1813–14, Francis Cabot Lowell established the Boston Manufacturing Company on the Charles River in Waltham, Massachusetts, the first 'integrated' textile mill in America. Lowell had previously spent two years in Britain secretly studying the textile industries of Lancashire and Scotland. America's first planned factory town, Lowell, Massachusetts, was founded in the 1820s as a manufacturing centre for textiles; by the 1850s it had become the largest industrial complex in the United States.

In Belgium, Germany and in the United States early industrialization was concentrated in regions with ideal conditions in respect of manufacturing traditions, skilled and cheap labour forces, the availability of water power or the necessary raw materials such as cotton and mineral resources such as coal or iron. In addition, in

Boott Cotton Mills on the Merrimack River, Lowell, US, recorded by the Historic American Engineering Record (HAER). Thirty years after the first textile mill opened, Lowell was the largest industrial complex in the country. The town is now a National Historical Park after a pioneering heritage-based regeneration strategy combining federal, state and city investment reactivated the town from the 1970s. (Library of Congress, Prints & Photographs Division, HAER MASS,9-LOW,7--66 (CT))

Belgium and Germany – like later on in Russia or Japan – financial and administrative support by the state played a major role in the industrialization process. Outstandingly, the rise of German industry in the nineteenth century was fostered by an active policy of the state in the fields of settling industry, infrastructural development (railways) and scientific and technological education with a state financed and controlled system of schools, universities and technical high schools. This engagement of the state was important and necessary for the development of the Industrial Revolution in Germany. At the beginning of this process the country was still split into more than thirty independent and autocratically ruled states with no unified national market, no suitable infrastructure and no developed, self-confident middle class. With the long process of political and economic unification of Germany under Prussian leadership between 1815 and 1870, this situation changed only slowly. Therefore the final breakthrough of the Industrial Revolution in Germany was delayed until the period of the German Empire

(1871–1918), when Germany finally changed from an agricultural into an industrial society. Shortly before the outbreak of World War I, Germany was the leading industrial nation in Europe.

Technical, economic, social and political changes similar to those in Britain or Germany in the eighteenth and nineteenth centuries can be found in all countries which passed or are still passing through the process of industrialization. Of course there are differences too, depending on the particular conditions and circumstances in each country and society as well as on the time and period when the process of industrialization was begun. This process – the setup of the Industrial Revolution – is dated for Britain to 1750/60, for France to 1780, for Belgium to 1790, for Germany to 1795, for the United States to 1800, for Russia to 1850, for Japan to 1860, for Brazil to 1929, for India to 1947 and for China to 1953. From a global perspective, industrialization spread out from west to east and north in Europe and America during the nineteenth century and then from the north-western hemisphere during the twentieth century to the east and the south of Europe, to South America, to Asia and Africa. From this point of view it is an on-going process in the twentieth century, especially in China, India, South-East Asia and Africa.

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3

Industrial archaeology: a discipline?

Barrie Trinder

> *'There is no substitute in the writing of military history for going to see for oneself.'*
>
> John Keegan, *Warpaths: travels of a military historian in North America* (2004 edn), p. 228

Historians and archaeologists gain many insights from observing the methodology employed by specialists in sub-disciplines other than their own. It is enlightening to read the thoughts of the late Sir John Keegan, the distinguished military historian, as, in 1992, he observed the sites of the Seven Days Battles fought in Virginia in 1862. He realised that when he taught Sandhurst students about the battle he had not grasped the relationships between the places that had featured in the fighting, even though he had based his teaching upon one of the classics of military cartography. It was not always obvious to earlier military historians that they should study battle sites or the ways in which weapons work, nor that they should analyse the social structure of armies, as Keegan did in *Six Armies in Normandy*. Similarly much of the history of industry written in Britain before 1960 is ridden with misunderstandings of technology – such as an inability to distinguish between a forge, a furnace and a foundry, for example – and with topographical confusions revealing that authors had not understood what Keegan called 'the special relationship between one place and another'. The task of industrial archaeologists might be defined as remedying that situation.

Six decades have passed since the term 'industrial archaeology' came into currency in the English language. The self-styled 'industrial archaeologists' of the 1950s and early 1960s had several distinct objectives. The first was advocacy, to argue that some of the remaining structures of the industrial age were beautiful, that all were historically important, and that consequently they were as worthy of legislative protection and of state-funded recording as the monuments of the middle ages or prehistory. It is significant that the international assembly in England in 1973 from which TICCIH developed was concerned with the conservation of industrial *monuments*. While it is necessary to be aware that conservation gains of the recent past can be nullified in a changed economic climate, and it would be hazardous to be complacent about the long-term future of the smaller industrial sites, it is broadly true that in most of the countries represented in TICCIH the most important monuments of industry, broadly conceived, are subject to legislative protection, and that threatened sites are given consideration for such protection. The industrial monuments and landscapes designated by UNESCO as World Heritage Sites provide evidence of broad change in attitudes internationally.

A second objective was interpretation, to explain to a broad public the significance of mining and manufacturing in our past, and in particular to use the evidence that remains in artefacts, images, structures, sites and landscapes to throw light on the history of the industrial period. Again, it is possible modestly to record some success. Industrial heritage is popular in a tourist context and can no longer be dismissed as a minority interest. The implications of this success across the world are discussed elsewhere in this volume, and are can be studied in detail on the website of the European Route of Industrial Heritage (http://www.erih.net).

A third objective, where rather less has been achieved, was to establish the academic credentials of a new academic discipline. Few courses in industrial archaeology appear in university prospectuses, and information about those few will probably be out-of-date within a few years. Universities in the West are no longer expanding, the nature of undergraduate teaching is changing, and in England there is uncertainty about the consequences of charging substantial fees to students. The mid-twentieth century in the United Kingdom was a time of increasing historical specialisation, of the creation of many sub-disciplines, such as economic history, social history, urban history, local history, the study of vernacular architecture, oral history, business history, historical metallurgy, the history of agriculture, and so on. In a contracting academic environment such specialisms are threatened as individuals retire or move on and courses are terminated.

Attempts to establish postgraduate courses have been scarcely more successful. The study of industrial archaeology flourished at the Ironbridge Institute in the 1980s when some graduate students could still gain public funding, but it has been displaced by courses providing students with a broad measure of employability in the heritage sector by teaching elements of other disciplines, the ability to understand balance sheets and draw up budgets, to hold meaningful conversations with software engineers or graphic designers, or to understand the mechanisms of the planning system. Similar courses in Heritage Management have proliferated in other universities at both undergraduate and postgraduate levels.

While industrial archaeology has made only fitful appearances in academia, there is plentiful evidence that it is widely practised. The current English Heritage publications list includes books on the warehouses of Manchester and the planned industrial suburb of Ancoats, on the Bradford suburb of Manningham, on the buildings of the Sheffield metal trades, the Northamptonshire boot and shoe industry, furniture manufacturing in the Shoreditch area of London, the flax and hemp industry in Bridport, the Birmingham Jewellery Quarter and the canal town of Stourport-on-Severn. Similar publications have emerged from other conservation bodies in the United Kingdom, and their websites show that the industrial heritage is far from neglected. Legislation in the United Kingdom now requires the archaeological assessment of many sites prior to development, which, as in other countries, has stimulated the growth of archaeological consultancies, much of whose work relates to former industrial premises. They continue to produce an extensive 'grey literature' of reports on sites and desktop assessments. It is paradoxical that while academic provision for industrial archaeology has diminished the demand for practitioners of the discipline has increased.

That paradox may in part be explained by the varied nature of practical industrial archaeology. The discipline can be defined in theoretical terms, as, for example, 'a means of allowing the study of artefacts, images, structures, sites and landscapes to stimulate new questions and new hypotheses'. When compiling the syllabus of a lecture series, defining the scope of a journal or setting out the contents of a book, it is necessary to go further and take decisions about content, methodology and chronological scope. Such decisions can readily be challenged, which over several decades has prompted debate. Many have been tempted to make 'ought' statements about industrial archaeology in general, that it should *always* be centred on measured drawings, that it '*should not be concerned with*' prisons or chapels, that it relate *only* to the period between 1700 and 1914.

In practice industrial archaeology has developed a network of sub-sectors, some of which are only ever likely to be practised by a few specialists, surveyors of buildings, explorers of disused mines, or interpreters of aerial photographs.

The study of machines, loftily dismissed by some as 'rivet counting', provides illuminating examples. Many adherents of industrial archaeology have asserted that familiarity with particular machines gained during long careers has provided them with an element of understanding superior to that of historians or archaeologists who lacked

The diversity of industrial archaeology: Bedlam or Madeley Wood Furnaces, near the Iron Bridge, the only works from the period of rapid expansion in iron-making in Shropshire in the 1750s of which there are substantial remains. Measured drawings, excavation, documentary research and the interpretation of paintings have contributed to our understanding of the site, but much remains to be discovered by future generations. (Barrie Trinder)

Industry in a complex landscape: the mining village of New Bolsover, Nottinghamshire, a community of about 200 houses built in the early 1890s to accommodate miners from a nearby colliery. It is viewed from the ramparts of a medieval castle which had been rebuilt as a mansion fit to entertain royalty in the early seventeenth century. (Barrie Trinder)

that experience, which, of course, in a narrow sense it does. Relatively few have actually used that understanding in the investigation of historic machines. Michael Bailey and John Glithero have shown over the past two decades that detailed study, in effect forensic mechanical engineering, involving the scientific stripping-down of historic locomotives, can provide insights into the manufacture and operating life of early locomotives. They have demonstrated that practical experience of engineering can be combined with archaeological discipline, and have established that ‘rivet-counting’ can be rewarding. Other projects have shown that much can be learnt from the evidence-based replication of locomotives and other machines. It is unlikely that forensic mechanical engineering will ever be widely practised, nor can it readily be taught in the narrow confines of a university course. Nevertheless, everyone with a concern for the industrial past can draw enlightenment from the work of Bailey and Glithero. We can gain more understanding by appreciating the skills and insights of those who work in different ways from our own than by erecting barriers between our work and theirs, whether such barriers relate to archaeological practice or time-period limits.

The same applies to many archaeological skills displayed in research centred on the industrial past, to excavation, the phasing and recording of buildings, the classification of artefacts, the study of landscapes, the laboratory analysis of slag and slimes, the interpretation of aerial photographs, the practice of oral history. Mastery of such skills is usually learned 'on the job', or sometimes through experience gained through adolescent enthusiasm, rather than in university lecture rooms or laboratories. University courses can draw attention to the varied approaches that can illuminate our understanding of the past. They cannot produce individuals fully equipped with the skills to practise from graduation every form of archaeological investigation.

Few of these specialised approaches to the past are unique to the industrial period. Aerial photographs are as likely to provide evidence of prehistoric settlements as of the water-power systems of eighteenth-century ironworks. The understanding of structures necessary for the effective recording of textile mills is equally applicable to the analysis of the roofs of cathedrals or tithe barns. 'Forensic mechanical engineering' can be practised on Renaissance astronomical clocks as well as on early railway locomotives or spinning frames. The study of the industrial past cannot be wholly isolated from other periods. The analysis of particular technologies over long periods of time, of weaving or working copper, is enlightening and worthwhile, whether or not it is called industrial archaeology. Linear archaeology, the study of transport features pioneered in the United States by Schlereth in his analysis of roads, and carried forward in Wales in studies of the Montgomeryshire Canal, the Brecon Forest Tramroads and the Holyhead Road, must necessarily take account of features of all historical periods, as well as the transport systems upon which it is focused.

When examining any question about the past it is enlightening to ask what we would understand if we had only archaeological evidence, with no documentation or any inheritance of written history to shape our thinking. If we are concerned with recent centuries we ask such questions, ponder the answers and move towards synthesising our conclusion with what we know from other sources. The prehistorian, practitioner of the 'purest' form of archaeology, has no 'other sources' to throw light on his question, other than the sometimes dubious legacy of whatever other people may have written about it, and his/her predicament can in many respects aid our understanding of the industrial past. Distribution maps can be applied to eighteenth-century tobacco pipes as well as to flint axe-heads. Kate Clark showed at Ironbridge that it is possible to understand the development of a series of limestone quarries by creating a Harris matrix.

The study of urban 'brownfield' sites, dictated by the requirement for archaeological assessments prior to development, has led some scholars to analyse the remains of eighteenth- or early nineteenth-century working-class housing in the same way that prehistorians would approach the site of a Bronze Age settlement, asking what the traces of structures and the remaining artefacts tell us about material culture, about living standards and the roles of women and children in society. In this and in other contexts the analysis of diaries, directories, census returns and account books is essential to take forward our understanding of an industrial community, alongside whatever archaeological techniques that may be appropriate, and the same applies, with variations in the types of document, to medieval monasteries or sixteenth-century fortifications. It is difficult therefore to claim either that industrial archaeology can be isolated from the archaeology of other periods, or that its methodology is distinctive.

The use of models, as commonly practised by prehistorians, is also enlightening. Michael Lewis's portrayal of the two distinct forms of railway that evolved in British coalfields from the early seventeenth century has been the foundation of much broader studies of early railways. Michael Nevell's interpretation of the development of domestic textile production around Manchester as a twin-mode process – one where manufacturing was combined with farming and organised on a family basis, where the archaeological expression of growth was the addition of workshops to farmstead; the other a merchant capital process of production, under which clothiers put out work to spinners, weavers and finishers working in their own homes – has proved similarly enlightening. David Worth's application of network theory to explain the growth of public utilities in Cape Town has proved valuable in the analysis of English suburbs.

Arguments can be advanced for more profound studies of the British 'industrial revolution' of the eighteenth and nineteenth centuries, but it is increasingly difficult to accord a special place for that phenomenon within industrial archaeology as a discipline. The establishment of TICCIH has helped to disperse the fog of parochialism. The contributions of Russian scholars to the Canadian conference in 1994, describing the sixteenth- and seventeenth-century ironworks and saltworks of the Urals, raised profound new questions about the place of mining and manufacturing in the history of Europe. Some scholars have come to interpret British technology in a global context by examining railways, ironworks or jute mills in India, or assessing the impact of technology from the United States on Britain in the decades after the Great Exhibition.

Arthur Young on his tour of France in 1789 progressed from Lorraine to Savern in Alsace and reflected on changes in material culture, in heating stoves and kitchen hearths. He concluded that crossing a great range of mountains and entering a level plain inhabited by a people totally distinct and different from France, gave him an understanding of Louis XIV's seizure of Alsace, 'more forcible than ever reading had done: *so much more powerful are things than words*'.

The evidence of things may be more powerful than that of words, but while observation is enlightening, a discipline should be based on scientific recording and evaluation. If it is difficult to justify industrial archaeology as a distinct methodology, the value of sound archaeological practice cannot be discounted. Nevertheless, there is a need for a vision that can be shared by all those practising archaeological research that concerns the industrial past, whatever methods they are employing, and by those working principally with documents, images or oral testimonies. For all that has been achieved in conservation, interpretation and publication there remains a need for innovative thinking, for productive methodologies and enlightening models that can only come from academic discipline. The significance of the industrial past needs to be asserted against those scholars of other periods who regard it with lofty disdain. There is a need for a constant re-thinking of the process of industrialisation. In 2000 Linsley suggested that Beamish presents a sanitised, integrated, ordered, harmonious view of a period, of which 'disorder, disharmony, disintegration, sacrifice, degradation and split blood' were features [Cossons, 2000], and the same is true of other industrial museums in the United Kingdom and elsewhere. Scholars should be prepared to challenge museum directors who ask them to provide 'what visitors expect' (unless those expectations relate to lavatories or refreshments) and point out that concepts change, that industrialisation, like the Renaissance, the French Revolution, Slavery or the Holocaust, will have different meanings for succeeding generations.

This essay began with a sage observation from a military historian and ends with another excursion in that direction. Some have suggested that the study of 'industrial archaeology' should terminate with the onset of the First World War. It is reasonable to make 1914 the *terminus ad quem* of a lecture course, or to determine that a journal should only publish contributions relating to the period before that date, but to suggest that the disciplined study of the physical evidence of the industrial past should be so confined is ludicrous and ultimately meaningless. We can consider some of the artefacts of the Second World War, the Supermarine Spitfire, the V2 rocket, the Boeing B-17 Flying Fortress, the T-34 tank. Military historians would sensibly consider them weapons. They are also artefacts, products of the engineering industries of the countries that produced them, and, like the munitions plants of that war – the Royal Ordnance Factory at Bridgend, the rocket establishment at Peenemünde, the Chrysler Tank Arsenal at Warren, Michigan, the Uralskiy Tankovyj Zawod No. 183 which produced T-34 tanks at Nizhny Tagil – their history reflects much about those countries' economies and social structures. It seems absurd to suggest that those who study them should necessarily come out of a different pigeon-hole from those concerned with Richard Arkwright's cotton mills. 'When I use a word,' said Humpty Dumpty scornfully to Alice in *Through the Looking Glass*, 'it means just what I choose it to mean, neither more nor less.' We can all try to define industrial archaeology, but if a scholar researching fourteenth-century copper smelting, the Dounreay nuclear reactor, or school buildings in nineteenth-century Bradford wishes to call himself or herself an industrial archaeologist there is nothing in a relatively democratic society that can be done to prevent it. Trying to put limits on industrial archaeology simply causes confusion. It is more helpful to regard an industrial archaeologist as one who affirms that mining and manufacturing are a significant part of our history, and that the study of artefacts, images, structures, sites and landscapes is essential in the formulation of hypotheses that will increase our understanding of the industrial past. 'Industrial archaeology' should perhaps be regarded as a creed, a set of beliefs, a faith, rather than a catechism or a monastic rule.

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4

The heritage of the industrial society

Louis Bergeron

Introduction

When reading the word *heritage* at the head of this chapter, one could be right in thinking immediately of a list of the numerous kinds of goods or elements embraced by the label *industrial heritage*, tangible or intangible. That is not, in fact, what is intended, but rather to help the reader to think of some selected values we have inherited from the kind of society which has been shaped by industrialization, in particular during the two past centuries, and which we are at present either enjoying or trying to convey to coming generations. And, further, to evaluate briefly to what extent these values are … valuable.

Mastering the space

Setting aside thousands of other easily recognizable remains – which are mainly related to production, trade and consumption, needs and habits – it can be argued that the heaviest mark of industrialization has been in the field of the relationship of human communities with one another and with respect to the planet Earth and to the passage of time. Contracting distances and travel times, mastering the space inside the continents, across the seas and finally over the world has, for more than two hundred years, been an uninterrupted obsession of advanced countries, resulting, for instance, in China's as well as Spain's passion for Japanese, French or German types of high-speed trains and connections. Within industrial heritage, railway history and its physical monuments (stations, tunnels under the Alps and so on) have helped to provoke widespread public interest, as has the more recent curiosity for cars and aircraft. But what about all that has existed behind that façade?

Practical means of transport and the various types of vehicles are just the thin layer on top of the history of infrastructures (and of power sources). And that history is the triumph, in the history of the human mind, of engineering genius and of knowledge and improvement or discovery of construction and building materials. This is not, of course, to deny an analogous relevance to the history of research, experimentation and discovery in other sectors of an industrialized economy. Canals, roads, bridges and railway tracks have been the cradle of industrialization and remain tools of the utmost importance for encompassing the earth in a single network. The long-term progress of engineering appears to be an exceptional illustration of an individual's or a national capacity for innovation. Now this last is the key word for the successful future of the industrialized economies – just as the search for unknown, synthetic and composite materials is a remedy to the exhaustion of natural resources.

A number of powerful engineers' associations have lived up to our key responsibilities of increased knowledge and awareness by tirelessly researching their predecessors, their training, careers, achievements, and inventions. In the United States, several associations have been instrumental in supporting the growth of industrial archaeology and heritage knowledge, and the first steps of TICCIH itself: the American Society of Civil Engineers (1852), the Mechanical Engineers, even of military and naval engineers. In Washington, the American Society for Industrial Archaeology (SIA) was promoted by Robert M Vogel, curator of the Division of Mechanical and Civil Engineering at the Smithsonian Institution. In Washington, the National Park Service created the Historic American Engineering Record (HAER), of which Eric DeLony was head for some thirty years.

In fact, the territorial expansion of the United States owes a great deal to the construction of bridges, from east to west. Emory Kemp, one of the SIA builders from the Department of Civil Engineering at the University of West Virginia, has precisely assessed the role of Wheeling Bridge, across the Ohio River, in opening the doors to the Mid-West. Crossing the Mississippi in Saint-Louis by means of Eads Bridge was another significant step, not to mention the symbolism attached to the crossing of the Hudson River by means of the George Washington Bridge.

Bridges – in particular suspension bridges – have also provided a wide range of exciting opportunities for builders to experiment with successive generations of materials, from metal to concrete. Different materials and techniques had to be deployed to suit the physical characteristics of each location, in some cases spanning extremely wide voids between the two main anchor points.

Does one need to remind the reader, in this context, of the pivotal role of British engineers in providing so many countries, as well as the United Kingdom itself, with the most inventive networks of land communication systems, prerequisites to the growth of an industrial capitalistic economy? This was a story that began with Scottish architect and engineer Thomas Telford (1757–1834), president of the Institute of Civil Engineers (1820), who built, among others, the Conway Bridge, forty bridges in Shropshire, and the St Katharine Docks in London. In England, Wales and Scotland, British Waterways clearly enhanced hundreds of works which are viewed as having been as fundamental as coal to the building of the long-term industrial prominence of the nation, or as characteristic of the national genius as was the command of the oceans. In the same years, French engineer Marc Seguin was busy realising the first suspension bridge in Tournon, on the river Rhône, and one of the first railways designed for steam power traction and service of industrial areas, between Lyons and Saint-Etienne. One may view communication as the key instrument for enabling the building of industrial societies as well as, apparently, for new forms of sustainable development.

On the other hand, in the heritage of industrial societies one can discern a major change in the composition of the leading social groups: traditional hierarchies were disturbed and constrained to open their ranks to growing cohorts of indispensable engineers, bearers of new talents and promoters of a new culture. Industry has been the theatre of that social rise, for several reasons.

In particular, constant expansion in the size and complexity of industry from the end of the eighteenth century required recourse to an unprecedented number of specific human capacities. The time had gone when entrepreneurs or companies – in creating new factories along watercourses, in opening new pits for the exploitation of underground resources, or in developing ironworks – could be satisfied by hiring the services of millwrights, iron masters or other qualified craftsmen from renowned regions or countries for the purpose of establishing and maintaining their installations. Engineers became permanent members of the staff, some of them relatively modest but definitely useful engineers of production, others very close to the head of the business and possible heirs.

Increasingly, the leading industrialized countries could boast of a wide range of schools at different levels of training, as well as an increasing specialization according to evolving stages of technologies. No longer could engineers belong exclusively to the closest circles of a sovereign, or to some *delegates* of the state military schools entering the creation or management of businesses or public works – as was the case in France for the École Polytechnique or the École d'Artillerie, or in the United States for West Point. Henceforth, engineers began to form a special social cadre that was strongly structured by networks of alumni (in France, for instance, from the prestigious École des Ponts et Chaussées or the École Centrale, down to the Écoles des Arts et Métiers) and of professional associations. Not only did this constitute an important mechanism for the renewal and reinvigoration of social elites, it was without doubt a most important legacy of the industrial societies, and a future asset, for these nations to have access to such channels for training and for the transmission of such technological traditions and consolidated results.

Of particular relevance was the social challenge now presented by the new engineers corps to the previously dominant representatives of the humanistic and more precisely of the beaux arts culture; that is, the development of the well-known rivalry between architects and engineers, embodied, for instance, towards the end of the nineteenth century by the quarrel around and against the Eiffel Tower in Paris. Prior to modern industrialization, architects used to be invited mainly for the purpose of enhancing industrial initiatives and activities, directly or indirectly supported by the political power in the interest of the state. Consequently, their plans and the elevations they realized had little connection either with the products or with the related production processes, but rather with the dignity of the principals who were eager to show the excellence of their industrial policy and to demonstrate their power. This was common behaviour among many European kings in the epoch of the *manufactures royales* of the seventeenth and eighteenth centuries.

Things changed radically when entrepreneurs and businessmen of the Industrial Revolution and afterwards ordered the construction of buildings intended to meet all the requirements of the new industrial economy, in terms of size and height, of dimensions of the machinery, in distribution of power (water or steam, and later electricity), of the organization of production, the circulation of goods or the workforce … and in terms of cost. Brick and metal were rapidly substituted for stone and wood, while scientific calculations were now brought to bear in the construction of multi-storey buildings, including the provision of wall openings to maximize natural light for all that required it, the division of internal space into standard cells of a determined volume, and the determination of weight limits of floors, while appropriate materials were carefully selected according to the different elements of the building.

For the major part these requirements were alien to the classical culture and training of architects. Many deemed it scandalous to use building materials as common or lowly-regarded as brick or metal, and considered as barbarians those engineers who were not first and foremost preoccupied by stylistic and ornamental references. Around 1850, the American inventor James Bogardus called himself an 'architect in iron' (in fact, in cast iron). The second half of the nineteenth century, however, was marked by

The Pontcysyllte Aqueduct, Wales, UK (1805) by Thomas Telford and William Jessop. 'It is,' Eric DeLony writes, 'one of the world's most renowned and spectacular achievements of waterway engineering. The structure was a pioneer of cast-iron construction and is the highest canal aqueduct ever built. It is one of the heroic monuments which symbolize the world's first industrial revolution and its transformation of technology.' (Crown copyright RCAHMW)

A view of part of the skyline generated by the waste tips in the Nord-Pas-de-Calais coal basin, France. In the forefront, one of the very many types of workers' colonies found in the western part of that area. (Marie Patou)

the success of 'architecture for industry', and even by examples of co-operation between architects and engineers.

A remarkable example is that of the different phases of the construction of the modern and highly rationalized chocolate factory of Menier in Noisiel (France). A prominent part in the wide diffusion of that new art of building, and in its standardization, was played by agencies who specialized in offering to industrial companies an on-demand planning and execution service. Examples include Stott of Oldham (United Kingdom), who equipped a number of textile factories in northern Germany, or Greene from Boston and Roebling from Trenton who were so active in New England. However, the greatest triumph occurred with Albert Kahn from Detroit, between the 1900s and the 1940s. He was particularly successful in forging a new aesthetic of the industrial age that was drawn directly from an exceptionally bold technical combination of glass and steel. Yet much should be said equally, in the same period, of another novelty combining brick in-filling and concrete framework in the construction of huge factory halls in America and later in Germany and other countries.

This all too brief overview concludes that from Pontcysyllte Aqueduct on the Ellesmere Canal in Britain to the Millau Viaduct in France, from the textile factories of Manchester and Oldham to Zollverein XII mine in Essen or the FIAT car factory in Turin, the industrial society has accumulated a heritage of a technical, architectural and social value which is today recognized all around the world. The names of the great engineers – Nervi, Hennebique, Freyssinet – are those of peaceful defenders of human creativity.

Creating landscapes

Industrialization such as it developed since the eighteenth century has noticeably altered the living environment in the areas it which it has occurred, and has been extremely space-consuming with respect to earlier periods. In some rural or hilly valleys, exploiting hydraulic power developed up to the limits of the streams' capacities while, elsewhere, industrial needs have relied heavily on forest resources. Above all, such needs have resulted in exploiting on a large scale the below-ground wealth (metal mines, coal seams) or of resources available in the open air or at a little depth, including brown coal in Lausitz, Germany, iron or copper ore near Nizhny Tagil (Middle Urals, Russia), in Rio Tinto (Andalusia, Spain), or Anaconda (Montana, United States).

Ancient and modern maps, or recent aerial or satellite photography, can demonstrate such evolutions. Large-scale landscape changes are easy to spot. Less immediately obvious, being more diffuse and scattered, are features to be found within economically powerful towns and cities such as evidence for a variety of wage earners' or craftsmen's housing, or in boroughs and villages where one can see, for instance, the influence of textile companies.

On the other hand, the actors of industrialization have assumed the role of new partners and decision makers in the urban fabric and in the growth of urban agglomerations. Within the limits of pre-existing cities, these forces have swallowed all the still-vacant space which was suitable for their activities. Beyond these limits, they have more or less extensively colonized the nearest well-served suburbs, enforcing their control over the real estate with regard to future utilisation of their productive locations. See, for instance, the process of settlement of industrial businesses in Manchester or in Lille-Roubaix-Tourcoing, or in the ironworks district of Longwy (Lorraine, France), as it has been investigated in the last twenty-five years by French researchers, starting from cadastral, notarial and company archives. Still more directly, a number of sizeable companies have created new settlements. After de-industrialization, these remain available for housing, albeit often with different populations, as well as being worthy testimonies of various styles of labour-force economic management and sometimes of philanthropic thought on the part of broad-minded entrepreneurs.

Once again, engineers played a central role in that kind of achievement, as designers and builders on behalf of the companies. Some of them, as early as the mid-nineteenth century, acted as 'social engineers' and claimed to stand at the core of contemporary societies, being best qualified for pointing the way of improving incomes, health, education and social rank of the salaried workers, due to a re-distribution of the global wealth created by industry.

Rather suddenly, de-industrialization has drawn attention to vast forgotten areas inside or near historic cities – sites of production, living spaces, symbolic places – which few people have been ready to qualify as 'heritage', and which most often political and administrative authorities have been at first glance considering as an unbearable financial burden if not assumed by private or state investments.

Large industrial heritage is not easily handled, being not just a collection of more or less valuable single monuments, either technical or architectural. Moreover, in the case of high-density industrial districts, the 'heritage' constitutes a new kind of geographical landscape, possibly in the dimensions of an extensively urbanized region (such as the Ruhr area, or Emscher Park, in Europe, or some parts of New Jersey and Pennsylvania).

The heritage of industrial society, in such conditions, can only be rescued under two conditions. First, an intensive effort to help the survival of a collective memory among the post-industrial generations regarding such ensembles, by making them globally intelligible after their loss of function. And, second, a mobilization of imagination, invention and creativity in view of re-integrating them into daily life, employment and other cultural or public service needs of the inhabitants.

Such uneasy achievements have been reached, for instance, in several major industrial cities of Nordrheinland-Westfalen, Germany, namely under the impulse of the IBA (Internazionale Bau Ausstellung) during the 1990s, and are also on the way to being successfully achieved in Sesto San Giovanni in Milan, Italy, in parallel with an expected nomination for the World Heritage List in the category of evolved cultural-industrial landscapes.

Conclusion

It goes without saying that the heritage of industrial societies should be considered and used, in the present times more than ever, as a heritage for the future. However, the processes of safeguarding and re-interpretation should not prevent us from looking at the subject with a critical eye. The heritage has also conveyed to us major deficiencies, such as the lack of solutions to the problem of a world running short of irreplaceable energy sources and raw materials; or of the endless quest for an efficient theory of an harmonious relationship between capital and labour. We should be ready to discuss the question: will a new industrial age be able to fill the gap?

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Part II

Understanding the evidence

5

Industrial archaeology

Patrick Martin

Introduction

The disciplined study, preservation and interpretation of the industrial heritage began as a passionate pastime which in recent decades has become a profession. The earliest use of the term 'industrial archaeology' has widely been credited to Michael Rix in Britain in the 1950s, and while this may well be the first use of the phrase in English, an earlier Portuguese writer, F M Sousa Viterbo, appears actually to have coined the term in 1896. The better-known British version of the field arose in the context of amateur enthusiasm as a means of preserving the cherished remnants of an important history; much of the initial work was undertaken by avid amateur archaeologists in adult continuing education courses. The pursuit of knowledge and understanding of industrialization has gradually evolved beyond those early roots into an approach to scholarship and practice that laps over several academic disciplines and government agencies worldwide.

The term industrial archaeology is still widely used in the UK and the US, but the topic is now more commonly called Industrial Heritage Studies, *industriekultur*, *patrimonio industrial* or *patrimoine de l'industrie* in international contexts, reflecting the expansion of coverage to include much more than traditional archaeology. Perhaps the greatest proportion of attention in the field concentrates on preservation of buildings, landscapes and monuments of the industrial past, along with government policies and private practices that serve these ends.

While arguments still occur about the appropriateness of the various labels, the fact remains that some practitioners of this field *do* still approach the study of historic industry from a strictly archaeological perspective, employing archaeological tools to generate evidence and insights into the industrial heritage that we find so fascinating and influential. This chapter will discuss the practice of industrial archaeology in this more narrow sense of the term, focused on excavation and archaeological analysis as a critical set of methods and perspectives for illuminating industrial sites, structures, landscapes and processes.

Archaeological techniques

Traditional archaeological excavation as a technique in industrial heritage study has been well discussed by several authors in the past (see suggested readings). While there is general agreement that the widespread use of the term archaeology in this context is justified because of the focus on the material remains of past industrial processes, practices and social patterns, the actual use of archaeological techniques in industrial heritage studies is fairly limited. The traditional methods of survey/discovery, excavation, stratigraphic dating and artifactual analysis are most generally applied in circumstances where site locations are poorly known, where they are in advanced states of abandonment and/or decay, or where they are threatened with destruction through actions such as development. Such techniques and perspectives are particularly useful on sites that date early in the history of industrialization, and those that are smaller and more vulnerable than the more established, later sites and complexes that are still or have recently been in use. They are, moreover, well suited to studies of process residues and waste to explore details about materials, production and technology.

Archaeological techniques also lend themselves readily to the study of the social dimensions of industrialization through the examination of workers' housing and material culture in the industrial context. Comparative studies of spatial layout and location allow researchers to contrast the living conditions of workers from place to place and examine change over time, as well as to compare the situations of rural and urban dwellers and the contrasts between workers and managers. Examination of food remains and furnishing reflect on the differences in status and social roles between different categories of people, allowing us to explore our assumptions about social hierarchies and the development of modern societies out of simpler precursors. While documentary sources are often extensive in industrial settings, they are seldom, if ever, comprehensive, leaving open many questions about both technical and social aspects of industrial operations. Archaeological insights may be the only avenue of exploration to answer critical questions, both in the specific circumstances and about more general, abstract and comparative matters about the process of industrialization.

To illustrate some of these principles, the remainder of this chapter will discuss two examples of archaeological investigations focused on North American industrial sites.

The Mill Creek site is situated on Lake Huron at the tip of Michigan's Lower Peninsula, nearly 300 miles north of the nearest substantial contemporary settlement, at Detroit. Established in the 1780s to support the English military occupiers of the region, this farm and mill complex was expected to provide sawn lumber and processed grain for both the military establishment at nearby Fort Michilimackinac and for the settlers that were being encouraged to move to the region. While this settlement ideal was never fully realized, the English, and later American military maintained a steady presence, and the area was a critical transshipment and staging point for the American fur trade, situated as it was at the connection between Lakes Huron and Michigan, close to the outlet of Lake Superior and, thereby, the path to the interior of the continent. Built by an early trader and merchant named Robert Campbell around 1785 and purchased in 1819 by a prominent fur trader and entrepreneur named Michael Dousman, a water-powered sawmill and gristmill were operated at this site until some time between 1840 and 1850. Various observers reported the ruins of the mill and dam during the remainder of the nineteenth and into the twentieth century.

The property was acquired by the Mackinac Island State Park Commission in about 1970, after the archaeological remains of the mill site were rediscovered, with a view to

Traditional excavation and analytical techniques employed at the West Point Foundry, New York. Archaeologist Arron Kotlensky in the buried raceway that flows beneath the blast furnace, visible in the background. (Patrick Martin)

incorporating the site into the interpretive programs of the Park. The Park Commission contracted with The Museum at Michigan State University to help in the historical and archaeological investigation of the site; the author focused on this site during the period 1973–76, ultimately producing a doctoral dissertation on the project, later published by the Park Commission. This work and subsequent archaeology by other researchers has provided guidance for the reconstruction of a sawmill and other buildings as the key elements of a public interpretation program at the site, now know as Historic Mill Creek.

Although square hewn timbers were visible in the stream that bisects the site, and depressions that marked building cellar holes did come to light after vegetation was cleared, Campbell and Dousman's mill and farm had largely succumbed to the ravages of time and nature, receding from sight and memory. After the initial discovery of period artifacts by local history enthusiasts armed with metal detectors and searching for another contemporary site location, it remained for archaeological survey to reveal the extent and nature of the remains. A student team employed a systematic random sampling scheme, a technique widely used in mainline archaeology in the 1970s and designed to reduce bias in the selection of a sample of material to allow subsequent excavation to focus on key elements of the site. This approach revealed the ruins of

The reconstructed vertical blade sawmill interior at Mill Creek, Cheboygan County, Michigan. The project was informed by archaeological study of the site and forms part of the interpretation of Mackinac Island State Park Commission. (Patrick Martin)

several buildings, some of which were not visible from the surface, and generated a collection of artifacts that confirmed the site's occupation range in the late eighteenth and early nineteenth centuries. The testing identified remains of two houses, a blacksmith shop and a storehouse/workshop, along with the base of the crib dam that provided water power.

Subsequent area excavation (an approach of extensive exposure directed by the results of the systematic sampling), produced a wide range of artifacts reflecting the milling and domestic activities, along with some surprises not expected in a frontier mill site. For instance, the blacksmith (and cooper's) shop was attached integrally to one of the residential structures, a spatial pattern not previously recognized. Furthermore, there were significant quantities of artifacts related to the fur trade, items such as beads, silver ornaments, fishing gear and firearms of types that were made specifically for the trade in beaver pelts with native peoples of the region. And there was a surprising number of military uniform buttons in and around the residences. While this was not an official military site, it appears that military personnel, either on active duty or recently discharged, were residing in the place.

Other artifacts and features more directly reflected the residential and industrial activities one would expect: architectural hardware, tools (including some specialized milling tools such as a pick for dressing millstones and a saw set for adjusting the teeth on a large vertical saw blade), firearms for hunting, ceramics, glassware and utensils, personal items such as buttons, musical instruments and smoking pipes, and furnishings such as clocks. The chronological development of the site was partly revealed through the dating of specific groups of artifacts and comparisons between and among the different building contexts. For example, detailed dating of ceramic types suggested that the buildings were not all constructed at the same time, a conclusion supported by a statistical study of the variability of thickness in window glass remnants.

The Mill Creek Site was by no means a highly specialized industrial site, but rather a very early frontier establishment where milling functions were combined with farming, trading and a domicile. However, the recognition of nascent industrial activities and facilities in this remote setting reflects on the expansion of industrialization into the far reaches of the frontier at an early date. A water-powered mill with specialized equipment was a completely new discovery, and the perspective offered through a combination of archaeological excavation and analysis with an understanding of milling supported through the industrial archaeology literature allowed for a richer interpretation of this critical facility.

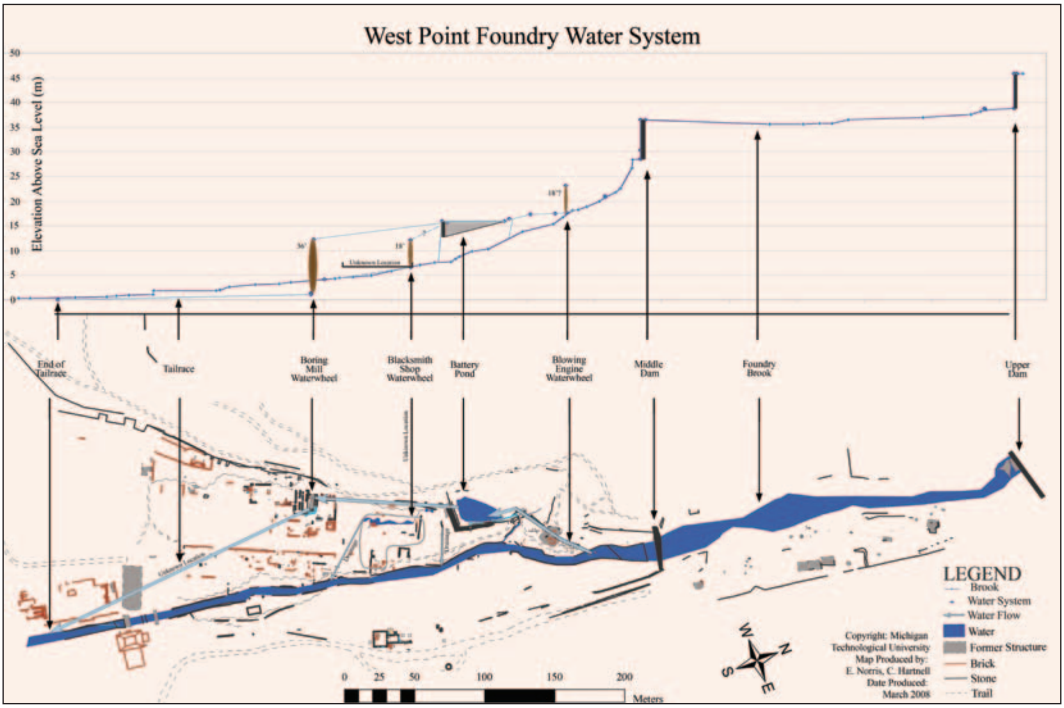
The second example illustrates several additional dimensions of the role of excavation on industrial sites in a larger, more complex context. The West Point Foundry, in Cold Spring, New York, was one of America's foremost early industrial establishments. Located on the Hudson River about 50 miles north of New York City, this heavy ironworks was opened in 1817 as a key part of the national effort to institute a new system of ordnance manufacturers spatially spread around the country. This distribution aimed to avoid a repeat of the unfortunate destruction of cannon-making capability suffered when the British destroyed the Georgetown foundry near Washington DC in the war of 1812. The West Point Foundry Association was a group of well-connected partners that enjoyed a strong relationship with the government and a steady stream of substantial contracts during the foundry's nearly 100 years of operation. While they also produced a wide range of heavy iron products, such as steam engines, some of America's earliest locomotives, cast-iron architectural parts, and sugar mills, among other things, they made their reputation and a considerable share of their income from the manufacture of cannon and shot. They began making other gun types, but this foundry became the home of the Parrott rifled cannon and projectile, patented by the foundry superintendent Robert Parrott in 1861 and widely used by Union forces in the American Civil War. Following the war, demand for the foundry's traditional cast-iron products waned, the original managers retired, and by 1912 operations had slowed to a stop. A succession of smaller firms used the space, but it was gradually abandoned until only one ruined structure stood on the nearly 100 acre parcel in the late years of the century.

In 1996 the foundry property was acquired by the Scenic Hudson Land Trust as part of its mission to protect open green spaces in the Hudson River Valley. Located on the river and adjacent to both the village of Cold Spring and land protected by another environmental organization, this property is a key element for local preservation; the industrial heritage character of the place was a secondary consideration to the new owners, but was embraced enthusiastically once they came to appreciate its unique importance. In 2001, Scenic Hudson approached the author and the Industrial Archaeology Program at Michigan Technological University (MTU) to develop a research program that would explore the site, with an eye to providing information to support an interpretive program. Over the next several years, MTU students, faculty and volunteers conducted historical and archaeological research focused on key portions of the site. Traditional excavation and analytical techniques offered significant insights into critical factors of operation, change over time, production details, environmental conditions, and a host of matters not fully described or explained in the fairly copious documentary records left by this substantial operation. We shall examine a few of these insights below.

The initial research forays at West Point Foundry involved intensive mapping of visible surface remains. While only one structure actually stood with a partly intact roof, the foundations of many other buildings were evident on or just below the surface in the wooded area that contained the foundry. Mapping those remnants and overlaying them within a Geographic Information System (GIS) that also included a series of historic maps allowed the team to work out a sequence of construction for the site and to target areas where remains were not so readily accessible or visible. Collecting spatial information in a digital format, using a laser-based total station, allowed the team to enter data into the GIS that supports an extensive array of manipulation and analysis capabilities. Overlaying historic maps upon the existing conditions portrays both the visible and the invisible former features of the landscape, providing a rich perspective for understanding change and development over time. Working from this system of maps, we were able to focus attention on topics such as the largely buried water-power system, worker housing, the boring mill and casting house, and the technological shift from charcoal to coke in iron-smelting.

The West Point Foundry was established on Foundry Brook, a small but reliable source of water power. Because all of the foundry's machinery was powered hydraulically, the control and efficient use of the falling water was essential to successful operations. In order to manage this critical resource, the company built a series of dams and raceways to store and channel the water to the wheels that drove the equipment in an orderly fashion. While the dams are obvious, some of the raceways are obscured, both by the degradation of the landscape in the century since abandonment and by the fact that they were fully or partly buried from the outset. For example, a blast furnace was placed just below the largest dam, with a water-powered blowing engine. We are fortunate to have access to a contemporary painting that illustrates the furnace, dam and overshot wheel for the blowing engine, a marvellous piece of evidence to interpret the location and operation of this complex. However, examination of the site itself revealed a small waterway entering upstream and exiting below the blast furnace, and excavation disclosed a channel leading from the stream bed above the furnace under the ruined foundation of the blowing engine and passing beneath the furnace. This arrangement runs counter to most reasoned advice about blast furnace operations; purposefully passing water near the intensely heated masonry mass of a furnace invites problems. However, the physical evidence is irrefutable, and is reinforced by an early twentieth-century photograph that clearly shows the channel leading from the brook toward the furnace, running full of water. Subsequent analysis suggests that this arrangement reflects careful management of resources, allowing waste water off the blowing engine wheel to be combined with water from below the dam and run beneath the furnace into a pond where it was stored for use in the boring mill located further down the valley.

From this storage pond, water was fed through an open headrace to the boring mill, where it exited onto a 36 foot diameter backshot breast wheel that drove the machinery to finish cannons and other products. The water exiting the wheel flowed into a buried tailrace to return to the brook, but the opening at the brook was not



Plan and cross section of the complicated water-power system at West Point Foundry, New York. This synthesis was attained after combining various different techniques. (Michigan Technological University)

immediately evident. The detailed topographic survey of the ground surface in the GIS revealed that the input to the tailrace was actually at an elevation below the streambed at its nearest point to the boring mill, making it impossible to drain water from the mill in the shortest straight-line distance. After excavating the wheel pit, opening the tailrace, and pumping down the ground-water level, the archaeological team deployed a remotely controlled submersible vehicle and attempted to trace the tailrace path. After negotiating some turns and about 50 feet of passage, the submersible was blocked by root growth. Meanwhile we had engaged some remote sensing equipment, including ground penetrating radar (GPR), an electronic technique that projects electrical pulses into the ground and carefully measures the reflected signals to identify and locate buried objects, soil layers and disturbances. The GPR work identified anomalies that proved, through excavation and observation of upwelling water at the stream bank, to reflect the nearly 600 foot long path of the buried tailrace. GPR prospecting, coupled with limited archaeological testing, also allowed teams to identify the extent and locations of a system of buried drains, as well as foundations not visible on the surface. These 'virtual' views of underground features, followed by excavation, provided significant insights into the structural nature of this ruined and largely obscured industrial complex, insights not possible through the documentary record.

In addition to these (and many other) research questions answered by archaeological excavation on industrial sites, this set of techniques has two additional powerful benefits. First, the process of excavation is an excellent tool for public interpretation. As excavators know, visitors love to witness discovery in real time. The work at the West Point Foundry is a classic case in point for this phenomenon. Each field season, the archaeological team held Open House weekends in the early part of the season and again toward the end. Hundreds of local citizens visited daily during these events, fascinated by the discoveries and delighted at the progress. Many people expressed amazement that archaeology, a discipline that in the minds of most relates to the ancient past, could reveal so much about events of a more recent time and about industrial activities, and that interesting evidence lay buried directly beneath their feet. While historical research takes place in some obscure archive or office, the active process of excavation opens a window to the research enterprise that is compelling for the public as they seek to understand the background of the industrial past.

The second benefit offered by excavation, beyond the research dimension, is the simple exposure of the physical evidence for interpretation. Buried foundations, walls, raceways, landforms and artifacts can be incorporated into interpretive schemes for permanent exhibit. While more passive than the dynamic excavation process itself, revealing otherwise invisible evidence is an important result of archaeological research.

Summary and conclusions

Excavation is a critical piece of the toolkit for many, if not all, industrial heritage studies. In circumstances where it is warranted, it is essential for identifying significant remains and exploring particular dimensions of the sites in question. Whether employed for discovery of ruins or artifacts, identification of processes by residue studies, confirmation or denial of documentary or oral history sources, dating and chronological reconstruction of site development or the social dimensions of an industrial community, archaeological excavation can offer an essential key to the understanding of industrial heritage sites. Furthermore, it provides an exciting and engaging glimpse into the research process for visitors who intensely enjoy a visit to an ongoing archaeological investigation.

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