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History of Technology in Teaching of History

There is a potential misunderstanding implicit in the title 'History of technology in the teaching of history' which I would like to clear up at the outset. It could be inferred that I am postulating an essential link between two parts of an equation, as though the teaching of history were incomplete without the history of technology. This is not the case. The relationship between the history of technology and the teaching of history, though useful, is not a necessary one, and to declare or even imply that it is so would overstate the argument. Clio the Muse is a willing servant, always ready to meet the requests of historians for particular types of historical interpretation so that the study of history has come to assume many different forms. Of these, the history of technology is a comparative newcomer seeking to establish itself amongst the range of historical disciplines, and although there are important perspectives which it can bring to the study and teaching of history, it would be wildly presumptuous to claim that it is indispensable. Many traditional historians would dismiss any such claim out of hand, and they are not likely to be impressed by the modest plea that I wish to present. Nevertheless, to carry any conviction, it is important that the case should be presented and open for consideration by those teachers of history who are least likely to be sympathetic to the history of technology.

There is another point of possible misunderstanding which might arise from my title, from which it could be assumed that the history of technology is already a well-established ingredient in history teaching. But in reality the subject has made remarkably little progress towards recognition as a university discipline, especially at undergraduate level. This lack of recognition is particularly the case in Great Britain, where the courses offered by departments of history in the history of technology – except for service courses offered to other departments – can be counted on the fingers of one hand. However, I suspect that the situation is similar in universities throughout the Western World, although the United States probably has a better record than most countries. The fact is that the history of technology is still largely confined to postgraduate studies and research so that any discussion of its role in the teaching of history must refer more to its potential than to its past performance.

I should add that I do not undervalue the service function of the history of technology, especially in providing a historical dimension to the studies of engineers and scientists. On the contrary, as one whose livelihood depended for several years on service teaching, I firmly believe in such studies and I wish that engineers and scientists in positions of educational authority could be convinced of their value. The conclusion may be that an expansion of such teaching is the most promising direction the history of technology can take. But in the context of this paper I see service teaching as essentially peripheral to historical study and teaching, and at this level we are operating on a very narrow basis of practical experience. I believe several of us have attempted to incorporate units or even substantial sections of technological history in undergraduate teaching programmes. Concerning my own attempts, I am not able to report significant progress and in the present climate of retrenchment in higher education I do not hold out great hopes for the immediate future.

These constrictions on the role of history of technology are serious, but they present a challenge. Since the subject is emerging as a distinct and articulate sub-discipline of history, it does pose questions of relationships and objectives about modes of study and teaching methods. My plan is to consider the subject of my title under three broad headings. Firstly, I will look at the subject matter of the history of technology in order to distinguish the sort of ideas and concepts that it can contribute to historical understanding. Secondly, I will consider the more practical aspects of the history of technology as a part of what I propose to call 'physical history'. Thirdly, I will seek to answer the question 'What is the use of the history of technology?'. Each of these sections will suggest applications to the teaching of history and at the end of the paper I will attempt to draw together these various suggestions and try to assess their significance.

History of technology and its contribution towards historical understanding

I have drawn attention elsewhere[1] to the dearth of speculative literature about the history of technology, but the subject is so important and relevant to our present exercise of determining the content of the study that it will bear a brief statement here. All historical studies contain a largely descriptive element. Indeed, it may be argued that all worthwhile academic studies need a basis of careful and factual description in order to prevent them from becoming too speculative or as jargon-ridden as some social sciences which occasionally seem to possess only the most tentative

connection with reality. Because its primary function is the reconstruction of the past, history can never escape from the painstaking research necessary to discover what actually happened at a particular time and place. Such reconstruction may reasonably be described as 'descriptive', although it is as well to remember that selection, interpretation and prejudice enter into even the most simple historical descriptions. The history of technology shares this element in common with other forms of history. As Lord Ashby has reminded us that 'technology is of the earth, earthy',[2] it is to be expected that the quality of factual description will be more pronounced in the history of technology than in those branches of historical research concerned with largely ideological subject matter such as the history of political theory. Most of the very substantial research which has already been published in the history of technology has been concerned with the fundamental task of recording and elucidating particular events or themes in the development of technology, thus establishing a solid core of carefully substantiated factual evidence. In this category may be placed *Oxford history of technology,* the great majority of the papers in the *Transactions* of the Newcomen Society, and most of the standard works on the history of technology that have appeared in the last two decades.[3] It would seem likely that the time has arrived for the history of technology to move on from this firm base and proceed to a stage of interpretative and speculative evaluation which will relate the parts to each other and to general principles of organization. It would also seem likely that the subject can now begin to feed some ideas into the teaching of history.

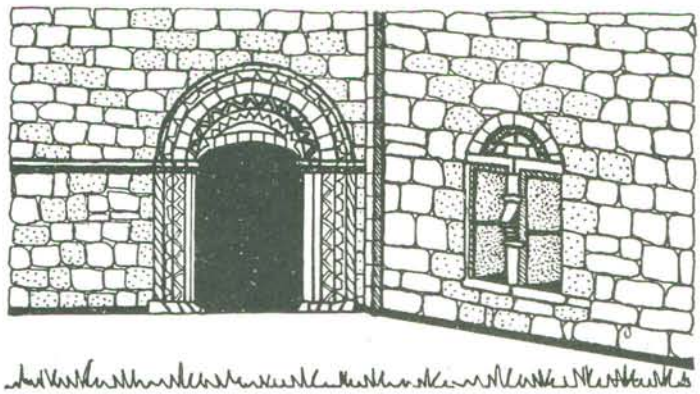
The history of technology has admittedly suffered from a lack of systematic quantification in the past. One consequence has been what might be called 'the fallacy of immediate invention' whereby it has been assumed, for lack of an adequate statistical basis of generalization, that a good idea is more or less automatically adopted since it becomes available. Hence the value of studies such as those which have endeavoured to calculate in detail the numbers of Newcomen-type steam engines which remained in operation after the introduction of James Watt's improvements and which have demonstrated the persistence of the older technology long after better machines came on the market.[4] It is astonishing, on reflection, how little statistical or tabular information is presented in the five volumes of the *Oxford History of technology;* the omission indicates the magnitude of the research tasks still awaiting quantification is not an admission that the history of technology needs to achieve an abstruse level of abstinence. On the contrary, a firm statistical base is necessary in order to derive more accurate inferences from technological innovations, transfers and impact that any made so far.

From the discussion so far it should be clear that I am advocating a scholarly *via media.* By applying analytical and statistical techniques to certain critical areas, my approach lifts the history of technology above the descriptive account where one thing happens after another. On the other hand, my approach leaves the subject firmly on the ground so that the discipline is not made subservient to the regimen of empty conceptual boxes which have to be filled with the available data. It seems to me that this *via media,* which is central to the purpose of my paper, is not likely to be relevant to the teaching of history. For while the scholar and teacher of history can safely ignore the descriptive, factual monograph on the technical performance of engines, machines and processes which has been the mainstream of publications on the history of technology until recently, the systematic treatment of the key themes which I have indicated can be of immediate value to a wide variety of historians.

History of technology as part of physical history

In addition to its conceptual contribution, both actual and potential, to historical scholarship, the history of technology can also make a highly practical contribution which is particularly relevant to the teaching of history. In this respect, the history of technology is a species belonging to the genus of historical disciplines which may be called 'physical history'. Together with local history, architectural history, archaeology, historical geography and several other types of study, the history of technology cannot avoid an emphasis on field-work. R.H. Tawney reputedly first called on historians to invest in a stout pair of walking shoes and W.G. Hoskins took up the call in his work on the English landscape.[5] Michael Rix in launching the study of industrial archaeology went further, requiring of practitioners a good pair of gum-boots.[6] What all of these spokesmen for physical history agree is that the physical evidence available through field-work to the senses of sight and touch has a vital contribution for historical scholarship. It may not be as important as documentary evidence, but where written evidence is lacking or inadequate – and these conditions pertain for our knowledge of all periods except the most recent – physical evidence, properly recorded and judiciously interpreted, can provide supplementation, while in such areas as the archaeology of prehistoric societies it becomes paramount. Moreover, in the most recent periods of history when there is already too much written material to assimilate, physical evidence can supply a missing dimension. Most particularly, it can give the student a sense of identity with the past that no amount of book-learning can inculcate. At the very least physical history is a useful teaching aid to the historian. And amongst the evidence examined by physical history and thus made available as a teaching aid to all historians are the surviving artefacts of past technologies, which it is the business of the historian of technology to interpret.

It could be argued that the preoccupation with the surviving evidence of obsolete industries and transport systems has acquired the status of a sub-discipline in its own right under the name of 'industrial archaeology'. As you might expect, I would go some way towards arguing this myself.



Physical History: observation and interpretation. Two archways in the cloister of Lilleshall Abbey: why are they here? Why are they like this? Who designed them and who made them?

But it is a matter of drawing a highly arbitrary line to distinguish so sharply between industrial archaeology and the history of technology. Admittedly, in so far as historians of technology are engaged in the important and overdue exercise of increasing the analytical and conceptual quality of their discipline in the ways already advocated, they have tended to show somewhat less propensity for field-work in their subject, and to this extent there has been in the last decade a certain drawing apart of industrial archaeology from the history of technology. However, a complete separation would be harmful to both and I prefer to regard them as complementary aspects of the same exercise, both being related in turn to the other subsections of physical history. I wish to make the point, therefore, that through industrial archaeology and physical history, the history of technology has a very real contribution to offer to the study and teaching of history.

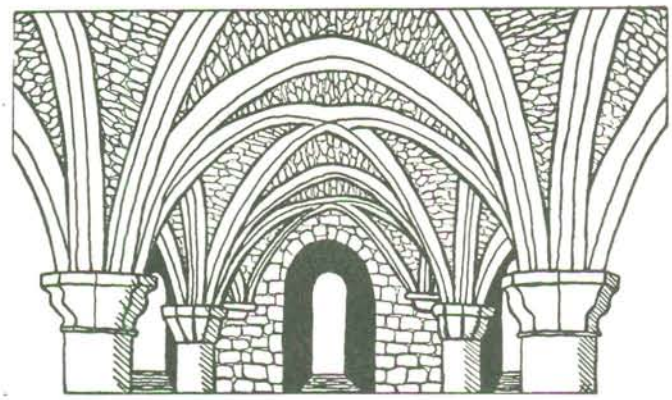
Information useful to the historian can be derived from physical evidence at four levels. Firstly, through the study of landscapes regarding such areas as geology, drainage, soil conditions and mineral resources and using a variety of specialized techniques such as aerial photography, it is possible to learn how any one particular landscape has been modified by man and so add to our understanding of its history. The identification of forgotten prehistoric sites through crop marks or of deserted medieval villages through hedge patterns are both examples of highly rewarding research of this nature in recent years.[7] The second level is concerned with existing settlement patterns, including farms, villages, small towns and cities, and the corresponding transport systems. Urbanization may be regarded as the dominant settlement pattern of a fully industrialized society and the study of the physical features of towns can elucidate the process of urban growth. The history of the Victorian town, for example, has benefited substantially from such examination.[8] Thirdly, structures such as houses, factory buildings, mills and public utilities provide further level of physical enquiry. Here the architectural historian has most to contribute, but as industrial buildings are usually highly functional, the historian of technology is often best qualified to interpret their shape and layout.[9] Finally, the artefacts in the shape of machines and equipment, street furniture and commercial products are the fourth level of examination for the physical evidence, where the history of technology has most application. In interpreting the remains of an obsolete metallurgical process through surviving artefacts, the skills of the materials scientist are invaluable, and for interpreting machinery of any age some engineering competence is equally useful. These are skills which the historian of technology usually knows where to find even if he does not possess them himself.

Perhaps I may permit myself a single illustration of this point in an area where I have found particularly exciting research possibilities. The lifetime spent photographing and recording stationary steam engines by George Watkins has succeeded in transferring information about a rapidly disappearing species of artefact to a permanent archive. As such, it is available to scholars and serves as a source of inspiration and enthusiasm while also raising a series of provocative questions for further examination. How many steam engines were produced of different types and for different services in the nineteenth century? What factors influenced the continuing improvement in the performance of steam engines throughout the nineteenth century? Why was there an apparent 'lag' in the application of improvements in some services such as marine steam engines rather than in others? What influence did the development of steam technology have on the internal combustion engine and how did steam technology react to competition from this and other alternative sources of power? For these and many other questions no precise answers are as yet available. However, the fact that they are being formulated as topics for research indicates the powerful stimulus derived from a painstaking attempt to collect and to organize systematically the physical evidence of steam technology by a scholar with the engineering competence to understand what he was observing while the artefacts were still available for study. This undertaking by Watkins also provides a valuable teaching aid for engineering and history students alike in learning to appreciate the qualities of steam engines and the consequences of the power revolution which they brought in the growth of an industrial economy.[10]

This outline of the sort of information which can be acquired from physical history demonstrates the indispensable contribution that the history of technology can make, especially at the levels of structure and artefact analysis. This contribution is primarily of a scholarly nature: like any historian, the historian of technology is concerned with the recreation, as exactly as he can make it, of past events, using as his distinctive technique in this exercise the interpretation of artefacts, whether these be recorded in documentary form or available for examination in three-dimensional reality. The secondary contribution is pedagogic, because the account of how a machine works or an artefact functions can explain more convincingly and teach more effectively than a corresponding paper exercise. The practical aspect which the history of technology can give to the processes of instruction in this way has so far been little understood, despite efforts by some of our more progressive museums to apply the lesson. It is small wonder therefore that historians have been slow to take advantage of these pedagogic opportunities although there are encouraging signs of attempts to combine instruction with field-work and visits to sites of industrial archaeological significance. There are great educational possibilities for this development which such schemes as 'Project Technology' are just beginning to exploit.

Physical History: analysis of design process. How was the rib-vault evolved? How was the construction method designed? Was it efficient technology?

(Illustrations by Angela Aldersley)



What is the use of the history of technology?

To the teacher of history who is anxious to justify his discipline in terms of its utility and relevance the history of technology is an especially rewarding field of enquiry. To all other historians what I have to say next will have no significance.

The contribution which the history of technology can make to the contemporary debate about technology and society falls precisely into those areas in which we have already observed the subject to be acquiring analytical depth. Firstly, there is much of value to be interpreted from historical experience about the process of innovation. Studies of innovation in the Industrial Revolution in Great Britain, such as the essays collected by Professor A.E. Musson[11] have a relevance to the general question of whether invention can be artificially stimulated and, if so, how. It is possible to argue, for example, that one of the essential prerequisites for the inventive boom in eighteenth-century Britain was the presence of a socially significant middle-class group which was disposed to experiment with new ideas and to apply them when they had any promise of personal profit. Such a historical interpretation may then be brought to bear on the examination of a currently developing society and may help to determine policies aimed at encouraging similar social focal points of enterprise in these communities. It is barely necessary to stress the tentative nature of such a projection, when so many other factors need to be taken into account simultaneously, and in any event it implies judgements about the desirability of particular patterns of development which the historian may consider to be beyond his brief. But at the very least, the historical experience provides a clue about one outstandingly fertile set of relationships which, along with other clues, may contribute to the solution of one aspect of a complex contemporary problem.

Secondly, the analytical area concerned with assessing the nature and scope of the ways in which technological innovation has been transmitted in the past from one society to another can supply helpful projections for the modern politician and administrator. The role of skilled personnel and professional journals, for example, in transmitting European technological experience to America early in the nineteenth century can suggest ways in which the dissemination can be continued to parts of Asia and Africa in our own time. In *The maze of ingenuity*, Arnold Pacey recently attempted to draw out the application of lessons learnt from the process of Western industrialization to the developing societies of the world today. Although not completely satisfactory in the fulfilment of its objective, this was a stimulating and pioneering study and Pacey subsequently abandoned his academic career to promote 'intermediate' and 'alternative' technology through Oxfam. His action is a very pertinent indication of the practical implications of the history of technology.[12]

Thirdly, in the analysis of the relationship between technology and culture, the historian of technology can show insight into the transformation of our own society and suggest policies for assisting or resisting similar changes in other societies. We have already observed that the implications of this interaction between the technological and cultural aspects of social life are extremely complex so that virtually no policy can be guaranteed to produce the desired effect and no other. The current debates amongst town-planners about policies to relieve traffic congestion and about 'high rise' development indicate the largely contingent and pragmatic quality of these policies, isolated from historical roots, so that any historical experience may help to determine the balance between conflicting possibilities. The work of historians of technology in examining the development of urban services can thus have contemporary relevance, as can work on the history of automatic controls and technological education. Even more important, at least potentially, is the work of analysing the impact of technology on value systems and its contribution to such key-concepts as 'progress'. The technological aspects of the 'ecology crisis' also have an important historical dimension, and as shown recently by Richard Wilkinson[13] the role of technology in this area may be more ambiguous than has been commonly supposed. Amongst other provocative ideas, Wilkinson indicates a fallacious tendency to equate quality with quantity in the implication that because an innovation produces more, it is therefore better. It is frequently only different, being a cheaper substitute for whatever it replaces. For example, when coke-smelting of iron replaced charcoal-smelting in eighteenth-century Britain, the former not only used a cheaper and more readily available fuel but it also promoted the construction of larger blast furnaces so that more iron could be cast. But the quality of coke-iron remained inferior to charcoal-iron even though the change became widespread. The implications of this and other historical resource substitutions for our understanding of ecological disequilibrium and economic growth are significant and have an important bearing on many topical policy decisions in relation to the developing countries.

Enough has been said, I hope, to suggest that there are certain very specific issues on which the history of technology can make something more than a casual contribution to the contemporary discussion ranging over all aspects of the relationship between technology and society. This contribution is an important function of technological history and arises from the main analytical preoccupations of the subject. As such, it has relevance to the teaching of history in two ways. First, it gives a specifically utilitarian orientation to the teaching of the history of technology because it emphasizes the value of a historical understanding in tackling a wide range of contemporary problems. The subject therefore becomes an important adjunct to teaching on environmental studies, ecology,

the energy crisis and so on. Second, it provides all professional historians with an example of the practical possibilities of their discipline and could inspire them to make linkages and interpretations relating their historical experience to the problem of understanding the complex patterns of motivation which provide the dynamic force of our civilization. Such an example will only be followed, needless to say, by historians who are already conscious of a need to demonstrate the utility of their discipline. But those are the historians who are most likely to take seriously the history of technology.

Summary

I have been arguing that the history of technology has an important place in the teaching of history. By sharpening its own conceptual and analytical focus it can contribute some important interpretative ideas to history in general and such ideas are already influencing parts of economic and social history. By exploiting its intimate relationship with industrial archaeology as an aspect of physical history, it can demonstrate the value of technological structures and artefacts in illuminating many parts of history for which documentary records are inadequate, while at the same time providing superb teaching aids to help the comprehension of students. By applying its insights to problems of the contemporary world, it is possible to justify the use of historical studies in general as well as of the history of technology in particular and to achieve a sort of functional relevance to the teaching of history which is at present rare. In the last resort, it seems to me that as we strive, as strive we must, to perfect our craft as historians of technology, we should never forget its essential earthiness and humanity. The history of technology is about people, and the way in which people have made and done things, and the implications of these actions upon each other. It is this human content to the subject which gives it valuable relevance to the great contemporary questions of our civilization and makes it important in the teaching of history.

Notes

1. Angus Buchanan, 'Technology and history', *Social Studies of Science*, 5 (1975) 489-99. Essay review.
2. Eric Ashby, *Technology and the academics*, London, 1958, p.66.
3. C. Singer *et al*, (eds.), *A history of technology*, 5 vols., Oxford 1954-8. The Newcomen Society for the Study of the History of Engineering and Technology has published its *Transactions* annually since 1922. For a succinct review of the standard works on the history of technology, see Robert Multhauf, 'The historiography of technology: some observations on the state of the history of technology', *Technology and Culture*, 15 (January 1974), 1-12.
4. See A.E. Musson and E. Robinson, *Science and technology in the Industrial Revolution*, Manchester, 1969, especially Chapter 12, 'The early growth of steam power', a version of which originally appeared in the *Economic History Review*, 2nd ser. 11 (1959).
5. W.G. Hoskins, *The Making of the English landscape*, London, 1955 called in his introduction for 'a combination of documentary research and of field-work of laborious scrambling on foot wherever the trail may lead' (p.14), and in his *Local history in England*, London, 1959, he claimed that no historian 'ought to be afraid to get his feet wet' (p.2).
6. M. Rix, 'Industrial archaeological field work' in R.A. Buchanan (ed.), *The theory and practice of industrial archaeology*, Bath, 1968, p.19.
7. Hoskins, *Making of the English landscape* pioneered work in this field. Amongst more specialized studies are M.W. Beresford and J.G. Hirst (eds.), *Deserted medieval villages*, London, 1971 and M.W. Beresford and J.K. St. Joseph, *Medieval England – an aerial survey*, Cambridge 1968.
8. There is remarkably little physical history in H.J. Dyos and M. Wolff (eds.), *The Victorian city – images and realities*, 2 vols., London, 1973. But other recent urban studies are more aware of the physical reality, e.g. J. Hume. *The industrial archaeology of Glasgow*, Glasgow, 1974. And even such a general work as Asa Briggs, *Victorian cities*, London 1963 conveys a strong sense of time and place by its perception of physical differences.
9. Jennifer Tann, *The development of the factory*, London, 1970 is a good example of this approach. Also K.C. Barraclough, 'The development of the cementation process for the manufacture of steel', *Post-Medieval Archaeology*, 10 (1976), 65-88 is an excellent illustration of skill in the interpretation of physical evidence.
10. This theme has been explored in R.A. Buchanan and George Watkins, *The industrial archaeology of the stationary steam engine*, London, 1976, and a detailed application to the questions raised is now being worked out in the subsequent research programme at the Centre for the Study of the History of Technology, University of Bath.
11. A.E. Musson (ed.), *Science, technology and economic growth in the eighteenth century*, London, 1972.
12. Arnold Pacey, *The maze of ingenuity: ideas and idealism in the development of technology*, London, 197 See also the essay review of the book in Buchanan, 'Technology and history'.
13. Wilkinson, *Poverty and progress*.