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History of Technology: An Area of Growth in Design Education III*

Technology Appreciation: what does this mean in practical teaching? Perhaps it can best be thought of by analogy with music appreciation: thousands of people, either through skilful teaching or by self-education (or both), have come to have a deep feeling for great music and a consequent enrichment of their lives without being in any way skilled practitioners of any instrument. By parallel thinking, it is evident that the essentials of technology can be appreciated without the need to be a skilled craftsman or engineering designer. In fact, just as the majority of our students will never be able to play a musical instrument to orchestral standard, an equivalent majority will never learn to handle data processing or sand casting.

Just as long-playing records and high-fidelity amplifiers revolutionised music teaching in the late 1940s and 1950s (and does anyone else recall that first massive impact of hi-fi Sibelius in the classroom?), so have industrial museums revolutionised teaching the nature of technology: that first sudden glimpse of the Iron Bridge is a memorable experience, as is the unexpected towering structure of the David and Sampson blowing engines amongst the woodlands of Blists Hill, another of the Ironbridge Museum sites.

As a research project we set out to investigate fully the technology of blast-furnace blowing-engines, a species of steam-engine now extinct, and to explore the eductional value of this unique survival on Blists Hill whilst, at the same time, evaluating educational use of the museum site in terms of teachers' effective use of the resources there. In particular, it was hoped to discover something about teachers' concepts of technology appreciation in a post-industrial society, in which rational decisions about the implications of technology require decision-makers to have an element of technology appreciation.

Early blast-furnaces, for smelting metal ores, relied on natural blasts of wind and were suitably sited on hillsides – an ancient example of optimising resources. Wind being an unreliable power-source, primitive technologists evolved simple bellows from animal skins (a principle still used in the bagpipes). An imaginative leap was the operation of bellows by a trip-device on the shaft of a waterwheel; but there is a limit to the frequency with which diagonal bellows can be exhausted by a cam and then reinflated by a weighted lever so, when this technology was fully exploited, the metal-working community was ready to open its mind to the idea of a more advanced air-pump.

The analogy with musical instrument technology is still valid, for organs were still being made with diagonal bellows, loaded with iron or stone and continuously reinflated by manpower, in the early 19th century, to be superseded by diagonal feeders to horizontal bellows. These were subsequently often driven from a crankshaft by hydraulic power just as in a mediaeval furnace; we often forget the snail-pace of technological evolution prior to our own time, when turbo-blowing has replaced all other methods.

The idea of an air-pump, a primitive large-scale bicycle pump with rectangular wooden cylinder and piston, replaced furnace blowing by bellows in some districts and was followed, in the mid 18th century, by cylinders of iron.

Since early steam engines, following Newcomen's Dudley engine of 1712, were thought of only as water-pumping machines, it was natural that steam power should be used for re-cycling the water that drove the waterwheels operating the blowing machinery; it took another half-century to realise that a Newcomen or Watt-type steam engine could work the blowing cylinders (or 'tubs') directly.

A large beam-engine (the 'Resolution') was used in Abraham Darby's Coalbrookdale to recycle water from 1783 but in 1776 Watt's first blowing engine was built a little over a mile away for John Wilkinson, a rival ironmaster. Darby's Iron Bridge of 1777 may have been partly in answer to Wilkinson's new installation. Although the Coalbrookdale foundry was able to produce steam engines, progress in design was inhibited by Watt's patents, which lasted till 1800, although many anonymous pirate engines were built by various makers.

By 1800 nearly all English blast furnaces were equipped with cylinder blowers, mostly steam-powered, but after expiry of the Watt patents progress was rapid and most manufacturers soon

* This is the third of a series of three articles.

adopted Watt's condenser, parallel motion, fly-wheels and double-acting cylinders; and steam pressures exceeding atmospheric. Cast-iron beams were introduced (replacing timber) and remained a feature of steam engine design (along with vertical cylinders) well into the railway age which, of course, depended on the entirely fresh concept of a horizontal engine. The vertical engine had been a direct consequence of the centuries-old need to pump out vertical mine-shafts, and the concept died slowly with its adaptation to horizontal propulsion.

The manufacture in Britain of beam-engine blowing machines seems to have ended in the 1860s, to be replaced by direct-acting steam cylinder + blowing cylinder combinations and later by the centrifugal blowers now in universal use for blast furnaces. Such turbo-blowers have one-fifth the weight and one-third the installation cost of reciprocating types. Only three cylinder-type blowing engines are known to survive in Britain: a low-pressure machine attributed to Watt and preserved on a traffic island in Birmingham, a machine with steam and air cylinders on a single vertical axis belonging to the Ironbridge Museum Trust, and a high-pressure beam engine made in 1851 for the Lilleshall Company and now a major exhibit on the Ironbridge Museum's site at Blists Hill; our educational research concerns the latter engine, locally known from time immemorial as 'David and Sampson'.

David and Sampson are an identical pair of beam engines with a common flywheel and designed for operation as a twin-cylinder unit; they were built by the Glasgow firm of Murdoch, Aitken & Company and this machine is believed to be the only surviving specimen of the firm's work. The Lilleshall Company in 1851 opened a new set of four blast furnaces at Priorslee, about four miles from Blists Hill: David and Sampson provided the air-blast for these furnaces continuously till 1900, and as standby engines up to 1952; in 1971 the entire machine was given to the Ironbridge Museum Trust and re-erected under a modern roof in the open air. It is a massive structure and the first thing one sees on entering the museum site; our aim was to research fully the design, construction, and use, of the machine in the historical context of the iron industry as a whole (the Ironbridge Museum's chief interest), and to investigate its value as educational material in History of Technology.

Many of the visitors entering the Blists Hill site are initially puzzled by David and Sampson; the machine now stands in isolation and has no obvious context, but is clearly a steam-engine of some sort – although even recognition of a steam-engine can no longer be assumed amongst younger adults. The machine stands 12m (40 ft) above ground level and the flywheel pit goes another 3m (10 ft) below; the steam cylinders are over 3m (10 ft) high and their valve-chests are in the form of classical pediments carried on cast-iron steam-pipes in the form of fluted columns correctly fashioned in the Tuscan order. Modern engineers would (and do) refer to this feature as an inappropriate style – and here is our first point for interpretation: the great architectural structures of classical times represent still the imagination and skill of the engineers, and the political might and power, of the Greek and Roman empires; in the 19th century the engineers of Britain saw themselves, and were seen, in a similar light. It is difficult for us now, but important in understanding the evolution of modern-technologies, to appreciate how steam power dominated industry, commerce, and world trade in the 19th century, and how the influence and prosperity of Britain (workshop of the world) depended almost solely on those temples of steam – the engine-houses that powered mines, mills, furnaces and factories – and on the skilled engineers and engine-men who designed and operated them. It is no coincidence either that the Victorian chapels of industrial towns often resembled the housing of mill-engines: the exploitation of one deity paid for worship of the other.

A survey of school parties visiting the Blists Hill museum site at Ironbridge showed that over 90% were brought in connection with an 'arts' discipline; that is, under 10% were studying technology under the guidance of a technical or scientific teacher or, put another way, technology appreciation is largely being taught not by technologists but mostly by teachers in non-technical disciplines. In fact, it was found that the majority of pupils and teachers making educational use of this museum of technological industry were preparing for examinations in History, Geography and General Studies, with History accounting for well over 50% of pupils attending over the period 1968-78 – a period of unprecedented expense and effort in the cause of technology education. The impression gained from the survey is that innovations in technology education have had greatest influence in History Syllabuses and teaching methods, although the new AEB syllabus in General Studies (A-level) gives a strong emphasis to technology appreciation and history of technology.

At the same time, it became apparent that although History teachers were attempting to use the museum site (and in particular the blowing engines) for educational purposes, very few had the technical experience to make efficient use of the machines as learning material: pupils' attention was not drawn to the evolutionary or design processes leading to the construction of David and Sampson, nor was it ever noted that the machine, an essential item in iron-making, was itself made of iron (that is, tools are needed to make tools – a vital concept in technology appreciation).

Nonetheless 32% of secondary school teachers at the Museum site claimed that their teaching already involved work in history of technology, and 25% of examination syllabuses being taught to parties using the site were founded to contain some study of technology methods.

A trial pack of teaching material was prepared and issued to teachers who had made party bookings, but when interviewed on site they claimed it to have been too technical, although designed with the non-technical teacher in mind. Even so, listening to these teachers' lectures to their pupils revealed that many had no clear understanding of the machine's function, and that some would give incorrect facts or bend visual evidence to fit their own preconceptions. In spite of all this, 29% of the teachers asked wanted a technical description attached to the machine. An even simpler teaching unit has since been devised, in which the blowing engine is built up from a series of transparent overlays (also suitable for overhead projector use), but this is still in the trial stage.

The inescapable conclusions from research to date on education in history of technology seem to be –

a) The technology education movement has transformed History teaching in the sense that:
(i) History is becoming more appealing to pupils through the introduction of studies in local industries, products, and people;
(ii) History teachers are being brought into contact with technological industries and their methods.

b) The same comments apply to Geography and General Studies syllabuses and teaching methods.

c) Industrial museums and historic sites are being used for field work in teaching far more by academic 'Arts' teachers than by Craft and Science Teachers.

d) Arts-subject teachers, although strongly motivated towards studies in technology, have not (in general) the technical experience to use industrial museums efficiently.

e) Industrial museum staff have not yet developed the skills of making their exhibits fully comprehensible to non-technical teachers and their pupils.

f) Craft teachers seem to be using historical material very little and Science teachers almost never.

The overall conclusion is that a great wealth of educational material for teaching the fundamental processes of technology and industry is being both underused and inefficiently used: early technology is simple and comprehensible (if correctly presented in its context), and forms the foundation of later and complex technologies that are not directly comprehensible without knowledge of their foundations. A growing number of teachers and pupils are attempting to use the historical resource-material of industrial museums and local buildings but much more education of teachers is required, together with much rethinking by museum staffs about presentation and interpretation methods – with continuous evaluation studies – before we can be certain that every possible resource for technology education is being fully and efficiently exploited in the cause of technology appreciation and towards a technologically-literate nation.