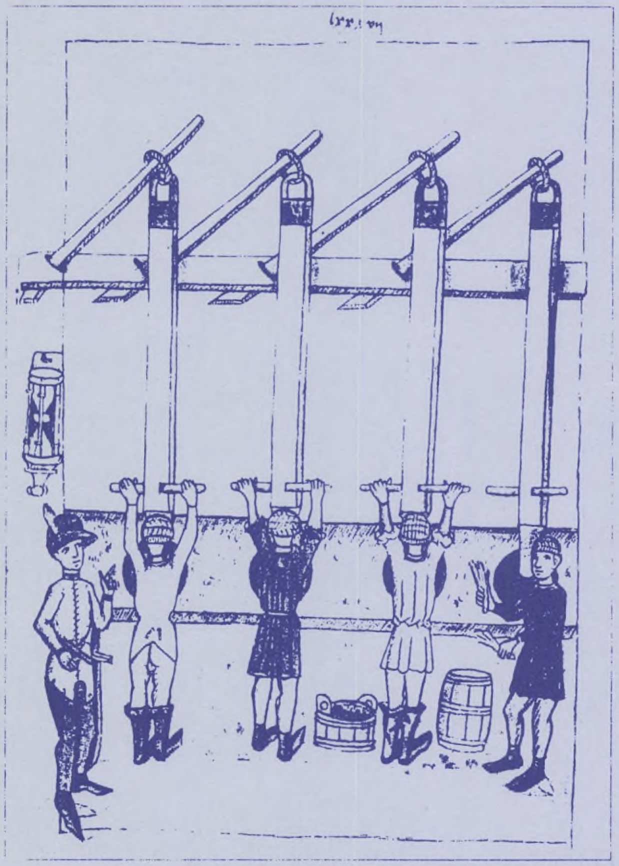
POLHEM

TIDSKRIFT FÖR TEKNIKHISTORIA



1997/2 Årgång 15

POLHEM

Tidskrift för teknikhistoria

Utgiven av Svenska Nationalkommittén för teknikhistoria (SNT),
Chalmers Tekniska Högskola, Biblioteket, 412 96 GÖTEBORG

med stöd av Humanistisk-samhällsvetenskapliga forskningsrådet
och Statens kulturråd

ISSN 0281-2142

Tryck
Vasastadens Bokbinderi AB, 421 52 VÄSTRA FRÖLUNDA
Omslag: Svensk Typografi Gudmund Nyström AB, 178 32 EKERÖ

Prenumeration
1997: 200 kr (4 häften)
Beställes genom inbetalning på postgirokonto nr 441 65 94 - 2

Lösnummer
1997: 60 kr/st
Beställes som ovan
Tidigare årgångar: lösnummerpris på begäran

Finns även som taltidning

Innehåll

Omslagsbild: Stötmalning av krut. Illustration ur *The Firework Book*, The Royal Armouries Library (Manuscript I. 3). (till recension sid 196 av *Gunpowder: The History of an International Technology* [sid 83])

"Engineering" eller "Technology"?

> "... within the engineering profession, and the learned societies which enjoy engineering expertise, there has been a general failure to understand history as a professional discipline, and a tendency to confuse it with what engineers do in retirement when they recall their past."

> "Many senior members of learned societies devoted to history of engineering have never studied the methods for carrying out historical analysis as a professional historian understands them ... "

> "The professional engineering institutions, as a whole, have not pressed strongly for the inclusion of history of technology in the engineering syllabuses in our universities."

Med ovanstående uttalanden i detta häfte av *Polhem* tar M.C. Duffy upp ett ämne som diskuterats så länge någon teknikhistoriker kan minnas. När "The Newcomen Society for the study of the history of engineering and technology". 1980 firade sitt 60-årsjubileum, ägnade man ett symposium åt grundvalarna för föreningens verksamhet. Distinktionen mellan "History of engineering" och "History of technology" diskuterades där, liksom den nya syn på ämnesområdet som kommit att utvecklas särskilt inom den amerikanska sammanslutningen "Society for the history of technology" (SHOT). Symposiet refererades i *Transactions of the Newcomen Society*, Vol. 51, 1979-80, sid 193-228.

Tidigare uppsatser av M.C. Duffy inom närliggande ämnesområde återfinns bl.a. i *Polhem* 1995/2, 1995/4 och 1996/3. Själv är han sedan 1994 redaktör för *The Newcomen Bulletin*.

Under rubriken *Dialogue* publicerade *Technology and Culture* i Vol. 32, Nr. 2, 1991 artikeln "Theory and Narrative in the History of Technology" av R.A. Buchanan, omedelbart följd av två starkt kritiska inlägg av John Law och Philip Scranton. De motsättningar som fördes fram där var av delvis annat slag än de som behandlats i "The Newcomen Society". I ett längre debattinlägg i detta häfte av *Polhem* besvarar Buchanan sina antagonisters kritik.

Med sin inledande uppsats i det allra första häftet av *Polhem*, 1983/1, tog Buchanan upp flera teman som senare kommit att behandlas i tidskriften. Här berör han också problemen med terminologin, hur ordet "technology" har fått en delvis annan betydelse än tidigare.

Debattinlägg, sådana som dessa, har varit av största värde för den fortsatta utvecklingen av ämnet teknikhistoria som akademisk disciplin, i Sverige liksom i andra länder. För 20 år sedan anordnade Tekniska museet det första internationella teknikhistoriska symposiet i Sverige med titeln ”Technology and its Impact on Society” (Hässelby 1977). Detta kan utan vidare sägas ha blivit startskottet till en utveckling som ingen ens anade skulle komma. Redan året därpå inrättades en lärartjänst i teknikhistoria vid KTH, ett Centrum för teknikhistoria tillkom 1979 vid Chalmers, och 1981 bildades Svenska Nationalkommittén för teknikhistoria (SNT) gemensamt av Ingenjörsvetenskapsakademien (IVA) och Kungl. Vetenskapsakademien (KVA). År 1983 började SNT utge tidskriften *Polhem*.

Under åren 1984-1987 var Thomas P. Hughes, University of Pennsylvania och känd av teknikhistoriker i hela världen, inbjuden som gästprofessor vid KTH en månad varje vårtermin. Genom detta program, finansierat av Riksbankens Jubileumsfond, kom en humanistisk-samhällsvetenskaplig disciplin att för första gången i Sverige etableras vid en teknisk fakultet. Gästprofessuren avlöstes 1987 av en nyinrättad extra professur vid KTH, som två år senare omvandlades till en ordinarie tjänst.

I dag leds forskningen i teknikhistoria vid KTH av två professorer (Svante Lindqvist och Marie Nisser) och en biträdande professor (Arne Kaijser). Lektorat i ämnet finns vid högskolan i Halmstad (Michael Lindgren), och universiteten i Linköping (Lars Strömbäck) och Luleå (Staffan Hansson). Ämnet är under uppbyggnad även vid andra lärosäten. Det är glädjande att i detta häfte av *Polhem* kunna införa en annons från Chalmers om en nyinrättad professur i teknikhistoria.

En ytterligare uppsats i detta häfte av *Polhem*, författad av Klas Boivie som ett projektarbete i en kurs i teknikhistoria vid KTH, behandlar frågan om hur det tekniska yrkeskunnandet i den svenska riksdagen har varierat över tid. Nedslag görs i tre perioder: 1760-, 1860- och 1960-talet. Den undersökta tiden omfattar således både ståndsriksdagen och den efterföljande tvåkammarriksdagen. De ändringar som kunnat spåras är små, men en allmän tendens är att den tekniska kompetensen hos riksdagens ledamöter varit avtagande, en utveckling som kanske inte känns helt betryggande för framtiden.

Jan Hult

MICHAEL C. DUFFY

History & Philosophy in the Education of Engineers

Introduction: The Issue in Outline

Engineering is changing its nature, and the rate of change is now sufficiently rapid to demand systematic study. This change in the nature of engineering has always been going on, and identification and analysis of the representative forms of the most advanced engineering systems in each age, followed by comparison of these forms, indicates a transformation of those essential features by which engineers identify and define a particular technical component or complex. This change, if it is to be understood, requires developments in innovation analysis; history of engineering; philosophy of engineering and education.(Duffy, 1979, 1995, 1996)

Many misconceptions need to be removed, relating to history of engineering (what it is; what it is for); relating to philosophy (its aims, methods and application); and relating to engineering (its nature, attributes and methods).

There is a pressing need to relate several areas of scholarship and to find answers to a range of disparate questions about the evolution of engineering, so that a unified picture can be built up. The manner in which engineering activity has effected the ways in which the human race interprets itself, from the Palaeolithic era to the present, needs more attention than it is getting. The cultural role of engineering needs clarification. Recent publications, some of them intended for students, witness in their subject matter to the changing nature of engineering (Aleksander, 1995; Aronowitz, 1995; Bishop, 1995; Gibbons, 1997; Hiroaki Yanagida, 1995) There is a need to redefine engineering method as understood in modern times, and to reconsider what typical engineers do in an age when an engineer is as likely to interface a microprocessor with an animal's brain, or to investigate perception, as to supervise the production of motor vehicle components. There are utilitarian reasons for doing this, in addition to the quest for enlightenment concerning the nature of things which motivates any civilised culture. Economics and innovation analysis would benefit if clearer definitions of engineering method and of engineering itself were passed on to those who study innovation and its industrial consequences. Specialists in the history of Scholasticism, or Aristotelianism, especially as understood by 13th C Christendom, may be interested to note that a neoscholasticism, even a neo-Aristotelianism, in the form of an authority attributed to correct reasoning (rather than to practical experience, or to experiment) appears to be returning to those advanced areas of science where simulation (using computers) is sometimes offered as a substitute for experiment.

These are some of the diverse subjects requiring review if the nature of late 20th C engineering is to be understood, and if the public is to be given a clear picture of what engineers do. First of all, the engineers - who have this responsibility - must educate themselves in this matter. Engineers will decide how to put historical and philosophical perspectives into the education of engineers. The engineering community will be responsible for examining the question "Why educate engineers in such matters?" And of course, engineering education extends far beyond schools and colleges.

The professions and learned societies have vital roles to play in responding to a challenge which arises from the need to integrate the insights into the nature of things, afforded by modern technology, and to fit the unified view into the current (always provisional) theories concerning the best ways of interpreting Mankind and the universe. The cultural consequences will be considerable.

Misconceptions concerning the History of Engineering

Historians have long been aware that historical studies can misrepresent the past rather than reveal it (Horne, 1984; Lowenthal, 1985; Wright, 1985), which is why methodology and philosophy of history are important. Any work written by an author who has no grounding in such matters should be read with great caution unless it be nothing more than a narrow narrative, or a diligent compilation of facts, in which case it hardly qualifies as history. Badly written so-called histories of engineering have grossly misrepresented the nature of engineering, and its role in culture, both to the engineering community, and to society at large. There are excellent, mature historians who have worked with considerable success to develop methods for interpreting history of technology (a broader category than engineering), especially since the 1960s, and influential schools of analysis, internalist and externalist, can be found in Europe, the USA and elsewhere. But in Britain, the situation is generally most unsatisfactory. This is not to cast a slur on those British and British-based historians of technology who enjoy international reputations, and whose work is vital to the activities of S7 Group of the Institution of Electrical Engineers (IEE), the Newcomen Society (NS), Society for the History of Technology (SHOT), International Committee for History of Technology (ICOHTEC), British Society for History of Science (BSHS), International Union for History & Philosophy of Science (IUHPS) and other learned bodies. It is to recognise that insufficient resources have been put into scholarly history of technology, and scholarly history of engineering in this country, so that in the universities and museums no sufficiently broad-based career structure has emerged for professional historians to encourage expansion of numbers to the level adequate for tackling the enormous problem to be solved. Likewise, within the engineering profession, and the learned societies which enjoy engineering expertise, there has been a general failure to understand history as a professional discipline, and a tendency to confuse it with what engineers do in retirement when they recall their past. Many senior members of learned societies devoted to history of engineering have never studied the methods for carrying out historical analysis as a professional historian understands them, and as they are set out in any of the standard texts employed in undergraduate courses (Carr, 1961, 1990; Collingwood, 1946, 1993; Marwick, 1970, 1989; Tosh, 1991). The professional engineering institutions, as a whole, have not pressed strongly for the inclusion of history of technology in the engineering syllabuses in our universities.

It is impossible here to review this vast and difficult area of the state of historical studies of British technology, and British engineering, and to survey what different groups of historians, from different professions, and belonging to different schools of methodology, mean by "history". It is beyond the scope of this paper, though it needs the attention of joint bodies drawn from the learned societies and professional institutions.

The subject of this paper is the education of engineers, and it focusses on engineering rather than the broader category of technology. It concentrates more on the internalist's view of engineering because it is transformations in the nature of engineering components and systems (that is, the machinery, the equipment) which are facing the modern engineer with such a challenge. The externalist's perspective is needed to chart how these changes in the nature of engineering are perceived and received by society, and it is to be hoped that someone with expertise in this area will present the IEE with a paper on this subject in the near future. The value of externalist history of technology (e.g. Fox, 1996) is not being denied because the emphasis in this paper is towards internalism.

Misconceptions concerning history of engineering have arisen through an overconcentration on naive, narrative histories of equipment or processes, usually lacking in any analysis, elementary classification system, or evidence of attention paid to methodology History of engineering is too often of this kind. In fact, history of engineering has an unfortunate history. Much of what passes for history of engineering is the reminiscences of engineers; the unsystematic catalogues of overactive and underthinking enthusiasts of antiquarian persuasions; or the efforts of historians which suffer from an inadequate understanding of the engineering discipline. The outstanding exceptions are too few. As a consequence, the professions, the educational institutions, and the learned societies, which include professional historians and professional engineers, misconceive history of engineering. History, like engineering, has become professionalised, on a global scale, with much resulting from the externalist American schools, and the French philosophical schools, as they developed since the 1960s, and which have found secure places in liberal-arts departments, mainly in the USA. A great gulf has opened up between the "internalist" schools and the "externalist" schools, which is evident in Great Britain, and it is to be hoped that both camps (which enjoy considerable diversity within) will learn to understand and respect each other.

This paper argues that the internalist study of engineering has been neglected, and has remained immature compared to externalist schools which have seen a great deal of development of methodology, of conceptual apparatus, of theory drawing on, for example, contemporary work in philosophy of language and sociology. There is a better chance of the externalist historian winning academic and professional recognition than the internalist, who is more likely to work as an outsider, or an amateur. This has led many to assume that internalism is essentially immature and that its defects cannot be removed. This paper argues that this is far from the truth, and that those who think thus, do so because their ignorance of engineering proper (its concepts, mathematics, methods and practice) prevents them from seeing that a mature internalism can be framed. Indeed, modern engineering demands a mature internalist history (and philosophy) of engineering which is firmly based both on the methodology of historical analysis and on a sound (engineer's) knowledge of engineering. Narrative history of equipmental form is at best the raw material on which analysis is grounded, and too often there is a failure to extend narratives to embrace conceptual apparatus, theory, and analytical systems used in the design of equipment. Methods of managing innovation (Twiss, 1980), and even methods of production, are often ignored. Engineering has for long been a matter of mind, yet it is rarely treated as a history of ideas. To this day, too much "history of engineering" is industrial archaeology written by narrow antiquarians who seek the certainty of one unsorted fact piled on another, rather than the wisdom which historical insight can bring.

There is also a vulgar idea that "anyone can do engineering history" provided he knows "how the wheels go round". This is an attitude too often found within the engineering profession where it is assumed that history of engineering is what old engineers write about when they retire. This can lead to the assumption that it is therefore an activity scarcely fit for serious engineers, who should be getting on with engineering, and that history is the harmless relaxation of tweed-hatted pensioners in gum-boots who poke their umbrellas into the industrial archaeology of the steam age. Unfair? Most definitely, but the unfairness persists, and some engineers can see no role for historical studies within engineering, and engineering education. (With philosophy, the misconceptions are even worse). Sometimes, it is admitted that history of engineering, in university courses, or professional activities, is justified because it encourages people to take pride in engineering, or because it teaches people to appreciate "our engineering heritage", and is necessary for advising in matters of preservation. This may be so. The author has no time for history used for a profession's propaganda; has a deep mistrust of "heritage history", and is hostile to preservation - even of engineering artefacts - if it holds up the modernising of the engineering infrastructure. The harmful effect of "history" used for purposes of propaganda, entertainment and escapism, and the misconceptions which result from carelessly executed historical studies, are reviewed by Horne (1984), Lowenthal (1985) and Wright (1985). The history advocated in this paper is that which leads to wisdom, insight, truth; which stimulates thought and discloses hitherto unrecognised relations between matters studied. It should provide lessons, of a general kind, which can be applied outside the particular study within which they have been cultivated; and the study of the past should assist in the solution of contemporary problems by sharpening and clarifying insight. The comparison of past with present objects also discloses the nature of change, and analysis of the various ways of conducting the comparison suggests improvements to contemporary conceptual apparatus.

Too many people, aware of the difference between knowledge and thought, assume that engineering (unlike science) is "just knowledge" that is, it is "know-how about facts", and that engineering history is a collection of facts, arranged in chronological order. They forget, if they ever knew, that engineering is more about thought, and that for understanding thought, philosophy is needed. Just why this mistake was made, and continues to be made with respect to British engineering, but not to British science, is an interesting question. It is to be hoped that some externalist historian, well versed in the sociology of British engineering, scientific and educational life, will answer it.

Misconceptions concerning the Philosophy of Engineering

There is widespread misconception that philosophy is of no use whatever and that it is the pastime of pretentious clever fellows who shun really hard work (i.e. practical) "where shams are quickly detected" and that it is best kept out of practical matters. This is another extraordinary notion which it is hoped some historian will chart in its development in industrial culture. It is very strong in Britain - even in the sciences. It is very hard to convince people that it is possible to frame a sound, practically useful philosophy of engineering worthy of the name philosophy. Perhaps the hostility of some engineers (like that of physicists) to philosophy arose because a "philosophy of engineering" (and a "philosophy of science") was too-often put about by historians and philosophers who took an externalist, or sociological approach, and who clearly lacked any authority, competence, or experience in engineering (or physics). Philosophy of physics, however, enjoys a large, recognised and growing number of philosophers who are competent physicists, and they have founded a discipline worthy of the name. Philosophy of engineering has not been so fortunate: it remains associated with the philosophical analysis of the "receiving systems" within which engineering systems develop, rather than being the work of philosophers who know engineering as a professional engineer does. Physics has its mature "internalist" philosophy of physics, yet engineering does not. Why? A philosopher of relativity theory or quantum theory who stated that he knew not the first thing about mathematics - not even "O" level - and that his understanding of physics stopped with the awareness that pendulums wagged, would be regarded as a self-confessed charlatan. Yet there are philosophers of technology whose ignorance of technology (whether engineering, management, or organisation) is of this order. They should call themselves philosophers of the social circumstances in which technical decisions are taken. They are neither philosophers of technology nor engineering, and it is a gross misuse of language to term them such. One presumes that they have got away with their carelessness, ignorance and pretentiousness because engineers and technologists do not read their works, which seem to be consumed by other "philosophers of technology" equally ignorant of technology itself. One wonders why they call themselves "philosophers of technology" or "philosophers of engineering", and so risk inviting the hostility of technologists and engineers who might otherwise read their work with profit. Anyone interested in 20th C philosophy may read the works of Ellul with profit (Hanks and Asai, 1984) - but it is not philosophy of technology. Both internalist and externalist historians and philosophers of engineering should consider the consequences of applying philosophy of language (after Derrida, Foucault) to scientific and technical concepts and constructs, and further noting how the meaning is assigned to such terms within a particular culture, and how such terms are interpreted from culture to culture. Such issues have to be faced: they impinge on history and philosophy of engineering. But the work of Ellul , or Rapp - to quote outstanding scholars - is not philosophy of technology, or engineering. It is rather philosophy of the "General Receiving System".

The lack of a mature, internalist philosophy of engineering is partly due to the supposition that "engineers make things". This hardly adequate definition, might serve if "things" is taken to include "concepts, constructs, abstract models, new mathematics, thought experiments, idealised mechanisms, and the like ". Usually, this is not the meaning. H.G.Wells might take it for granted that engineers made new worlds, but Practical Man's perspective goes no further than what he himself can make, usually with his own hands. If it does go further, he would be well advised to express a broader vision in his speech, because the widespread belief that "engineers make things", in a culture such as is found in Britain, is interpreted in a way which results in lowly status being given to engineering. This hardly helps an increasingly backward-looking nation to face the challenge of an age in which what we are, and how we define ourselves (our very concept of what Humanity is), will be transformed by techno-science. The attitude of many amateur historians of engineering, who concentrate on industrial archaeology, and naive narrative history, has encouraged the belief that philosophy has no contribution to make in engineering studies, or history of engineering.

The inadequate histories of engineering, covering the period from the early 19th C to the present era ("Post Newcomen") add to the distorted picture of the role of engineering in evolving cultures. These histories, especially those written before 1950, usually omit all mention of the philosophy of engineering which was expressed by, and used in the work of 16th, 17th and 18th C engineers, which was to develop into the "philosophy of fit and fitness" taken up and systematised by Taylor, Gantt, and Ford, based on the very old principle of replicating the rational order of the cosmos in mechanism, and in the organisation of work.

Few histories of engineering, of the kind read by engineers, stress sufficiently the impact made by basic mechanisms, such as the clock, pumps, the lens, and musical instruments on transforming the basic concepts by which the philosophers of former times interpreted the nature of things. (Hill, 1996; Klemm, 1959; Wolf, 1935, 1968) The mechanical world view, expressed by La Mettrie, or D'Holbach, owed much to a mechanised Cartesian-Newtonian method for interpreting the universe (and mankind in the case of La Mettrie) which grew out of experience with mechanisms like clocks. Experience with astronomical clocks, and other devices, between the 13th C and the 16th C helped to separate the rational, mechanical elements of experience from the occult, alchemical and supernatural. The latter were once attributed to material objects, along with the physical or mechanical attributes. Experience with engineering systems, clocks, cannon, gear trains, lenses, canals and windmills changed Mankind's perception of things. Man's understanding of reality was changed by engineering artifacts - yet this is too seldom brought out in the engineering histories set before the general public, issued (sometimes) by the engineering professions, and often published by the museums. What is needed is for the engineering professions to invite the professional historians, and philosophers, who have written such works, to prepare a series of volumes deliberately intended to serve in the education of engineers. Too often, the serious works of major historians and philosophers go unrecognised by the engineering profession.

The transformation of Mankind's self-understanding by engineering artefacts continues, (Aleksander 1995; Aronowitz, 1995; Porter, 1996). Thermodynamics, information theory, artificial intelligence, engineering studies of the brain, nanoengineering, information technology, and virtual reality systems are some developments associated with engineering which have had both a direct and an indirect philosophical impact, (Boden, 1990, 1996; Bishop, 1995; Cornwell, 1995; Gibbons, 1997; Millican, 1996; Rothwell, 1995). They have changed the way we look at ourselves, (Tiles and Oberdiek, 1995). Yet engineers seem reluctant to develop the mature, internalist philosophy of engineering adequate for interpreting this relationship between engineering and mind, and this vital task is therefore left to those who lack the engineering insights to do it properly.

Perhaps some engineers forget that everything which to them, today, belongs to common sense, and is obvious, was the advanced thinking of philosophers yesterday. This may be one reason why internalist philosophy of engineering has not yet been raised to a level of maturity equal to that of philosophy of physics, or of some other department of science. There are excellent texts dealing with the philosophy of general relativity, quantum mechanics, consciousness and personality. It is not being claimed that there are no equivalent works in engineering, but they are less conspicuous. This is strange, because throughout the history of rational engineering, which is post 17th C, and largely the creation of philosopher-engineers typified by Huygens, Von Guericke, Papin, Leupold, Polhem, Smeaton, Carnot, and Seguin to name but few, the practical use of philosophy was much in evidence, (Mayr, 1976). Scientific engineering, guided increasingly by mathematics, experiment, theory, and abstract thinking, transformed the nature of strategic technologies. The invention of analogues, models, analytical methods, new concepts, mathematical symbols and expressions, raised epistemological and ontological questions about the reality of entities interpreted by the newer analogues. As the solution of engineering problems - practical problems - demanded the use of abstract thinking (consider the invention of phasor algebra, or network theory) - engineers were compelled to ask questions about the existential status of inferred entities (directly or indirectly perceived), about the status of models, symbols, correspondence between elements in different but equivalent analogues, and the nature of Heaviside's Operators, etc. Electrical engineering stimulated the development of very advanced mathematics, and raised difficult questions about the relationship between symbols and objects, (Duffy, 1994; Gibbs, 1962, 1967; Kron, 1930, 1934, 1939; Stigant, 1964;) These questions were, and are, as complex as any in fundamental physics, and they were resolved in the same way. A few philosophically minded engineers (e.g. Hopkinson, Heaviside, Steinmetz) resolved the problems, worked out consistent mathematical apparatus, standardised terminology and symbolism, proved the results were accurate enough to help provide solutions to industrial engineering problems, and passed on this work into the corpus of knowledge available to their colleagues through the profession. The vast majority of those who used it, to a greater or lesser degree, paid no more heed to the history or philosophy behind it all than the average working physicist paid to history and philosophy of physics - though science has been better served by philosophers than has engineering. If the nature of engineering is to be understood better, so that engineering might progress without opposition, then philosophy of engineering is required.

There have been occasions in the past when particular problems have compelled a more than usual number of engineers to discuss philosophical issues in the technical press. It is striking how many of these occasions involved electrical engineering which made the use of abstract models essential. One thinks of the "Entropy Polemic", and the discussion of the nature of entropy, involving Max Planck, Lodge, and other physicists as well as leading engineers, which followed a presidential address, at the IEE which touched on the thermodynamics of power stations, (Cardwell, 1971). There was the long discussion on the geometrising of engineering, which grew out of Kron's desire to do for engineering what Riemann, Minkowski and Einstein had done for physics (Kron, 1930, 1934, 1939) . Kron's geometrising of motor theory and networks, and the introduction of tensor analysis into engineering, and the interpretation of engineering systems using non-Euclidean geometry promoted much discussion about the relationship between elements in models, symbols and actual machine elements. (Earlier, in the 19th G, there had been some discussion concerning the legitimacy of geometrising the kinematics of linkages and mechanisms, such as were found on steam engines. Sylvester had done work in this field.) Kron's work with the generalised, idealised motor led to controversy concerning the extent to which considerations of symmetry should guide electric motor design (Gibbs, 1962, 1967; Stigant, 1964). The legitimacy of treating DC motors as AC motors with zero frequency was another source of argument. Yet the advanced

geometry and other mathematical techniques were accepted as practically useful tools, even if their use troubled those who found the basic notions bizarre. One can find similar reservations being expressed over the mathematical "tricks" (involving imaginary entities) which were used in the design of the Blackburn Analyser.
Here are subjects eminently suitable for close study by those wishing to develop both a mature history and philosophy of engineering. Earlier examples of the fruitful use of philosophy in engineering, which have been well covered, include Sadi Carnot's work, which introduced the ideal cycle for a work producing thermal engine (Mendoza, 1960). Today this cycle is termed an abstract disclosing model which relates the ideal to the actual, and indicates the limits to performance. One wonders why later, electrical engineering examples have been ignored by historians and philosophers.

One problem which is likely to receive attention from philosophers, and to which some extent has done so in France, Germany and the USA, is the use of language by engineers. Do engineers use language "Realistically" (in a reductionist sense)? Or do they use language as a provisional tool, which changes according to experience and which can be termed (in the original scholastic sense) Nominalist? Surely the latter? But then, to what extent is the engineer's claim to objectivity undermined by the philosophies of language, and by the social constructivist/deconstructivist schools of analysis which have enjoyed much influence in the externalist schools of history of science and "technology" in the USA? Can engineers, like the majority of physicists, simply ignore this issue as of relevance only to a small minority who are onlookers to activities which they do not understand, and in which they can play no creative part, even if they style themselves "philosophers of technology/science"?

The Nature of Engineering

The concept which many engineers have of the essentials which define modern engineering, which is shared by many of the public, owes much to the engineering systems which dominated the eras of British industrialisation between 1800 and the recent past. These systems are reviewed by Buchanan (1972, 1980) If the transformation of the nature of engineering in the last 30 years is to be understood, it will be necessary to take a look at the major phases through which engineering - and engineering thought - has evolved from at least the stone age. Only by identifying the defining characteristics of the strategic engineering of the epoch 1800 - 1945 (which of course subdivides) will it be possible to note which new features characterise the radical, new engineering systems of the recent past, as described in the texts by Aleksander (1995), Rothwell (1995), Schalkoff (1989) or Millican (1996). Only then will it be possible to do justice to the engineering achievements of the pre-1800 periods.

Developments in other disciplines is making this task a lot easier, and the coming together of studies conducted separately is providing much insight. Medical engineering provides striking examples (Texon, 1996). There is a pressing need to set the growth of engineering skills in the perspective of evolution of Homo Sapiens Sapiens, and to set engineering thinking in the context of the evolution of mind. Engineering has become increasingly associated with the ability to invent new symbols and models; to observe and to analyse; to invent new ideals and to realise them; and to co-ordinate rationally planned physical and mental activities.

The author has outlined his own history of the major phases through which engineering design has evolved since 15,000 BC (Engineering Designer, 1979), but far more profound studies have come from specialists in the history of palaeotechnology, and the history of mental skills. Much, however, remains to be done - especially in the matter of integrating the results from several studies into a unified whole, should this be possible.

Previously widely separated disciplines are finding they have much to say to each other. The idea of self-scanning systems, suggested by research into control engineering, information theory, artificial intelligence, and other advanced areas of engineering has been taken up by specialists studying consciousness, and self-awareness, in humans and animals. It has been suggested that human self-awareness is due to the self-scanning action of the brain, and that the lower level consciousness in other creatures may be due to a lower degree of self-scanning. Perhaps some creatures (insects?) though able to recognise, and to act with an apparent purpose (e.g. the queen ant killing potential rivals) enjoy scanning, but little self-scanning. This difficult area of study has involved engineers from such fields as robotics, and information technology, as well as researchers from psychology, physiology, philosophy, biology, zoology, etc. Studies of the brain, mind, and intelligence (including AI) are provided by Boden, 1990, 1996; Churchland, 1984, 1988; McCulloch, 1995; Millican, 1996; Popper and Eccles, 1984. Speculators have suggested that we are essentially self-monitoring, self-observing biotechnical ensembles, capable of providing an entirely physical model of ourselves and our world. If so, the cultural consequences are great, especially for traditional notions enshrined in religion and theology. This paper pronounces no judgement in this matter: it is mentioned as an example of one of the many fundamental areas of current research in which engineering is playing a vital part.

The need to understand the nature of intelligence, and to identify the several kinds of intelligence, has enhanced the importance of investigations into the intelligence of different animals; and attempts to assess the intelligence of hominids at different stages of evolution. Naturally, the problems of carrying out investigations using methods worthy of the name "rational" and "scientific" are enormous, and it is difficult to resist the temptation to build too much on the basis of the work done so far, but this work is proceeding, with the intention of discovering the extent to which the several kinds of intelligence (including biological, and artificial) resemble each other or differ.

The study of very ancient technology, emerging language, early use of symbols and models, and the emergence of engineering ensembles has revealed much about mental skills in the long period which in their classic work, the Frankforts term "Before Philosophy". More needs to be done to study the making of things, ideas, assessments, values, imaginary constructs and languages, within the context of engineering from circa 50, 000BC to the present. This is vital if the transformation of engineering thought (the most important part of engineering) is to be understood.

Engineering studies are also influencing general theories of biological evolution, and may cast light on the emergence of life. Studies of chaos; analogues of chaotic media (vortex-sponge); models of the physical vacuum have suggested how stable patterns (elementary particles) might emerge from energy filled space, or space-time. Self-programming structures, possibly able to interpret evolutionary genetics, are being investigated. Much of this is speculative - but much is guided by rational, scientific analysis and experiment which has come out of engineering research into molecular-scale and sub molecular-scale phenomena; chaos; and the physical vacuum. In these cases, the distinction between physicist and engineer disappears, (Yariv, 1988). Very small scale engineering, nanoengineering, is already an established discipline, (Taniguchi Norio, 1996).

Engineering Design and Engineering Method

Analysis of engineering design, and the less common attempts to define engineering method, show that they have changed radically from epoch to epoch, (Duffy, 1979, 1994, 1996). Definitions which serve for one age will not do for another. Granted that "engineering" covers an immense class of objects and activities, from the making of Stone Age axes to the investigation of perception, it is necessary to divide the historical record of engineering into epochs, to devise some classification system for each period, and to identify within each age those components and systems which are representative of that time. One cannot study them all. Clearly, the method for carrying through this preliminary exercise depends on one's conception of history - its philosophy, and its method - and a lasting accusation directed against much engineering history by professional historians (largely based in universities these days) is that too few of the "histories" coming from the engineering side are by writers who know anything about the method by which historical analysis is carried out. Much "engineering history" is immature, and little more than narrative. If sound history of engineering is to play its part in the education of engineers, then it must be presented by those who have demonstrated their ability in the discipline of history. Obviously, these historians must also have an adequate understanding of engineering if internalist studies are to be carried through. Ensuring that these requirements are met, both in and out of the universities, is a job which it is hoped that the professional institutions will undertake, by criticising engineering syllabuses; by promoting dialogue between engineers and historians; and by encouraging the publication of mature, scholarly histories of engineering.

The author's own general approach to the problem, as used in his lectures to engineering students in Sunderland, can only be sketched in barest outline. It is to trace the emergence of rational, scientific engineering (with its crucial roles of conceptualisation, abstraction, idealisation, and thoughtexperiment) concentrating largely on the period post-1500, but set in perspective against the evolution of thought, social organisation and technology in the period (roughly) 5000BC to 1500AD. Within the period 1600AD to 1950 AD, analysis was used to identify those engineering devices, from simple components to complex systems, and their attendent conceptual apparatus, which represented "best practice". This was done by identifying engineering systems which served as exemplars, and which were of strategic import. Of course this begs many questions about methods for defining "exemplary", "strategic", and "best" from the viewpoint of 1997, and applying them to say the engineering in the 16th C, granted that assessments of technology change with time and from culture to culture. This is why some knowledge of the methods and philosophy of history is required. In devising a system for carrying out "best practice" analysis, the author has found history of economics, and military history, to be particularly valuable, as they suggest useful classifications and methods, and contain valuable case studies involving engineering, technology and industry from the 15th C onwards. Best practice analysis, which concentrates (though not exclusively) on those engineering systems which define what is meant by advanced engineering, of strategic import, in a particular period, greatly simplifies the problem of selecting objects for study from an otherwise unmanageably large number. The methods by which each was evolved, and the extent to which conscious design played a part in the creation of the exemplars, can then be charted.

It is the author's contention that post-1600 strategic engineering was increasingly created by, and dominated by rational and scientific thinking, and was far more the creation of philosophy than is commonly realised, (Mayr, 1976; Wolf, 1935, 1968).That this strategic engineering (which called into existence the successive phases of industrialisation) co-existed with a much older "craft" engineering tradition (which had caused an earlier industrialisation) is not being denied. It must be stressed though, that by the late 17th C - certainly by the early 18th C - strategic engineering depended on natural philosophy and to some extent on ideals (Pacey, 1974, 1992) . Bad histories, which misrepresent both engineering and philosophy, the "Pure Science Myth" of 19th C Britain, and the lack of studies of engineering thinking, and engineering method, have spread false ideas to the contrary. This has enabled "Practical Man" to enjoy his illusions for too long. Even worse, it has enabled school teachers, and the British educational establishment, to enjoy their illusions about the educative value of engineering for too long.

The author's own system identifies the "creative", "synthetic" and "derivative" design traditions, and uses (as an abstract disclosing model) the concept of an engineering archetypal unit (component or system) evolving from inception, through representative form, into evolutionary innovation, towards the classical condition (optimisation), anachronistic perfection, and obsolescence. This provides an idealised model of the development of an engineering system from inception to obsolescence, and resembles similar models for both components and systems, used by other workers. They are called disclosing models because they disclose the similarities and differences betwen ideal and actual systems, and suggest limits to performance. There is some evidence that there are periods of history when relatively few strategically important technologies, each of which has gained its "representative form" (the one which establishes it as a proven solution to a technical problem), interact. These strategic groups of engineering systems support strategic industries which usher in new phases of global economic development. The concept of "Receiving System" has proved useful. Each engineering system (which often can be precisely defined) has to be integrated with a larger system, which often cannot be defined with the same precision. Part of the engineering method is concerned with integrating the "internalist" engineering system (which is itself the realisation of an ideal, subject to evolution), with a broader receiving system defined by a wide range of social, economic and other factors. The receiving system itself is subject to change (sometimes rapid and violent), but the engineer - especially the strategic planner - has to integrate the engineering ensemble with it so that it works sufficiently well to complete its technical and economic tasks, whilst being capable of improvement. Much of engineering is trying to match two evolving systems - the engineering ensemble, and a broader receiving system. The latter may be an engineering system, under engineering control, but when it is not - when it is defined by non-scientific factors - matching can prove difficult.

Much can be learned by examining case studies of engineers seeking to do this, and noting how both "internal" and "external" factors influence the outcome of a project. Many engineers prefer to focus attention on the quantifiable, those aspects which are capable of precise definition and accurate measurement, and they tend to accentuate the internal aspects. This is often perfectly legitimate, as in very advanced research where determining what is possible is the main objective. Yet generally, integration with external systems has to be effected, and is born in mind from the early stages of design though history presents examples where the inability to define the receiving system with any precision has left the initiative (with respect to development within an industry) in the hands of the "internalist" engineer. The development of methods for quantifying and modelling the receiving system with greater precision shifted more of the initiative (effecting design and engineering strategy) to the "externalist" engineer or to the economist, or financial officer, within a company. The author's own studies of the evolution of electric railways bears this out. Externalist parameters play a much greater role in electrification policy after 1920, though analysis of the economic receiving system remained very simple - even crude - down to the 1950s.

Assessing internalist and externalist influences on design is a task which needs a mature internalism to supplement the reasonably mature externalism which is being developed by members of SHOT, ICOHTEC, BSPS and other societies. Much of the work done by engineers, like Wellington, (1887, 1889) or Lomonossoff, (1933) who tried to develop comprehensive mathematical models for integrating the description of railway engineering systems with the quantified model of the general physical and economic receiving system, has yet to be recorded by historians. Without such studies, understanding of engineering design, in all its aspects, will be limited.

Engineering, Innovation & Economic History

The evolution of engineering must be related to the evolution of mind. If the period under review is post-1600, then the changes in equipmental form must be related to the emergence of new symbols, methods of modelling, and language. The most important part of engineering design takes place in the engineer's head, and any study of engineering must take into account the mental activities of the designer. Hence the need for philosophy. Concentrating on the equipmental form (industrial archaeology) is not sufficient in itself. Unfortunately, much so-called "engineering history" does not rise above this level, and there are too-few systematic attempts to correlate evolving equipmental form with changing design theory.

The failure to remain aware of the engineer's mental processes, and the part played by creative mind, in histories which are little more than records of apparatus in chronological order, has fostered technological determinism. This effects both internalist and externalist historians of engineering. It suggests that better (more advanced) technologies are compelled to develop from earlier more primitive forms, and that the technological imperative is basic. Some historians describe the history of a technology as if biological evolution provided an adequate model for the "evolution" of a modern technology from an earlier one. Other historians, for example those motivated by an historicist ideology, have tried to present the engineer as an agent of historicist forces, who is driven towards some preordained end. Good design is then the result of the engineer surrendering to the forces underlying historical evolution - "putting himself on the side of history" - whilst bad design is the consequence of resisting, or denying the ends of history, whether this is the victory of the proletariat, the triumph of Aryan Man, or the other forms of historicism which lie hidden behind various political and religious ideologies. The definition of engineering in particular cultures and the role of engineers, in the 20th C, has been effected by historicism, and by notions which are metaphysical. Engineers should learn to guard against it.

Historicism and determinism were closely associated with several influential theories of global economic development, which sought to identify the part played by technological innovation in this process. The models of economic development put forward by Mensch, and Kuznets, which enjoyed a vogue in the 1960s and 1970s were of this type. Other innovation analysts who made use of S-curve analysis, and life cycle traces, to chart the development of technical components and systems for the benefit of managers, made claims that were essentially determinist, or historicist. This led to some of these models being used as a base for prediction, in the grossly missnamed exercise of "technological forecasting", with the eventual discrediting of this entire approach, and a reaction against engineering econometrics, technomorphology (the author's term for it), and attempts to use systematic analysis to chart engineering change. This was most unfortunate, and unnecessary, and one should look again at this work and identify the valuable elements.

Much of the qualitative work retains its value, such as the classification systems for different kinds of innovation; the definitions of different kinds of innovation and invention; the idealised life-cycle analysis of components and system using S-curves; attempts to relate innovation to the economic fortunes of large industries, and global economics. If the mathematical models are treated as disclosure models, indicating limits, and disclosing the possible links between actual and ideal, they have great value. If they are treated as reliable instruments for prediction, they are worse than useless because they lead to dangerously misleading ideas about innovation and its consequences. It is a great pity that Mensch (1979) involved his general analysis of post 1770 global economic development and technological innovation, with a deterministic "long-wave" theory derived from Kondratieff, (1925) which was metaphysical rather than scientific. Yet the general classification of technical, industrial and economic development from 1700 to the post war era is well founded, (Kuznets, 1953, 1965, 1971; Schumpeter, 1961). In this period, global economic growth was largely dominated by long-life, large-scale, heavy engineering, with periods of change during which strategic groups of new systems triggered fresh development, and attracted investment. Much of this analysis assumes that the strategic engineering of this period, which shall be termed the Newcomen to Colossus era, can be interpreted in terms of idealised archetypes which evolve from a representative form to the classical condition. The ability to define an archetype for each major engineering system is assumed. Without it, the comprehensive econometric systems of Mensch et al., and much of the rest of systematic, analytical history of engineering, whether classified with econometrics of not, cannot be framed.

Recent developments in engineering, especially those associated with microelectronics, have raised the question concerning the existence of representative forms, and archetypes, for strategic engineering as it is understood today (1997). If the nature of engineering has changed in the last 30 years (and the author believes that it has) then the methods which serve for classifying the systems of the Newcomen to Colossus period are no longer adequate. Either there may be no archetypes, or archetypes may endure for such short periods that a completely new approach to classification of types and change is demanded. The traditional model of a successful representative form emerging, which then evolves by incremental improvements to a classical condition, and then obsolescence, may not serve. Some analysts think that it does, and argue that the whole process is greatly accelerated but can still be used to interpret change: others argue that a revolution in the concepts, models, interpretations, symbolism and language for studying engineering change, is urgently needed. Obviously, without philosophy and history, progress in this difficult area will be slow.

It is likely that traditional methods for analysing engineering change will become obsolete, or severely limited in application. Historians will likewise find that they need to develop new skills to make sense of the history of the latest generation of devices, particularly if they concentrate on internalist studies as the author does. But then, engineering has always rendered professional skills obsolete. Ones skills learned in youth might serve for a lifetime, guided and developed by industrial experience. But from the late 19th C onwards, it has become increasingly the case that engineers need to revise skills every few years. Today, the revision of our world-view, professional and social, is profound and continual. This is more a cause for rejoicing than regret. Engineering is a science, certainly in its currently-strategic departments, and as such it is "a way of knowing" in the metaphysical sense: it can fittingly be termed a way of acting in the truth. The engineer who recognises this, and chooses to act on it, as the philosopher-engineers of the 17th and 18th centuries did, performs a cultural role of the very greatest importance. This is what has been termed the "integrating function of the engineer". British culture hardly recognises what the terms mean.

Philosophical consequences of modern engineering

The naive realism of many engineers, and the misunderstanding of the nature of engineering method widespread in British culture, has resulted in a general failure to recognise that engineering innovation has always had the most profound philosophical consequences. For example, many innovations dating from the Newcomen to Colossus period, or even earlier, changed Man's perception of self, and interpretation of the universe. Well-known examples include the lens and prism, which in microscopes, telescopes and interferometer, transformed concepts of biological life, size and structure of the cosmos, nature of space and time, and caused the questioning of the reliability by which such things are perceived and interpreted. Engineering operations with surveying instruments likewise effected geometry (Gauss and spherical geometry); 19th C work with vacuum tubes resulted in new theories of matter, and an early exposition of relativity theory. If it is argued that these were developments in physics, one should respond by asking why, and when, and by whom were they classified as belonging to physics or pure science? Likewise, the Carnot engine (Mendoza, 1960) - an outcome of industrial mechanics - disclosed the relationship between ideal and actual behaviour of heat engines, and became a foundation of thermodynamics with all its philosophical implications. The disclosing models used by Szilard, Brillouin, and others in founding information theory, and based on Maxwell's sorting demon were as much the consequence of engineering as physics, and only those who think of engineering in terms of steam locomotives and aqueducts will fail to see this.

Today, the division between physics and the latest engineering developments hardly exists: the classifications belong to the products of a past era. Engineering studies of the brain, including studies of self-awareness; engineering investigations of neural network theory; micro-engineering and nano-engineering; studies of the physical vacuum; engineering investigations of chaos; attempts to identify technical applications of space-time theory - these represent exemplary engineering activities today, as did engineering thermodynamics, vacuum tube research, wireless telegraphy and polyphase electrical theory in the 1890s. Information theory and its application has led to investigation of the "efficiency" of language, and other symbolic systems for conveying intelligence. An entropy function of language, and an aesthetic function (for visual imagery) have been devised and used to analyse sentence structure and composition of pictures. The interfacing of biological and engineering systems has been carried further than in previous years (it dates from implants, or even earlier in the form of artificial limbs, false teeth, etc.) by the implanting of a microprocessor in a rat's brain. This promises improved means for carrying out scientific investigations into human brain activity. The researches into genetics is another example of work made possible by new devices enabling accurate control of very small scale activities to be achieved. This kind of work has stimulated interest in the debate concerning the nature of mind; the extent to which human beings are advanced machines (one must avoid saying "only" advanced machines), and the extent to which personality might be controllable by technical agency, (Churchland, 1984, 1988; McCulloch, 1995; Millican, 1996; Popper and Eccles, 1984).These debates were all carried out in the 18th C and the early 19th C, and indeed like issues were discussed in much earlier civilisations, though by a minority of philosophers. Today there is evidence that "man as a machine" is a notion accepted by a sizable section of the community, if the attitude of the author 's students is a guide. Though there is not likley to be a final opinion on such matters, the impact of this research on traditional beliefs is considerable. Many once-accepted notions regarding "soul", "spirit", "supernatural", "afterlife" are becoming less tenable and survive only in the private world, having largely disappeared from the public realm, and from science - where they were once all pervasive, (Cupitt, 1984).

Virtual reality systems are transforming the way in which perception itself is perceived. Studies of consciousness, the brain and mind, have called in question the dualistic world picture, which in its modern form owes much to Descartes, and which of course is much older in origins. The suggestion that awareness is due to the brain's ability to scan itself, and that the mind is a state in a complex physical system, certainly challenges that Cartesian dualism which has formed a central tenet of Western Civilization's philosophy since the 17th C. Likewise, the remnants of Platonic Idealism are in danger of being swept away by the transformation of epistemology and ontology arising from the insights into the nature of things provided by modern technoscience. The way we know about things, interpret them, and assess their status in being has been changed by recent technical developments.

The prospects of personality change; microengineering implants in the human body; advanced bio-engineering hybrids; perception transformed by developments in virtual reality systems challenges virtually every department of contemporary culture, including religious metaphysics, morality, legal systems, and political frameworks to name but a few. Generally, these have failed to accomodate the insights provided by modern technoscience, and much of the malaise of contemporary culture is because of this. Late 20th C problems (philosophical, metaphysical, ethical, moral, political) are being tackled with obsolete religious and political thought systems which cannot be reconciled with the truth about ourselves and our world which technoscience - particularly electrotechnoscience - reveals. Physics has accepted the displacement of the Newtonian paradigm by the paradigms of 20th C physical science associated with relativistic and quantum mechanics, but there is much greater reluctance to accept the need to reform paradigms in other fields which are demanded by the revelations of technoscience. This amounts to a refusal to respect the truth, leading to a sterility in many once-vital departments of cultural life. The impact of modern "technoscience" and other features of the post-modern world on traditional culture are reviewed by Cupitt (1984), Richardson, (1996), Sassower (1995), Tiles (1995).

Different aspects of present day engineering innovation show how philosophy is becoming necessary to aid further progress. In Virtual Reality studies, the question arises how best to define "reality", and how to assess the ontological status if the mechanisms by which humans perceive things are themselves modelled using concepts transformed by experience of VR. Studies of the physical vacuum, zero point fields and chaotic media (such as the vortex-sponge) suggest that stable patterns, representative of material particles, might emerge from the vacuum to acquire a self-organisational ability which possibly might result in complex patterns representative of early life forms. The questions concerning the nature of mind and consciousness, partially suggested by information theory, intelligence studies, and investigations of advanced computers, have already been mentioned. There is much unresolved speculation, but the speculations which are guided by science, and which are accompanied by recognition of limits to knowledge, and due caution, suggest that a widespread and fundamental revolution in Mankind's self-understanding is imminent.

In less dramatic fields of innovation analysis, the need for philosophy makes itself felt. In rapidly developing systems, how are archetypes to be defined, if at all? If identification of archetypes is abandoned (for components and systems), how are transformations to be identified, described, compared and modelled? How are system boundaries to be determined? Will methods for abstracting and generalising need to be reformed? How is the identity of a component and system to be established if there are no representative forms or archetypes? It should be noted that the ability to interpet evolving engineering forms in terms of archetypes; and the ability to use idealised types against which to compare actual devices, has been part of the engineering method for several centuries.

As the phenomena studied by engineers gets smaller scale, the problems of modelling phenomena, and selecting between alternatives models, will become increasingly problematic, especially in nanoengineering (Taniguchi Norio, 1996; Yariv, 1988), or on the quantum-mechanical scale, where - for example - interpreting the wave-function collapse physically may become necessary if engineering is to use activities of this kind. At one time, within the last 20 years, the need to consider the physical, mathematical and ontological status of models in quantum mechanics, chaos, or space time structure was not commonly regarded as one the engineer faced. This is not so today when technicians use and maintain superconducting quantum interference devices, or scanning tunnelling microscopes. In an era of rapid change, care must be taken to avoid carrying over uncritically the attitudes to engineering defined in a former epoch, however recent, if exemplary engineering has changed its nature in the intervening period.

Philosophy of the physical sciences has served as a model for the developing philosophy of engineering, simply because (for cultural reasons) the former grew to maturity before the latter did, but in the near future, a general, engineering-based philosophy may emerge. This would identify concepts, constructs, and models which work in the sense that they correlate a wide range of pointer readings and enable physical and other metrical problems to be solved: this procedure has a long tradition in the physical sciences, and engineering may develop it further and introduce it to a wider audience. It would be a pragmatic-instrumentalist philosophy, which was nominalist (i.e. "non-realist" to use the current term) and which did not abolish the concept "reality", but accepted that alternative but equivalent descriptions of a particular phenomenon were possible. Convergence of initially diverse (culturally conditioned) descriptions of a particular phenomenon towards an accepted theory, and model, would be guided by experiment and scientific method. Objective reality would be a "limit concept", disclosed or indicated by progressively perfected idealised models or evolving symbolic structures which pointed to the source of the data which they described. The existence of "ultimate reality", beyond the subjective, is indicated by the experience that "not any combination of symbols" will work: observation and experience is tramelled. Structured models, created by Man, cannot be arbitrary, grossly inconsistent and still useful in the engineering sense, and engineering models have long achieved a standard uniformity world-wide, in all cultures. In this sense (as limit concepts) truth and reality can be retained as meaningful terms, even though truth and reality will never be finally encapsulated in words in a reductionist Realist sense.

Nominalism has always accepted this, and it is commonly accepted in contemporary physics. For example, it is evident that one day the electron concept will be supplanted by a better one, and the complex body of theory associated with it, will be replaced by something else, with very different concepts and models. Even during its brief history, the concept "electron" has evolved through several major stages, and been expressed via various kinds of theory, including the geometrical. Closer observations of the electron, by experiment and inference from experiment, result in changes to the concept, theory and models. Yet electron theory works as a servicable description, a working tool, and an instrument for deepening insight into the nature of things. In this sense it is a vehicle for gaining a more accurate picture of reality, though it be one which is always giving way to a more accurate one. It is a symbolic indicator of a truth which is approached and partially described, but never finally captured in a complete, final descriptive system. The language is invented, as are the symbols, models and theories, and their operational ability to correlate experience enables the useful ones to be selected. Engineering experience, in the physical sciences, in the industrial sciences, and perhaps in broader fields capable of metrical description, enables the accurate, truer models to be selected. These fit the trammels of the objective world. Not any construct will serve to correlate observations and experiences sufficiently well to solve a problem. In fact the whole of engineering experience is a gigantic test of concepts, models and theories, embracing physical science, economic theory, and even management theory: it is a scientific experiment as far as the testing of concepts, theories and models is concerned.

One interesting question facing the modern engineer concerns the danger of a new form of Aristotelianism threatening the sciences, though the peril may be exaggerated. For centuries, the experience of the engineer with his creations tested the accuracy of his thinking, and after 1600 this experience became more scientific and reliant on universally repeatable experiment, (Wolf, 1935, 1968; Kranzberg and Pursell, 1967). However, before the Renaissance, for example in the 13th C, the accuracy or validity of an engineering design was not so decided: nor were occult, or alchemical qualities excluded from engineering - they were accepted as properties of materials along with what today would be termed the physical properties, (Klemm, 1959). The early history of attempts to develop perpetual motion devices gives examples of many philosophers who claimed to have demonstrated perpetual motion, and thus established the success of their designs. There is no evidence that the proposed machines were ever constructed, let alone put to trial. The designers were not necessarily charlatans: they were simply following a different code, and were influenced by a different system of beliefs than the designer of today, who will no doubt be criticised in turn by the engineers of the future. In the 13th C, it was considered sufficient to demonstrate the "workings" of a machine by rational.argument concerning its design, and by appealing to authority, usually Aristotle or works attributed to Aristotle). If no inconsistency in the chain of reasoning, or no claim contrary to Aristotelean learning could be identified, then the philosopher could state that he had "demonstrated" (for example) perpetual motion. By the 17th C, this was no longer the case, and there was increasing stress on the need for actual, performable, universally repeatable experiment, however clear and faultless the reasoning during the design stages had been. This Baconian and Galilean emphasis on practical investigation and trial became the norm.

It is therefore interesting to note that in recent years there have been increasing claims that it is no longer necessary, in every case, to validate a design by actual experiment because computer simulation reduces, or in some cases eliminates the need for actual, physical experiment. It was recently argued, as justification for condemning atomic weapons tests, that it was no longer necessary to detonate actual bombs because computer simulation was so reliable that a simulated explosion would suffice. It would be interesting to explore how far this attitude is owed to a transformation in perception of what constitutes reality and reliable evidence (formerly linked to some contact with reality), brought about by the computer and electronic simulation. Many computer engineers, technicians and users seem to be arguing that it is the computer model which displaces what was previously regarded as an observation of reality. In pure physics, some mathematicians place mathematics prior to physics, and accept any mathematically consistent model as a potentially valid model of reality, though none (one trusts) would dismiss experiment as unecessary. Perhaps the computer is encouraging some engineers to think along equivalent lines, or even take the step of arguing that experiments which can be carried out (like detonating an atomic bomb) need not be executed because a computer simulation renders it unecessary. Certainly the computer has changed attitudes to language, evidence, experiment, arguments, models, reality and perception.

It is interesting to speculate on the philosophical implications of synthesising the findings of information theory, information technology, computer simulation, virtual reality engineering, nanoengineering, engineering studies of intelligence, neural networks, and other fields representing engineering and technoscience at their most advanced. Will a comprehensive materialism prove possible, with every activity including awareness being modelled by some physical activity in a universe of event-particles? Such controversial questions are being suggested by several areas of engineering research.

The Engineering Profession & Change

The history of the engineering profession is one of constant change. New branches of the profession have been created following innovations which led to new classes of engineering activity and new professional institutions, such as the Institution of Electrical Engineers (IEE), and the later Institution of Electronics & Radio Engineers (IERE). A system of classification covering "engineering", "engineer", "science", "technology", and other related matters, has grown up with these developments, and - imperfectly understood - has passed into the public perception of engineering. It effects the view which the general public, educationalists, schoolchildren, politicians, and professionals take of engineering. Admitting to a necessary simplification within the limitations of this address, it is claimed that the dominant view of engineering, and the current definitions of what it is, and how it is best classified, date from the "Newcomen to Colossus Era", roughly 1700 to 1950. Post-World War 2 electronics challenged this inherited classification system, and the developments of the last 20 years undermined it. The old structure was at first extended rather than taken down and built anew with modern strategic engineering made the foundations of the redesigned fabric. It was like an old 18th C mansion, greatly extended in the Gothic Revival style during the 19th C, and then extended still further in the 20th C in a variety of styles. The electronics wing is much in evidence, with its ultra modern architecture, but the older styles are clearly visible and characterise the building. The public still think of "Engineering Palace" as pre WW2, if not Victorian, and many are unaware of the significance of what is going on in the newest wing. Engineers understand, right enough, but too many politicians and schoolteachers do not, and misconceptions are spread by popular histories which concentrate too much on the 18th and 19th C parts of the building. The antiquarians wish the later wings had never been added, and would like to demolish them to leave the 18th and 19th C portions of the building ready for restoration so that they might be visited by those members of the public who show an interest in engineering only when it is obsolete. Fortunately, there is a growing interest in the history of the later parts of "Engineering Palace", and an awareness that what has taken place within demands reassessment of the activities which once took place in the older rooms. The greatest days of "Engineerin Palace" lie in the future and are not those during which the 18th and 19th C portions of the house were erected. Why then, do so many of the visitors regard the engineering housed in the electronics wing as "very clever technicians' stuff" and hasten on to show their children the displays in the pre-1939 galleries? It is the innovations of the last 20 years which are going to revolutionise culture on a deeper, and more widespread scale than any previous developments have done. Kranzberg and Pursell (1967) have charted the revolutionary impact of technology down to the recent present, but the innovations of the last 20 years promise more radical changes than any of previous times: they promise to transform our understanding of what it means to be human. But museums are still struggling to find ways of displaying the thought systems, and the abstractions of engineering to complement the displayed apparatus. This problem will increase, as the engineer of the 21st C., working in the future strategic disciplines, may be more a creator of ideas, new mathematics, novel concepts, abstract models, than a maker of tangible things (Aleksander, 1995; Haralick, 1996; Rothwell, 1995; Schalkoff, 1981, 1991; Millican, 1996).

Furthermore, the lines of development which are leading into the new systems which are emerging, come from mathematics, medical research, neuroscience, information theory, fundamental physics, nanoengineering, in addition to those which come from activities which have been classified as engineering for several decades, such as electronics in all its forms. Former important departments of engineering may be terminated, or transformed into something different. Witness the transformation of traditional engineering activities by computing, VR, IT, and new philosophies of manufacture, production, supply and management. Once-important activities, regarded as vital to the engineering discipline, may no longer serve as stepping-stones on the path towards the vital departments of engineering in the 21st C., and may cease to be common. The future of 21st C engineering may lie as much in present biophysics, neuroscience, and quantum chemistry as it does in current microelectronics or materials science. Does public understanding and perception of engineers, engineering and education reflect this?

Evidently, the effects of change within the many departments of engineering will eventually compel widespread changes in the organisation of the profession, the structure of the institutions, the education of engineers and the relations with other professions, and of course with industry and the public.

It is perhaps significant that the professional engineering institutions which have most responded to this challenge by fostering debate, by encouraging analytical historical studies of the changes (internalist and externalist), have been those closely linked with electrical and electronics engineering, such as the IEE and the IEEE. The mechanical and civil engineering institutions have been much more conservative in their reaction, especially in connection with their conception of the role of history in helping solve the problems arising out of this transformation of engineering. The problems of the post-Colossus era cannot be solved using the undeveloped methods taken from the pre-Colossus age: this applies both to history and engineering. Perhaps the extensive and rapid changes in all the activities of departments of engineering linked to modern electronics, compels those departments to be flexible, and aware of the extent to which they are undergoing ceaseless transformation.

The shifting perspectives can lead to an unjustified revisionism when tracing lines of development back to their origins in former ages - origins lying outside engineering - because current classifications can be assigned, carelessly, to periods when they were unknown. Some knowledge of critical methods in history is essential if unjustified misclassification is to be avoided. For example, suppose one were trying to answer the question "Who is the engineer?" in each age, and that a study was being made of the evolution of the technologies leading up to virtual reality engineering. A common outline of virtual reality engineering prehistory, and history, compiled in part by tracing the history of components back to origin identifies major "source" contributers as Stanhope (1777, logic machine); Wheatstone (1832, stereoscope); Boole (1854, logic solutions); Russell and Whitehead (1910, symbolic logic); down to the introduction of the Uttal glove in 1962, and later innovations. Now, the persons listed were not regarded as engineers in their own time, though the activities associated with them might be the stuff of engineering in the next century. If the meaning of "engineer" is redefined in the next century as engineering changes its nature, the danger may well arise that former classifications, made from the perspective of 1997, may be revised, and persons once classified as mathematicians, and philosophers may be classified as engineers. In certain instances this might be justified; in other cases it most certainly would not be. If engineers were setting up a gallery, in a museum of information technology, or virtual reality systems, showing the portraits of the pioneers of these disciplines, who would be in it? Boole, Russell, Whitehead, von Neumann certainly, but how should they be classified? (The enthusiast's history of communications technology , and computing, provides examples of careless classification in abundance).

If the role of the engineer in culture is to be clarified, histories which avoid errors in this matter are needed. A current national biography of technologists and an encyclopedia edited by senior members of the Newcomen Society indicates orthodox historians' choices of engineers worthy of note and themes important in history of engineering (McNeil and Day, 1995; McNeil, 1990) Unfortunately, the history of many very recent technologies, where the engineering concepts are difficult, and the life cycle of systems may be extremely short, is often left to enthusiastic engineers and technicians engaged in the development of these systems. Their engineering knowledge is great, but they know nothing of the methods of historical analysis, and very often their work - whilst providing valuable data about early components and systems -

suffers from unjustified revisionism. Trends (say in 19th C. data sorting devices) which are now (1997) known to precurse 20th C electromechanical "computers, sorters and information systems" are given an emphasis (with hindsight) without any attempt being made to judge how they were assessed in their own time. The amateur historian too often makes connections when there were none: a historian knowlegeable in methods for conducting an analysis of historical events, knows how to safeguard against mistaken revisionism and other errors. If engineering is to get the history it deserves - and needs - engineering writers will need to become more professional in the methods of history. An exemplary text which shows what can be done is the history of the computer by Campbell-Kelly and Aspray (1996). The "enthusiast's" history no longer meets the requirements of the professional engineer. The growth of popular history ("Heritage History") aimed at an uncritical public, which is intended to entertain, and to be easily assimilated, spreads the misconceptions still further (Horne, 1984; Lowenthal, 1985; Wright, 1985).

The Education of Engineers

The education of engineers is not confined to the universities and students. It is carried on by institutions such as the IEE via the agency of papers, books, lectures and conferences, and if history and philosophy are to realise their potential in engineering education, they will require much more than a few lectures in the undergraduate syllabus. Universities have a crucial part to play, as have the learned societies which specialise in history of engineering, the museums, and the archives - not least in educating the general public about engineering. But first, engineers must be educated about engineering (its nature and its cultural role) if they are to correct the public's view of what engineering is and does.

One obvious step is to include history and philosophy of engineering in the engineering (undergraduate) syllabus, but how can this be done in an age when there is great pressure on all university departments, and there is never enough timetable space to accomodate all subjects deemed essential? Why should the professional institutions encourage it? Why should this suggestion, certain to be greeted with hostility in some quarters, be heeded and not dismissed at once without further thought? The short answer is, because the further progress of strategic engineering, and the standing of engineering in modern culture, depend on it. The damage done to British culture, and the British economy by an anti-engineering bias has been well recorded (Barnett, 1986; Wiener, 1981). One is not advocating a revival of the old "liberal studies" history of engineering, with perhaps a dash of philosophy, which used to be included in engineering courses at the insistence of "Two Cultures Liberals" in order to "civilise the philistine", (Snow, 1962). The damage done by this amateurish program took a long time to repair, and what is being advocated owes nothing to the old liberal studies (or "Engineer in Society") programs: their day is over. The author rejects the "Two Cultures" classification, and the interpretations of science and the arts advanced by the leading participants in that revealing debate, (Snow, 1962). The identification of two cultures arises from a profoundly erroneous, and ignorant, misunderstanding of engineering and science with a consequent failure to understand engineering as a cultural activity which discloses new insights into the nature of things. There is only one Culture: engineering is part of it, as is literature. Recognising the unity of culture, which embraces the sciences and arts as one, is one of the greatest glories of Humanism (Bullock, 1985)

Literature and art are not being decried. They are essential in any truth-seeking culture, but they have no a-priori claim to supremacy over engineering in cultivating the mind. Only a narrow ignoramus like F.R.Leavis could assume this. The element in British education which opposed engineering as an intrinsically inferior instrument for education, (like F.R.Leavis, and C.S.Lewis) saw it as being solely "technician's routine activities in the slavish service of brutish commerce" - an attitude derived from blighters like Newman (1852) and Arnold (1869), and kept alive by a small but influential anti-progressive element. Any mind seeking enlightenment should immerse itself in literature which cultivates enhanced command of the spoken and written language, increases the level at which conceptualisation takes place, and develops the mind's ability to think and to communicate. This is additional to the ability of literature to provide insight into the human condition. These practical benefits of literature and art in no wise detract from their standing as ends in themselves: the arts are not justified by their utilitarian roles - but neither are the sciences, including engineering. The highest roles of sciences and arts are as truth-bearing agents, and Enlightenment Humanism was built on recognising this. Unfortunately, due to the pernicious influence of aestheticism in the 19th C, an influential group in British culture believed that to put something to ultilitarian use degraded it, and that - in consequence- anything which was primarily utilitarian was degrading, especially if related to commerce. This paper argues that both the sciences and the arts find their fulfilment in being put to practical use. The professional engineer should have a mind shaped by the great literature, and art, of his own culture, and have some understanding of the arts of other cultures just as he must be well grounded in mathematics and the physical sciences. He needs literature, mathematics, engineering science, philosophy and history to serve engineering better - not to come up to some standard determined by some other disciplines deemed intrinsically superior. Fortunately, the cast of mind which accepted the "Two Cultures" classification is becoming extinct as that debate recedes into history, but it has left misconceptions which require correcting. These misconceptions may be more prevalent, in 1997, amongst the older generation who were young when the "Two Cultures" debate attracted much attention, and the younger generation of engineers are free from the misconceptions about its nature which was found in the 1960s, 1970s, and into the 1980s. The misconceptions, however, are still found outside the engineering profession, and though it is increasingly older people who cherish them, these include persons of considerable influence. Through “Heritage History” these people are seeking to exercise control over the preservation of engineering artefacts, even to the point of trammelling engineers and delaying new projects. They grossly misrepresent the nature of engineering, and they are fundamentally driven by a fear of the widespread changes resulting from engineering innovation. They only respect engineering once its artefacts can be regarded as antiquities.

Engineering history and philosophy need to be put into the syllabus - but how? There is a case for including a module or part module, of lectures dealing with history of engineering, and philosophy of engineering, which covers the basic methods by which history and philosophy can serve engineering. The changing nature of engineering; the role of strategic technologies and industries in stimulating economic growth; the link between engineering and mind, and the advent of the radically new engineering systems of the past 10 years could be covered. Engineering as a cultural activity would be covered in this module (or part module). Modules covering these themes should be included in all years of the course, and not limited - as is too often the case - to a part module (e.g. Professional Studies) in the first year. Other aspects of nature of engineering, related to life-cycle analysis, engineering method, nature of innovation, social studies of innovation, and special case studies from the history of engineering, could be examined in this module, but might better be placed as elements in the parts of the syllabus dealing with design, management, engineering economics, production, etc. so that the usefulness of history and philosophy are made clear.

Unless tested in the solution of problems, history and philosophy tend to become sterile, and a close involvement with engineering will benefit both disciplines. It will also benefit engineering students by improving their ability to think, and to deal with abstract concepts, imaginary models, and the terminology and methods of advanced analysis. The author's experience suggests that many engineering students today cannot abstract, generalise and deal with advanced analysis. The concepts necessary for understanding modern engineering are proving too difficult for many students, who are subliterate and illiterate in the language of analysis, as well as being subliterate in English or whichever tongue they use as a vehicle for communication. The latter point is suggestive. Many students have never been trained to think, speak and write at an advanced level, with a mature grammar, syntax, and vocabulary, because they have not been nurtured in a literate and lterary culture. They have reached adult years bereft of that essential mental training which previous generations got through great literature, music, and art. Generally, science and engineering were encountered later, though their works can of course cultivate the mind as letters and the arts do.

Students who have been conditioned (rather than educated) by the sub-literate press; who take their patterns of speech from the popular media; who ignore the classics and who give themselves over to a sub-culture which emphasises emotional response rather than rational consideration are not what progressive engineering requires. They might gather impressions of subjects; store away narrowly technical facts; and perform low level activities (until replaced by robots), but without an advanced vocabulary of words, and symbols, and the mental ability to use them - and the desire to seek understanding - these students are of little use. A competent technician-engineer requires a much higher level of intellect than is found in many engineering students today, some of whom (in the author's experience) take ideas, concepts and outrageous pseudo-philosophies from science-fiction, and the escapist media, and take them seriously. Introduction to the elements of historical criticism and philosophy should rescue some students from this dreadful darkness and teach them how to discriminate, and to resist the superficial outpourings of the shallow and irresponsible quacks who exploit so much of electronic communications.

If engineering is to thrive, at all levels, it will need good quality engineers (technicians, and chartered engineers) who will be recruited as students from the most gifted sections of the community. Students must be sought from amongst the brightest pupils in the best schools, and one way to do this is to tell the whole truth about modern engineering, and the many-faceted challenge it presents to the highest-calibre school-leaver or pupil in a technical college. Engineering courses must seek the most literate and intellectually gifted pupils, so that their gifts can be used to solve the problems arising from the changing nature of the current generation of strategic innovations. Some of these literate students will be needed to develop a mature history and philosophy of engineering within the engineering profession.

The pressure on timtetables in universities is limiting, but it should be possible to give students enough understanding of history and philosophy so that they can use it in their professional careers, and build on it later, if they wish or if they need to. They should be given sufficient knowledge of these disciplines to defend engineering itself against the various ideologies, pseudo-philosophies, political and commercial influences, which threaten its integrity from time to time. History and phil~osophy of engineering also provide a bridge between the humanities and the sciences which our culture badly needs.

If history and philosophy of engineering are to develop to the benefit of engineering, there will need to be some professional recognition of their status and roles in the syllabus, and a small number of specialist historians and philosophers of engineering will need to work within the institutions, to advise them and to help organise meetings, conferences, and publications, in co-operation with learned societies and other institutions with expertise in this field. The roles-of the IEE and IEEE in fostering engineering-based history of engineering suggest how this might be done, in co-operation with the groups and departments responsible for engineering education. Increased co-operation between the engineering professional institutions and learned societies could do much in cultivating a more accurate public (and professional) perception of engineering, and thus facilitating the creation of an elite body of engineers which each industrial community requires. What is needed is a modern version of the 18th and 19th C learned society, many of which embraced several disciplines and performed a centralising, synthesising function, drawing several scholarly pursuits together, and educating members and the public. Today this might be done by a network, linking the professional institutions, university departments, forward looking learned societies (no escapist antiquarianism, nor obstructive "Heritage History"!) and those enlightened museums which act as information forums.

A good example of the latter is the Heinz Nixdorf Centre, Paderborn, Germany, which combines a traditional museum of information technology with a forum for discussing, with the public, the social impact of the new engineering systems. The example set by CHIDE (Centre for History of Defence Electronics), University of Bournemouth, in using electronic communications to co-ordinate, stimulate and develop history of electronics is a praiseworthy model of what might be done on a larger scale to link professional institutions, centres for history and philosophy of engineering, university departments and museums, after the pattern by which CHIDE drew several military museums together. The concept of the Virtual Museum, which CHIDE has introduced to military electronics, could be used in other fields of engineering (such as railway electronics, which the author hopes to develop). Helping to develop these systems (which would embrace archives) could be a task assigned to undergraduates and post-graduate students as part of their work for first or higher degrees. Virtual reality systems plus electronic communications promise to transform many museums, and turn them into what museums were in the 18th C - centres of public education, introducing society to modern ideas, and bringing before the populace the latest knowledge, whilst providing a venue for debate, and lecture. An electronics information forum, including a virtual museum, and archive, for each department of engineering, controlled by a network based on professional institutions, university departments, learned societies, and progressive museums could transform the roles of history and philosophy throughout industrial societies. It could free history from the stifling hand of antiquarianism, and escapist historians (who flee the present and deny the future), and develop history and philosophy to solve contemporary engineering problems, and to help engineers face broader issues related to their discipline (ethical, moral, social, cultural, political matters).

Explaining modern technology to the public, with greater authority and respect for the truth than the popular media evidence, could be done by the profession via such a network, and public disquiet, and misconception, allayed. Even the most unimaginative member of the public is aware that we are in the midst of a profound revolution, driven by engineering. Virtual reality technology alone is enough to convince the most escapist antiquarian that something mighty is going on. The antiquarian who rejoices in progress (and there are some), hastens to use it, and welcomes the promise of the virtual museum, and the simulation of antiquity. When brain surgeons can be trained by operating on simulated brain, which can be seen and felt, with every activity monitored, and the consequences accurately reported, even those who intend to greet the 21st C with a wallow in nostalgia for the receding days beloved of "Heritage History" must take notice. When virtual reality systems enable a "rider" on an exercise bicycle in a gymnasium to experience an outdoor trip, or two fighter pilots (each in his simulated cockpit) to feel and see as if in combat, with systems linked so that they could (apparently) realistically fight each other, then the dullest student realises that this heralds more than just a new generation of amusement machines for the benefit of the denizens of dreary arcades. When a rat's brain (and perhaps a human's) can be interfaced with an advanced microprocesser so that its neuronal activity can be monitored (and controlled), many members of the public become disquieted. If the engineering profession does not prevent this disquiet becoming an irrational fear of engineering, then in a world experiencing a deplorable recrudescence of superstition and unreason, the further progress of science, engineering and the rational planning of society will be hindered and perhaps reversed.

There is a crucial role for those engineers who are creating these new systems in helping their colleagues, and the public, to learn from the past to enable the future to be faced rationally, with a confidence built on understanding. Truth-seeking, and understanding, drive out irrational fears, and there is a great deal of irrational fear and superstition standing in the way of further progress. An integrated program of conservation, and preservation of the engineering systems of the past, done in such a way that the modernisation of the infrastructure is not hindered, which is linked to analytical history and innovation analysis would educate the public in the cultural role of engineering, and rob modern technoscience of its terrors.

Preparation of a Progressive Receiving System

History and philosophy in general, with history and philosophy of engineering as particular cases, have parts to play in cultivating a progressive "receiving system" capable of, and willing to,accept recent strategic innovations (such as electrical technoscience or ETS) and the new kinds of industry and society which are, in part, consequences of them. The most general receiving system is the national (increasingly global) culture of which engineering, technology and industry, and their support systems, form a sub-unit. If new kinds of engineering, new kinds of industry, new kinds of applications of engineering are to be made, and are to flourish, they must be received and not rejected. They must be integrated with the general receiving system, and be supported and encouraged by it. One reason why analytical histories of engineering, industry and the economy in wartime are so instructive is that they describe a particularly close, and comprehensive integration between systems defined by technology (e.g. long-range bombers) and a receiving system organised to encourage innovation and production. That different cultures receive engineering innovation with different degrees of welcome is evident by comparing present-day Britain with Japan (Barnett, 1986; Lorriman, 1996; Wiener 1981).

Whether in war or peace, there is a need to foster public understanding, and to educate the non-engineering professions. History has many case studies of a nation's technical and industrial progress being retarded by the cultural rejection of modern engineering. In some cases, the receiving system was hostile because powerful interests (an imperial court, a social structure, pre-technical businesses, a religion, or non-engineering professions) felt threatened by progressive engineering and its consequences, sometimes with good cause. This is particularly so when a whole nation, or empire (like Tsarist Russia) attempts to industrialise, in which case every part of society is threatened with change. There are other cases where transformation is not sought (indeed conservation is the object), but the engineering products of more advanced nations are imported, as needed, to increase the power of the rulers. In this latter case, comprehensive integration of the technical system and methods of production with the general receiving system is not necessary. But societies where this is found depend for support and supply on an external ally. History provided cases of hostile receiving systems, which failed properly to employ the engineers of genius, and the technical talent which might be found there. The increasingly backward general receiving systems of Tsarist Russia, and the Ottoman Empire, to quote but two examples, meant that very talented individuals did not flourish and found industries of global import as they did in the USA, or flourished after they left their native land. Tsarist Russia did not lack individual engineers of great genius (Borodin, Lomonossoff) in the 19th C. and early 20th C, but there is no Russian Edison, Westinghouse or Ford. Coanda, Tesla and Constantinescu were appreciated better in Britain, France and the USA. than in their native land. The history of Rumania, as a part of the Ottoman Empire, or as an independent nation, is one of talent hampered in the net of a quite inadequate receiving system. The education of engineers should convey some awareness of this problem, and here the externalist schools of history, well versed in the history of economics and politics, have much to contribute, (Kranzberg and Pursell, 1967).

The British have no cause to be complacent. Once reknowned, in the 18th C and early 19th C for having a general receiving system which greatly encouraged engineering progress, they are now accused of having one which promotes a "broker's culture" and which is inimical to the sort of rapid engineering-based advance which should be possible if ETS were exploited as were the innovations of the mid-18th C, or early 19th C. Any general receiving system which promotes engineering advance must have receptive financial, political, legal, administrative and educational elements. If the City of London, the Church, bankers, politicians, lawyers, senior civil servants, and school teachers fail to understand engineering and engineers, and their place in the global economy, then the future phases of rapid industrial expansion will take place elsewhere. In many ways Britain is a country dominated by old ideas which are no longer creative (Wright, 1985).

Engineering has always been a universal activity, as any science is, and once rapidly changing nations (like Malaysia, or South Korea) determine to develop their general receiving system to cultivate industrial progress, they do so and are rewarded. To maintain progress requires keeping the receiving system in a fit condition, as Japan intends todo (Lorriman, 1996). If Great Britain wishes to exploit the latest innovations it will need an appropriate receiving system. This will require a cultural commitment going beyond the revision of the engineering education system, and providing more support for research. Certainly everything should be done to produce an elite corps of engineers, with the most outstanding gifts, recruited from the finest intellects, from all nations, classes and creeds. Certainly a receiving system of talented "general purpose" engineers, or technician engineers, and engineering technicians, should be developed, with each department, grade or level of the entire profession grouped round its own elite.

This will demand widespread changes in education and training, and it is hoped that this address has convinced engineers that history and philosophy have a part to play.

But this will come to little (if not quite nothing) if the culture of Britain is dominated by short-term money-making, and the values of shallow-consumerism, because (as history clearly shows) engineering progress demands a general receiving system committed to the scientific pursuit of the truth, and progress, in the Enlightenment sense. If these ideals are set aside, and some linguists argue that "truth" and "progress" are meaningless terms, then there is a danger that engineering (and science in general) will be seen as merely the tools of power elites: the intrinsic worth of engineering, as a discloser of truth about the nature of things, will be denied. Engineers will become hirelings, or perhaps well-paid slaves, to whichever power system controls them. It has happened before, in Classical Antiquity, in Italy during the Renaissance, under Fascism, under totalitarian Communism, and under the more brutish forms of Capitalism. The latter, however, tends to buy talent rather than bludgeon it, but whether hireling, bondservant or slave, the engineer has been debased, and his profession demeaned, in the service of unworthy regimes. History shows this, and the lessons should be made clear to all engineers, not just students.

In Britain, if short-term money-making continues to be the defining activity, which conditions every part of the general receiving system, the danger is that the nation will lose its chance to be one of the global leaders in ETS (and related technologies), and its greatest talents will be employed elsewhere in cultures which receive it, and use it. It is worth asking if any creative culture, making full use of the opportunities offered by science in all its forms, has ever been managed into existence, and kept flourishing for long, by persons with an exclusive concern for money, who make immediate profit in an activity (including research, and education) the measure which determines its fate. Now that the "Cold War" has removed the stimulus of military-related research, the country could suffer a massive failure in engineering expertise, unless a massive reconstruction of engineering education and professional organisation, is carried through in hand with an education of the public, and all elements of the receiving system.

Conclusion

If anyone asks why history and philosophy should be introduced into the education of engineers, the short answer is - to make better engineers; to tell the truth about engineering; and to play a part in preparing the engineering profession face the technical and ethical challenges which will result from developments in ETS. History and philosophy will help engineers cultivate their discipline in the highest humanist tradition - using the term "humanist" in the Enlightenment sense of seeking truth, and identifying the limits to reliable knowledge whilst using the latter in the cause of progress (Bullock, 1985). History and philosophy can help defend the engineering profession from the depredations of the "scientific savage", who (as H.G.Wells warned) would threaten civilisation if knowledge of facts became divorced from understanding, from a respect for truth, a concern for civilisation' with a failure to relate science to other departments of culture. One common charge against engineers is that they are too often narrow philistines, who know all, understand nothing and cannot relate engineering to anything broader. This grossly unjust charge is still made: last year I was introduced by a philosopher to his colleague, in a university milieu, with the words "Don't worry about Duffy - he's not a typical engineer!" Just what is one to make of this? Statements implying the same thing, from senior members of educational establishments, and learned societies, are heard too often. They help to influence children and students, with the finest intellects, to choose careers other than engineering on the grounds that first rate minds - scientific intellects- will be wasted in engineering.

This attitude is dying, but it cannot die fast enough, and engineers should kill it as quickly as they can. It is also a ridiculous attitude in an age when the sternest challenges to prevailing systems of religious thought, philosophy, social theory, and mankind's vision of its own nature, are being transformed by ETS. New philosophies, and myths for socialising ethics and social values are required. Ethical, moral, philosophical, social, and economic problems cannot be solved using obsolete thought-systems carried over uncritically from the past. The situation cannot be comprehended without an internalist understanding of engineering, and a working knowledge of the methods of philosophy and history. Without this, how can engineers help provide the solutions to these problems? A refusal to help provide solutions will simply confirm the prejudice that most engineers are content to "watch the wheels go round" and are uninterested in broader issues.

As engineering becomes the exemplary science, the education of engineers, and the organised activities of the professional institutions should evidence greater awareness of history and philosophy as essential activities within the discipline.

The profession should ensure that a mature history of engineering, and a mature philosophy of engineering, are cultivated with the encouragement of the professional institutions, the university departments, and the relevant learned societies. An expert team should be set up, to be ready to serve the profession, through the institutions and universities, as needed. If it is not possible to make every engineer a philosopher and a historian, it should be possible to give each engineer an understanding of the importance of philosophy and history, and knowledge of how to get expert advice when required.

A start can be made by compiling a classified directory of individuals and societies with expertise in this area, and developing a network for encouraging co-operation between them. The first task of such a network or team should be to draw up provisional syllabuses to suit the educational requirements of future engineers. Getting history and philosophy into the engineering syllabus will not be easy, but it is hoped that this paper has successfully argued that there is a strong case for making the attempt.

Note: This paper is based on an address delivered to the Institution of Electrical Engineers, Savoy Place, London, WC2R OBL, on Wednesday, 26th February 1997.

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KLAS BOIVIE

Riksdagens tekniska kompetens - en kvalitativ granskning av förändringar under 300 år

"Men historien är det som verkligen..."
"Har hänt?" Cidi Hamete log överseende. "Är den det? Måste inte historikern lika väl som poeten välja? Gjorde han inte det skulle han svepas bort av tidens flod. Men historikern fiskar i denna flod, räddar ett faktum här och låter ett annat drunkna där, överlåter åt en annan historiker att rädda ett tredje - han siktar och sållar, med andra ord gör ett *urval*. När han gör det förlänar han de fakta han valt en innebörd som ofta förväxlas med sanning. Gör inte poeten detsamma? Tala då om för mig: vems sanning är sannast?"

Ur *Riddare av en slump* av Stephen Marlowe

Om problemet

Vi lever i en tekniskt expansiv tid, och våra folkvalda har ständigt att fatta beslut i frågor där ämnet har teknologisk natur och är avgörande för hur Sveriges framtid kommer att te sig. Det är inget nytt, det är en något som följt människor och deras makthavare genom tiderna. I alla tider har makthavarnas bakgrund och kompetens varit avgörande för vilka beslut de har fattat. Hur skulle det kunna vara annorlunda? Samtidigt är varje tids makthavare beroende av föregående tiders beslut, dels i tekniska frågor, dels, på längre sikt genom att besluten avgör vilka utbildningar och försörjningsmöjligheter som kommer att stå till buds. Men kanske huvudsakligen *hur* gruppen av makthavare skall vara sammansatt och därigenom vilken bakgrund makthavarna kommer att ha. Därför är det intressant att jämföra hur den tekniska kompetensen har varierat i den svenska riksdagen under en längre tidsperiod, för att på så sätt få ett perspektiv på situationen idag. När man söker fakta om den svenska riksdagens tekniska kompetens i ett längre perspektiv genom historien finner man snart att den är mycket svårspårad. I riksdagens bibliotek finns riksdagsmatriklar och numera även böcker med korta biografiska beskrivningar av riksdagsledamöterna, men bara från och med tvåkammarriksdagens införande 1867. För information om ledamöterna från ståndsriksdagarna är man huvudsakligen hänvisad till respektive stånds riksdagsprotokoll. Riksdagsmatriklarna, och i viss mån även protokollen, är i sig intressanta, inte för att de ger en heltäckande bild av riksdagsledamöterna - det är snarare tvärtom - utan för hur ledamöterna *tituleras*. Civila och akademiska titlar behöver ju inte nödvändigtvis säga vad innehavaren i själva verket har för bakgrund, men de visar med övertygande tydlighet vad som betraktas som betydelsefullt i respektive tidsperiod.

Vad beträffar ståndsriksdagen går det endast att få tag på biografiska data om de mera bemärkta ledamöterna. För det stora flertalet ledamöter är man hänvisad till riksdagsprotokollen, och där gäller olika förutsättningar för de olika stånden. Protokollen är nämligen inte fullständigt överförda från unika handskrivna dokument till tryckta eller elektroniska böcker. Det innebär att betydande delar tills vidare måste betraktas som svårtillgängliga för allmänheten. I de fall där protokollen verkligen finns att tillgå, ger de inte nödvändigtvis särskilt mycket information. Någon lista på vilka som sitter i riksdagen ingår nämligen inte i protokollen. Däremot har i några fall sammanställts en lista på vilka som *omnämnts* i protokollen, ibland till och med deras civila titlar, men det är inte samma sak som att sitta i riksdagen (till exempel figurerar såväl Erik XIV som August II av Sachsen och Polen). Detta innebär att en kvantitativ jämförelse mellan ståndsriksdagarnas tekniska kompetens och senare tiders riksdagar skulle bli om inte helt omöjlig så i varje fall ett oerhört omfattande arbete. Samtidigt är just övergången från ståndsriksdag till kammarriksdag den mest radikala förändringen i Sveriges riksdagshistoria, och därmed också den största och tydligaste förändringen i förutsättningarna för den tekniska kompetensen i riksdagen.

På grund av dessa problem kan en granskning av riksdagens tekniska kompetens här inte gärna bli mer än en "Kvalitativ granskning av tendenser i riksdagens tekniska kompetens genom 300 år". För att kunna bedöma det tekniska kunnande som står till buds i respektive tidsålder och skaffa en djupare kännedom om vissa ledamöters bakgrund måste förutom nämnda protokoll och matriklar undersökningsmaterialet kompletteras med allmänhistoriska verk. För att få hanterligare data och tydligare skillnader mellan epokerna har tre betydelsefulla perioder, nämligen 1760-, 1860-, och 1960-talet, utvalts att representera respektive århundrade.

1760-tal: Frihetstid, upplysning och ståndsriksdagar

Frihetstiden (1719-1772) i Sverige var en tid då man ivrade för ekonomiska, och därmed även tekniska, framsteg. Den militära och politiska makt och pondus som Sverige förlorat med stormaktsväldets sammanbrott skulle kompenseras med en ekonomisk återuppbyggnad. För detta fodrades ny och förbättrad teknik inom alla kända näringar, samt om möjligt, skapandet av nya inkomstkällor genom inhemsk produktion av tidigare importerade produkter. Dessutom hade 1600-talets vetenskapliga landvinningar ute i Europa och män som Polhem i Sverige gjort att naturvetenskap och teknik kommit på modet i samhällets högsta kretsar. Symptomatiskt nog kom Laboratorium mechanicum, även kallad Kungliga modellkammaren (inrättad år 1700) och Kungliga vetenskapsakademien (grundad 1739) att förläggas till Stockholm, hovets och maktens centrum istället för till Uppsala, lärdomens centrum. 1760-talet var frihetstidens höjdpunkt, makten låg under riksdagens kontroll; monarken måste lova att "alltid instämma med rikets ständer som maktägande att nu och framdeles att förordna om sig och riket" (ur 1719 års kungaförsäkran) för att få tillträda tronen. Stånden utsåg själva sina talmän och utskottsrepresentanter, och det var riksdagen som hade bestämmanderätt över rådets rekrytering. På det viset kunde rikets ständer behärska politiken även mellan riksmötena. Ståndsriksdagen styrdes enligt majoritetsprincipen såväl inom stånden som ständerna emellan. Parlamentarismen var inarbetad och fungerade relativt smidigt. När dessutom upplysningstidens nyttoideal hade varit på modet en tid och visat sig fruktbart, utvecklades handeln och vetenskapen som aldrig förr.

Riksdagsprotokollen från 1760-talets riksmöten, 1760-62, 1765-66 samt 1769-70, säger något litet om representationens sammansättning, men egentligen mera om hur man betraktade varandra inom de olika stånden. Det vara värt att fundera över vad som avgör den ordning i vilken respektive stånds protokoll kommer i tryck.

Adelns protokoll är samtliga utgivna, prydligt sammanställda med register över omnämnda personer. Däremot saknas en lista på deltagarna. Denna brist kan till någon del kompenseras av att adeln representerades av huvudmännen för respektive ätt. Protokolltexten visar också, genom tituleringen av riksdagsmännen, att det inom riddarhuset fanns en betydande spridning i representationen. Högadliga tituleras till exempel greve eller friherre, medan lågadeln, i likhet med de borgerliga riksdagsledamöterna i mån av militär grad tituleras med denna och i annat fall bara som herr. Detta påminner om den ståndsutjämning som hade pågått sedan årtiondena direkt efter 1730, och som adeln försökte stävja genom att 1762 stänga riddarhuset för ointroducerade ätter. Präster och borgare gjorde motdrag 1766 genom att utesluta de präster som adlats och de borgare som hade ämbetsmannatitlar. Denna fejd torde i någon mån ha påverkat representationen i stånden.

Vilken kompetens hade då adeln på 1760-talet? Den större delen av de adliga bedrev jordbruk på sina gods och säterier. Adelns rikliga kontakter med omvärlden kom att leda till att det var den vägen som många nya impulser nådde landet, och det var främst adeln som hade kapital till att sätta dem i verket. I anknytning till godsen bedrevs manufakturer och bruk. Den svenska industrin spirade med adliga trädgårdsmästare, även om intresset för lönsamheten tycks ha varit mindre än intresset för de tekniska nyheterna. Detta kan ses som ett uttryck för den lekfullhet som alltid tycks finnas med i bilden när teknik utvecklas, och naturligtvis - sådan var tidsandan. Även jordbruket reformerades på adligt initiativ: Rutger Maclean på godset Svaneholm (han satt för övrigt som riksdagsman) drev igenom mönsterbildande reformer som enskifte, penningarrende och växelbruk. Adelns traditionellt militära anknytning gav även den bidrag till den tekniska kompetensen. Kännedom från ingenjörstrupperna, fortifikationer och skeppsbyggnad fanns inom adeln och måste därför även ha funnits i riksdagen. Som lysande exempel på detta finns Polhems mångbegåvade lärjunge Augustin Ehrensvärd, hattpolitiker och den som ledde arbetena vid bygget av Sveaborg.

Inom adeln fanns alltså en betydande erfarenhet av tekniska system i praktiken och dessutom tillgång till det teoretiska tekniska kunnande som fanns vid den här tiden. Detta torde man ha fört med sig in i riksdagen. Mycket riktigt förde också det adelsdominerade hattpartiet en merkantilistiskt inriktad ekonomisk politik efter franskt mönster, med bland annat stora statsanslag till manufaktur- och bruksverksamhet. Deras politik avslöjar deras intressen, och intresse för något brukar innebära att det finns kunskap om det man intresserar sig för.

Prästerståndets protokoll är fortfarande under utgivning, och man har kommit så långt att arbetet med riksdagen 1742-43 pågår. Detta gör att man får utgå från protokollen från det senast utgivna decenniet och granska sammansättningen som den framträder där. Sedan kan man modifiera på grundval av de valbarhetsförändringar som genomdrevs under perioden.

Här måste man göra ett antagande: att den grundläggande sammansättningen av representationen i prästerståndet inte förändras i allt för stor utsträckning. Men det finns absolut inget, utom nämnda valbarhetsförändringar, som tyder på att så skulle vara fallet. Vid en ganska ytlig genomgång av protokollstexten finner man flera namn och titlar, och från dessa igenkänner man en tendens som även tycks finnas hos de övriga stånden - det är förhållandevis framstående personer som har kommit in i riksdagen: biskopar, domprostar, prostar, kyrkoherdar, magistrar och teologie doktorer,- och de presenteras också med dessa titlar i enlighet med deras ställning inom den kyrkliga hierarkin. Sockenprästerna och kaplanerna som torde utgjort den stora massan av prästerskapet tycks inte vara särskilt manstarkt representerade. Mycket riktigt riktade sig också valbarhetsförändringarna 1766 inte bara mot de högsta och adlade prästmännen (ärkebiskopen och ett tiotal andra) utan även mot de lägre: innehav av pastorat blev ett krav för att få tillhöra prästerståndet. Detta kanske inte påverkade proportionen på sammansättningen i så avgörande omfattning men det visar med all önskvärd tydlighet att det var det högre mellanskiktet (prostar och kyrkoherdar) som dominerade politiken i prästerståndet på 1760-talet.

Vad kan man då tänka sig att dessa prästmän hade för teknisk kompetens? Rent praktiskt innehåller inte prästyrket så mycket teknik, ur den aspekten kan man nog förutsätta att deras eventuella kunnande kommer från barndom, vardagsliv och eventuella resor, och den är därmed sannolikt av så allmän art att den kan bortses från. Med prästernas teoretiska bildning förhåller det sig lite annorlunda, prästerna var det enda ståndet som hade en självklar teoretisk utbildning, och det var inte bara teologi som studerades. Det kan styrkas av att flera Linnélärjungar började som teologistuderande (till exempel Kristofer Ternstöm, Per Kalm och Per Löfling,) och i flera fall följde med expeditioner och handelsskepp som skeppspräster Detta kom sig bland annat av att prästerna förväntades bestå sina församlingar med enklare läkarvård och att vara ett slags lokala experter i diverse frågor. Tidsandan kom även den att påverka prästerna till att deltaga i den naturvetenskapligt-tekniska debatten, till exempel genom att deltaga i Vetenskapsakademiens prisfrågetävlingar, och genom att skaffa sig kunskaper om hushållningsfrågor. Prästernas teoretiska naturvetenskapliga bildning kan därför inte förbises på samma sätt som deras praktiska tekniska erfarenheter.

Borgarståndets protokoll är inte heller fullständigt utgivna. Här har man kommit fram till riksdagen 1742-43. Därför får man granska dessa protokoll på samma sätt som prästerståndets, med samma reservationer och med modifikationer i enlighet med valbarhetsförändringarna. Textgenomgången av borgarnas protokoll visar att även här är det de mest socialt framstående personerna som representerar, (vanligen presenterade som "herr"). Det finns gott om borgmästare, rådmän, officerare, handelsmän och högre tjänstemän men även flera hantverkaråldermän, bruksägare, hammarverksägare, bergmästare och bergsråd. Detta ger en tydlig fingervisning om representationen, och tur är väl det, eftersom en granskning borgerskapets tekniska kunnande på samma sätt som prästernas skulle ge en om möjligt ännu större osäkerhet. Borgarna var en betydligt mindre homogen grupp, med betydligt mera varierad kompetens än prästernas. Trots det går det att bilda sig en kvalificerad uppfattning. En avgörande del av produktionen, bortsett från jordbruksprodukter, låg i borgerliga händer. Eftersom varje stånd tycks ha skickat sina mest framstående representanter till riksdagen, är det inte underligt att det fanns personer som hade betydande erfarenheter från produktion och handel bland borgarståndets representanter. Faktum är att kombinationen storföretagare och politiker var vanlig under frihetstiden. Som typisk representant för dessa kan man nämna Thomas Plomgren, som förutom att vara en framstående ledamot av borgarståndet (talman 1751-52) också var delägare i ett av de största handelshusen i Stockholm och ledamot av Jernkontoret.

Här kan det vara på sin plats att uppmärksamma att det var mycket vanligt att handelshusen, genom krediter eller uppköp, investerade sina vinster i bruken, för att på så vis kunna försäkra sig om tillgång till stångjärn som var den viktigaste exportvaran. Som ytterligare ett exempel på hög teknisk kompetens bland borgarna kan man inte låta bli att nämna Jernkontorets grundare Anders Nordencrantz, som var utbildad i teknik och nationalekonomi i London och satt som riksdagsman för Sundsvall i riksdagen 1726-27. Ursprungsidén med Jernkontoret var att göra bruken oberoende av handelshusen...

Nya valbarhetsbestämmelser beslutades, som tidigare nämnts, även i borgarståndet 1766. De utgick från mellanskiktet och riktade sig mot borgare med ämbetsmannatitlar samt bruks- och fabriksägare på landsbygden. I synnerhet det senare kan ha inverkat menligt på den tekniska kompetensen i riksdagen. Men att en sådan reform kunde genomdrivas tyder på att landsortens bruks- och fabriksägare inte var någon särskilt inflytelserik grupp inom borgarståndet. Skråsystemet var fortfarande mäktigt och där fanns det inbyggt en social struktur som gjorde att städernas borgare hade ett etablerat ledande skikt grundat på professionell tillhörighet. Det faller sig naturligt att det var från detta skikt som huvuddelen av riksdagsledamöterna hämtades. Detta styrks av att städernas hantverkarskrån var tillräckligt mäktiga för att kunna förhindra flera beslut som skulle ha ökat konkurensen inom hantverksyrkena.

Mycket av adelns traditionella militära sysslor hade en civil motsvarighet, men med den skillnaden att i det civila livet sköttes samma sysslor av borgare (jfr fortfikationsingenjör - byggmästare, militär och civil skeppsbyggnad, etc) ordnade enligt skråsystemet. Vid de större gruvorna och bruken tillexempel i Falun betraktades bergsmännen som ett borgerligt skrå. Det vore förvånansvärt om inte en lokalt så betydelsefull grupp skulle representeras i politiken lokalt och nationellt. Å andra sidan är historien fylld av förvånansvärda saker...

Bondeståndets protokoll har, till skillnad från prästernas och borgarnas, utgivits i sin helhet. Vid genomgång av bondeståndets riksdagsprotokoll från 1760-talet finner man, att ledamöterna, till skillnad från övriga stånd, inte tituleras alls utan presenteras kort och gott med sina namn. Om man undersöker vad som finns bakom namnen finner man (föga förvånande) att representanterna mycket riktigt till den absoluta huvuddelen faktiskt är aktiva inom jordbruket. Men det är inte torpare och drängar eller småarrendatorer, utan självägande skattebönder och hemmansägare som främst är representerade. Beträffande den tekniska kompetensen, bortsett från tekniken inom jordbruket, faller det huvudsakliga intresset på flera "bergsmän" från bergslagslandskapen. Skillnaden mellan dessa bondeståndets bergsmän och gruvorternas borgerliga bergsmän är att vissa bergslagshemman gav sin ägare viss skattefrihet under förutsättning att han även ägnade sig åt bergsbruk och dessa hemmans ägare kallades traditionellt för bergsmän. Det var dessutom vanligt att landsbygdens ynglingar för en tid sökte sig till lokala manufakturer och faktorier för att där lära sig ett yrke och sedan flytta hem och fungera som underleverantör från hemmen. Så skedde till exempel omkring Jönköpings (senare Husqvarna) gevärsfaktori. Ståltrådsdragningen bland bönderna i trakten av småländska Gnosjö är även det ett av de mera framstående exemplen på den hemindustri som var så betydelsefull för bönderna i stora delar av riket. Överhuvud taget var det vanligt med till hemindustri gränsande hemslöjd i de magrare jordbuksområdena. Särskilt kan nämnas tjärbränningen i Finland, kolandet i bergslagsskogarna och textilslöjden i sjuhäradsbygden och Hälsingland, men kanske främst i Ångermanland, där linslöjden med tiden kom att ge ett stort välstånd. Mycket betydelsefull var naturligtvis också all den träslöjd som utfördes i skogslänen över hela riket. Allt detta tyder på att det även inom bondeståndet fanns en beaktansvärd teknisk kompetens om så i mindre och i mera hantverksmässig skala än den kompetens vi finner hos adel och borgerskap.

För att summera 1760-talets riksdag kan man säga att det tack vare att respektive stånd valde representanter bland sina mest framstående medlemmar och att de olika stånden representerade inte bara olika sociala grupperingar utan även olika traditionella kompetensområden medförde det att den genomsnittliga tekniska kompetensen var, praktiskt och i synnerhet teoretiskt, större än i landet i övrigt. Det faktum att majoritetsbeslut gällde, såväl inom stånden som ständerna emellan, gjorde att riksdagsledamöter med teknisk kompetens, till exempel inom adel och borgerskap, kunde få ett oproportionerligt stort inflytande på de politiska besluten och därmed att det tekniska kunnandet troligen fick ett större politiskt inflytande än någonsin senare. Däremot var vissa grupper som bara indirekt berördes av tekniska utvecklingen, inte representerade. De som skulle komma att utgöra rekryteringsbasen för arbetskraften vid bruken och den begynnande manufakturverksamheten fick inte ett ord med i laget, - men vad skulle de ha brytt sig om en teknisk utveckling som ännu inte berörde dem i någon större omfattning?

1860-tal: Industriell tillväxt och politisk omdaning

Under 1800-talet nådde den industriella revolutionen Sverige på allvar. Detta medförde förutom en accelererande teknisk utveckling att det blev allt större och mera uppenbara skillnader mellan modellen för folkrepresentationen i ståndsriksdagen och hur samhället egentligen såg ut och fungerade. Därmed restes det krav på förändringar, och riksdagen övergick till tvåkammar-representation i och med 1867 års riksdags öppnande.

Mitten av 1800-talet var, liksom 100 år tidigare, en period av industrialistisk teknisk entusiasm. Även denna gång var det huvudsakligen ekonomiska orsaker som låg bakom. Finansminister Gripenstedts pådrivande av järnvägsbyggandet byggde på tron att tekniken och industrin snabbt skulle utveckla ekonomin, och de kraftfullaste medlen som stod tillbuds för detta var utveckling av kommunikationerna i landet. Men det var säkra kort som Gripenstedt satsade på, komunikationsmedel hade redan visat sig ha en positiv effekt på den ekonomiska utvecklingen på de andra håll (och det var många), där de redan hade införts. Naturens krafter skulle tämjas och ställas till människans tjänst, därför hade tekniska skolor grundlagts vid århundradets början: Bergsskolan i Falun 1819, Teknologiska institutet i Stockholm 1823, Chalmersska slöjdskolan i Göteborg 1828, och Artilleri och Ingenjörs Högskolan i Marieberg utanför Stockholm, grundad 1818, med civil ingenjörsutbildning från 1842. Detta innebar att det fanns fler människor med en högre teknisk utbildning i landet. Samtidigt medförde industrialiseringen att det manuella arbetet kom att förlora alltmer av sin hantverksnatur och fodrade en lägre övergripande teknisk kompetens en tidigare. På samma sätt ställdes det allt högre krav på teoretiskt kunnande för att förstå de alltmer komplicerade tekniska processerna. Dessa förändringar kan enklast beskrivas som en efterhand allt högre specialisering i alla led inom produktionen, och därav följande en koncentration av det tekniska kunnandet till vissa kretsar som blev allt tätare knutna till industrin. Detta måste beaktas när man skall försöka bedöma den tekniska kompetensen i 1860- talets riksdagar.

De sista ståndsriksdagarnas protokoll finns att tillgå, men även här saknas några egentliga personbeskrivningar. Detta gör att granskningen blir av samma kvalitativa art som gällde för 1760-talet. 1860-talets riksdags protokoll från riddarhuset visar en liknande uppbyggnad av representantsammansättningen som på 1760-talet, riksdagsmän som omnämns, omnämns med sin adliga titel enligt samma mönster som hundra år tidigare. Intressant nog tycks andelen lågadliga ha ökat något, "herr" återfinnes oftare än tidigare, men det kan också ha ett samband med adelns allt lösare band med försvarsmakten. Lågadliga ätters representanter hade i lägre grad en militär bakgrund än tidigare. Adelns representanter i riksdagen utsågs dock på samma sätt som på 1760-talet, så det är möjligt att använda en liknande värderingsmetod av adelns tekniska kompetens. Betydande förändringar i förutsättningarna för adeln pågick; sedan 1809 kunde frälsejorden köpas av ofrälse personer och därmed förlorade adeln alltmer sin position som jordägare.

Samtidigt miste adeln alltmer sin rangställning inom statsförvaltningen. Det var inte längre lika självklart att adeln främst arbetade inom krigsmakten utan flera andra karriärvägar hade öppnats inom såväl civil förvaltning och den akademiska världen som inom finansvärlden och industrin. Till exempel figurerar det flera jurister än tidigare i protokollen, särskilt bemärkta är: Louis De Geer, Gustaf Lagerbjelke och Curry Treffenberg. Förändringarna pågick dock under en längre tid. Personer som den tidigare nämnde finansministern, J.A. Gripenstedt, började sin karriär som artilleriofficer (troligen utbildad vid högre artilleriläroverket i Marieberg), ägde stora egendomar och var bruksföretagare. Inom den praktiska tillämpningen av industrialismen hade initiativet däremot efterhand glidit över till borgerliga händer, och till sådana som inte kunde definieras inom ståndssamhället. Men fortfarande kunde särskilt framstående personer inom olika områden adlas (som till exempel kanal- och järnvägsbyggaren Nils Ericsson; adlad 1854), och det bör ju ha ökat den tekniska kompetensen i riddarhuset. Ett annat exempel på adlig teknisk kompetens inom riksdagen är järnvägspionjären Adolf von Rosen.

Sammanfattningsvis kan man säga att 1860-talets riddarhus tycks ha innehållit en icke försumbar mängd teknisk kompetens, om än inte i riktigt samma omfattning som 1760-talets.

Även prästerståndet förändrades. Efterhand kom den bildning som sträckte sig bortom kyrkans läror, till exempel naturvetenskapen, att växa i betydelse och anseende, och därmed öppnades flera fakulteter och studievägar vid universiteten, vilket ledde till att den tidigare självklara positionen som lärostånd förlorades. Samtidigt fanns det reforminriktade präster som önskade koncentrera prästernas arbete till de rent själavårdande uppgifterna ute i församlingarna, och det tyder på att intresset inte längre var lika stort för ickekyrkliga ämnen. Det kanske inte är så konstigt eftersom det, som tidigare nämnts, fanns flera alternativa studievägar att följa för den som hade sådana intressen, och därmed torde bredden inom prästerståndets intresse- och kompetensinriktning ha minskat. En viss kompensation kom 1823, då det lagstadgades att universiteten skulle få tillsätta högst fyra ledamöter och att Vetenskapsakademien skulle få tillsätta två ofrälse ombud i prästerståndet. Det har beaktats vid värderingen av prästerståndets tekniska kompetens.

Sedan 1810 stadgade riksdagsordningen att alla protokoll skulle tryckas. Därför finns prästerskapets riksdagsprotokoll från hela perioden, men både namnlista och personbeskrivning saknas. Samma typ av granskning som gjordes av 1700-talsprotokollen ger samma sammansättning som 1700-talets prästerstånd: det domineras av prostar, kyrkoherdar, biskopar, domprostar och teologie doktorer. Dessutom har ärkebiskopen återtagit sin plats bland de andra prästerna. Därmed kan man dra slutsatsen att den tekniska kompetensen hade ungefär samma förutsättningar som hundra år tidigare. Men när man dessutom betänker det som tidigare nämnts: den ökande bredden av utbildningsvägar med den därav följande minskade kompetensbredden för präster, och dessutom gör avdrag för att det inte längre fanns ett naturvetenskapligt upplysningsideal, drar man slutsatsen att prästerna torde tillfört en försumbar mängd praktiskt tekniskt kunnande till riksdagen, - däremot en liten naturvetenskaplig bildning, men då främst från de fåtaliga icke kyrkliga ledamöterna. Därför kan man dra slutsatsen att det har varit en minskning av prästerståndets tekniska kompetens i förhållande till 1760-talet.

Inte heller borgarståndet undgick att påverkas av den föränderliga tiden. Handeln och industrin utvecklades främst av människor utanför de traditionellt burskapsägande grupperna. Flera av näringslivets mest framträdande män saknade därmed representationsrätt. Den ökande läskunnigheten ledde till att större delar av befolkningen tog del av, och deltog i, den politiska debatten vilket gjorde att skribenter och tidningsmän både kunde öka i antal och politiskt inflytande. När dessutom handels- och näringsfrihet stegvis infördes genom förordningarna 1846 och 1864, försvagades själva förutsättningarna för hela ståndets existens. Den första reformen som antogs kom vid riksdagen 1828-30, då de ofrälse bruksägarna fick fem platser i ståndet, bör naturligtvis ha höjt det tekniska kunnandet. En grundlagsändring från riksdagen år 1858 innebar att en tregradig förmögenhetsskala grundad på skatterna avgjorde rösträtt och valbarhet till borgarståndet, oavsett om man hade burskap som borgare eller inte. Detta var visserligen ett tafatt försök till anpassning till en verklighet som allt mer hade fjärmat sig från ståndssamhället, men det innebar att grosshandlare, småhandlare och framförallt hantverkare förlorade i inflytande och i och med det minskade den tekniska kompetensen inom borgerskapets riksdagsrepresentation. Allteftersom som hantverket minskade i betydelse och flera näringsmöjligheter öppnade sig, delades borgerligheten in i flera nya intressegrupper. Men på flera håll hade man börjat att uppmärksamma behovet av teknisk kompetens inom det civila området, och de allt mer ekonomiskt mäktiga industrimännen hade börjat efterfråga en teoretisk teknisk kompetens. Detta hade lett till de tekniska skolornas grundande men i och med det kom, som tidigare sagts, en hög teknisk kompetens att koncentreras till en bestämt skikt i samhället.

Genom borgerskapets riksdagsprotokoll kan man ana små men inte försumbara förändringar. Riksdagsgruppen har under 1860-talet kommit att i än högre grad att präglas av män med civila titlar och som tycks befinna sig längre från produktionsledet. Man finner många borgmästare (vilket i och för sig är naturligt då en borgmästare har en ledande och representativ funktion), grosshandlare, jurister, men fortfarande finns det disponenter och representanter för hantverkarna där.

Ett försök att summera den tekniska kompetensen inom borgarståndet som den framträder vid denna granskning, blir att andelen ledamöter med tekniskt kunnande bland borgarna i riksdagen hade minskat i förhållande till hundra år tidigare. Det fanns mindre kännedom om teknik ur en praktisk synvinkel, och förhållandevis få ledamöter med en hög teoretisk teknisk kompetens. Men samtidigt hade det tillkommit ledamöter med en mer mångsidig kompetens med större erfarenheter inom administration och arbetsledning.

Förhållandena förändrade sig också för bönderna. Bondeståndet kom att reformeras i tre steg: 1834 fick innehavarna av frälsehemman representationsrätt (utom de som antingen tillhörde eller hade tillhört något annat stånd, eller om innehavaren hade varit, eller fortfarande var ämbetsman). 1844 kunde även säteriägarna vinna tillträde. Slutligen fick 1862, alla ofrälse jordägare som uppfyllde alla övriga kriterier rösträtt och valbarhet, oavsett om de hade varit ämbetsmän eller tillhört något annat stånd.

Samtidigt befann sig bönderna på frammarsch som jord- och fastighetsägare, i synnerhet som de numera kunde förvärva frälsejord, och därmed kom bondeståndet att utvecklas från ett jordbrukar stånd till ett organ för ofrälse jordägare i allmänhet. Industrialiseringen kom efter hand att resultera i att slöjd- och hemindustrin förlorade i betydelse i stora delar av landet, dels genom att man blev utkonkurrerad av billigare industriellt tillverkade produkter, dels genom att somliga gick över till att driva produktionen mera industriellt. Slutligen spelade rationaliseringen av jordbruket sin roll, i och med att det därmed inte var lika nödvändigt med kompletterande näringar vid sidan av jordbruket. Bondeståndets representation visar inga säkra tecken på att ha förändrats, ledamöterna presenteras fortfarande genomgående med för- och efternamn, men om man undersöker vidare vilka de är, finner man att ståndet är sig likt. Där sitter hemmansägare vid hemmansägare uppblandat av några jordbrukare, (man kan tänka sig att det därmed kan röra sig om en välsituerad arrendator). Däremot finner jag ingen bergsman längre, vilket kan bero på att utvecklingen av bruksväsendet hade gjort att det inte längre fanns förutsättningar för bondebergsmännen.

På det hela taget tycks bondeståndets ledamöter hålla ungefär samma relativa tekniska kompetens i förhållande till de övriga stånden som på 1760-talet, men precis som för de övriga stånden så har den sociala tyngdpunkten förskjutits, från att ligga på familje- eller yrkesmässig grund, till att ligga på ekonomisk grund. Och i likhet med de övriga stånden har den samlade tekniska kompetensen allt mer kommit i skymundan när andra behov och ökad specialisering inom respektive område har gjort sig gällande.

Omvälvningen som förväntades i och med övergången till tvåkammarriksdag blev långt mindre än väntat. Valbarhetskraven och kraven för rösträtt var satta vid för sin tid så hög inkomst eller förmögenhet, att fyra femtedelar av den manliga befolkningen ställdes utanför; kvinnorna var helt uteslutna. Därmed gick man över till att i första hand indela landets manliga befolkning efter deras ekonomiska situation, istället för efter ett medeltida socialt mönster. Det tidigare systemet hade, trots, men faktiskt paradoxalt nog, också på grund av sin uppenbara otillräcklighet, inneburit att det fortfarande fanns rester av den kompetenskvotering som ståndsriksdagen ursprungligen hade inneburit, men i och med detta utplånades de sista resterna. Å andra sidan hade utvecklingen redan gjort att den ursprungligen ofullkomliga modellen över samhällets uppbyggnad än mer fjärmats från verkligheten.

Från och med tvåkammarriksdagens införande finns betydligt rikligare information om ledamöterna att tillgå. Riksdagsmatriklar finns tryckta, men mest upplysande är "Tvåkammar riksdagen 1867-1970, Ledamöter och valkretsar" del 1-5, med korta biografier över ledamöterna och deras mandatperioder. Det innebär naturligtvis att det skulle vara möjligt att göra även en kvantitativ jämförelse mellan den tekniska kompetensen i riksdagen mellan tvåkammarriksdagens första och sista år. En sådan jämförelse skulle vara nog så intressant i sig, men resultatet skulle det inte gå att sammanlänka med slutsatserna från granskningen av ståndsriksdagarna, och därmed med den utveckling som förhoppningsvis har framträtt genom artikeln så här långt.

Därför kommer även perioderna 1867-70 och 1960-70 att granskas på samma överskådliga sätt som de övriga perioderna i undersökningen. Trots den radikala representationsreformen känner man igen flertalet av de mest bemärkta ledamöterna, och varför skulle de som efter intensiva debatter röstat igenom den stora kompromissen sluta att engagera sig politiskt i och med det? I första kammaren återfinner man då huvudsakligen ledamöter med militär eller högre tjäntemannabakgrund, godsägare, jurister och affärsmän, med bekanta namn som DeGeer, Bildt, Schartau, och Lagerbjelke. Genom att första kammaren fylldes av förmögna, höga ämbetsmän och mäktiga finansmän, varav de allra flesta var adliga, blev det en långt mer konservativ församling i den första kammaren än vad riddarhuset någonsin haft under ståndsriksdagarna. Samtidigt försvann den största delen av den tekniska kompetensen från den "övre delen" av riksdagen.

Andra kammaren i sin tur fick en dominerande andel av välbärgade hemmansägare och borgmästare, jurister, journalister och skriftställare, lärare, grosshandlare och läkare, men trots det fanns det fortfarande plats för enstaka ledamöter med mera tydlig teknisk kompetens, såsom bruksägare, disponenter, hantverkare och militärer. Även här framträder flera bekanta namn som Gripenstedt, Treffenberg, Rundbäck, Ifvarson och Posse. Just att flera av namnen är bekanta från riddarhuset kan ses som belysande av främst två effekter av den nya representationsformen; för det första, att förmögenhetskraven till första kammaren verkligen var satta högt och att en mindre förmögen och mera liberalt sinnad grupp därmed försvann från den ena halvan av riksdagen, och för det andra, att trots de pågående sociala förändringarna i samhället var flera adliga fortfarande mycket inflytelserika på sina respektive hemorter. De ingenjörer som utbildades vid de högre tekniska skolorna sökte sig knappast till politiken utan tycks i stället tillsammans med andra industrimän entusiastiskt ha ägnat sig åt att genomföra den industriella revolutionen. Varför skulle de annars ha börjat att studera teknik? Ett lysande undantag förtjänar dock att lyftas fram: Professor, A. H. E. Fock, vid Teknologiska institutet, som satt i andra kammaren i slutet av 1860-talet. Men en sådan hög teknisk kompetens koncentrerad till en eller ett fåtal personer får av uppenbara skäl svårt att göra sig gällande i en församling där majoritetsbeslut gäller. Avskaffandet av den sociala kvoteringen, och införandet av ett ekonomiskt grundat valsystem gav tydligen även i den andra kammaren upphov till att kompetensinriktningen inom riksdagen minskar inom flera områden, inte minst det tekniska. Vidare kan man fråga sig i vilken utsträckning detta system bidrog till att öka klassidentifieringen och därmed till en ytterligare polarisering av samhället.

1960-tal: Professionellt, politiserat parlament

De reformer som genomfördes i början av 1900-talet, till exempel införandet av allmän och lika rösträtt för män 1909, och även kvinnor 1918, flermansvalkretsar 1909, samt bildandet av politiska partier under slutet och början av 1800- respektive 1900-talet överförde tyngdpunkten i riksdagen från ekonomisk ställning till politisk hemvist. Detta har tydligt satt sin prägel på riksdagens representation. Riksdagens första kammare valdes indirekt det vill säga av stadsfullmäktige och av landstingen, men när den allmänna och lika rösträtten infördes även vid kommunal val, gjorde detta att den första kammaren kom att få en betydligt mera demokratisk, men också en mycket mera politiskt färgad sammansättning. Skillnaderna mellan kamrarna blev alltmer en ren formsak och tvåkammarsystemet ersattes med en enda kammare från och med 1971.

Den genomgångna industrialiseringen av landet har medfört att den utveckling som skissades i stycket om 1860-talet har gått längre, och den högre tekniska kompetensen har kommit att koncentreras till grupper närmast i och omkring industrin och de tekniska högskolorna. De manuella arbetsuppgifterna har också specialiserats så att dessa fodrar knappast längre någon övergripande förståelse för de tekniska systemen. Samhällsförändringarna framträder också genom riksdagsrepresentationen. I första kammaren finner man nu betydligt färre höga ämbetsmän, godsägare, bruksägare, militärer och jurister, och adeln har blivit sällsynt. Däremot hittar vi ymnigt med ombudsmän, redaktörer och journalister. Den kvinnliga rösträtten gör sig påmind i och med titlarna "fru" och "fröken". Vidare finns det enstaka direktörer och lantbrukare. De innehavare av akademiska titlar som lokaliseras visar sig i flera fall vara lärare.

Andra kammarens sammansättning skiljer sig marginellt från första kammarens, det finns något fler yrkes- och färre akademiska titlar (men faktiskt även ett par civilingenjörer). När man granskar ledamöterna närmare finner man att de framför allt har en gedigen bakgrund inom sina respektive partier. Den stora överrepresentationen av "ombudsmän" och att det är så vanligt med "f.d." framför yrkestitlarna illustrerar den genomförda övergången till ett partipolitiskt grundat parlament. En "metallarbetare" borde väl till exempel ha praktisk erfarenhet av teknik, men endast inom ett ganska snävt område där det knappast fodras någon mer omfattande förståelse för tekniska system eller förmåga att sätta sig in i tekniska problemställningarna. Däremot ledde utvecklingen av partiapparaterna och deras dotterorganisationer till att det fanns rikliga möjligheter för personer med politiskt intresse att organisera sig, förkovra sig politiskt inom partiet, utbilda sig politiskt på partiets kursgårdar och skaffa sig en ordentlig inblick i partiets arbete. Under senare delen av 1900-talet hade riksdagen därmed blivit alltmer professionell, och riksdagsmän rekryterades på grund av politiska och fackliga meriter.

Det mönster som framträder genom stickprovskontroll i de biografier som finns att tillgå tyder på att 1960-talets riksdagsman hade en lång bakgrund av politiskt och fackligt arbete och att det är detta som fört honom eller henne in i riksdagen. Särskilt väl framstår tendensen hos de riksdagsledamöter som har akademisk bakgrund. Där verkar det som om det politiska intresset snarast har styrt utbildningens inriktning, och det politiska engagemanget har odlats intensivt under studieåren. Riksdagsmatriklarna och biografiska data tyder alltså på att riksdagen på 1960-talet har en utomordentlig politisk kompetens men däremot en måttlig teknisk kompetens.

Reflektioner

Örebro riksdag i februari 1617 lagfäste för första gången att riksdagen skulle bestå av de fyra ståndens representanter. Den medeltida samhällsuppfattningen om ett oföränderligt samhälle bestående av de fyra stånden: adel, präster, borgare och bönder avspeglas i ståndsriksdagens uppbyggnad. Man tog uppenbarligen hänsyn främst till de, med ett modernt uttryck, större särintressena, och bortsåg från hur många människor de olika grupperna representerade. Denna sociala kvotering medförde trots sina uppenbara brister, att riksdagen fick en kompetens-kvotering.

Varför har då böndernas protokoll från 1700-talets riksdagar prioriterats, till skillnad från prästers och borgares? Bondeståndet representerade utan tvekan den största delen av befolkningen, men på den här tiden var deras inflytande i riksdagen precis lika stort som vilketdera som helst av de övriga stånden. Att identifiera bönderna med "folket" som vi i vår tid lätt gör, är att bedöma ett samhälle med en värdeskala som samhället själv står helt främmande för. Det är att försöka mästra historien - inte att studera den. Senare tiders historiker tycks ha tillmätt bondeståndet en större betydelse än vad deras egen tid gjorde. Å andra sidan måste ju något stånds protokoll publiceras först...Vad gäller adeln så har adel alltid, i egenskap av maktelit, rönt ett stort intresse, inte minst av sina samtida och sentida gelikar.

Präster och borgare har som varande medelklass (= mellanstånd?) varken kunnat beraktas som "folket" eller "eliten" och är följaktligen inte lika intressanta. Kan det vara så, att vi handskas med historien på precis samma sätt som vi handskas med vår egen samtid? Då skulle det som vi ser i historien säga minst lika mycket om oss själva som om den historia som vi studerar.

Presentationen av riksdagsledamöter i protokoll och matriklar är intressant som symptom över tidsandan. De adliga presenteras i enlighet med sin adliga titel, "greve", "friherre" eller liknande, militär grad eller bara med herr, men vad säger det om riksdagsmannens kompetens? Präster har professionella och akademiska titlar, men vad har en "borgmästare" för bakgrund? Det är rimligt att anta att en "disponent" har någon erfarenhet av drift och arbetsledning vid någon form av industriell verksamhet, och det borde fordra en i alla fall grundläggande förståelse för det tekno-sociala system där han är verksam, men *vad* disponenten vet är helt och hållet beroende på vilket system han är verksam i, och det förtäljs inte. Vad säger egentligen titeln "hemmansägare", är det en person som har erfarenheter av att driva ett jordbruk? Nej, inte nödvändigtvis, det säger bara att personen i fråga *äger* en jordbruksfastighet, tydligen ansågs *förmögenheten* vara mera betydelsefull än kompetensen. Det tycks ha varit betydligt viktigare att framhäva att riksdagsmannens sociala ställning, utöver riksdagsman, än att visa vad som gör honom särskilt väl skickad att fatta beslut som berör rikets framtid.

I det ljuset framstår inte den representation som skapades i och med kammarriksdagens införande fullt så märklig som den kanske verkar från vår tid sett. Representationen som tidigare hade varit grundad på olika särintressen hade övergått till en social grund och gick vidare till en ekonomisk grund, i enlighet med den nya identiteten som klasssamhälle. Detta kanske ur en ytlig social synvinkel kan verka vara samma sak men är i grunden väsensskilt, innehav av pengar är en sak, som måhända ger möjlighet till en viss livsstil som är gemensam för personer med motsvarande förmögenhet, men det är hur förmögenheten förvärvades och hur den förvaltas som avgör hur en människa resonerar och vilka intressen denna människa kommer att försöka ta till vara. Denna skillnad har säkert spelat roll i den fortsatta utvecklingen.

Svenska folkets representanter hade alltså gått ifrån att kvoteras från ett medeltida socialt mönster, till en ekonomisk indelning och slutligen till en parti-politisk indelning. Varje system har sina förtjänster och brister. Utvecklingen innebar att det som blev avgörande om en riksdagskandidat kunde bli riksdagsman var främst vilket politiskt parti kandidaten tillhörde, och vilka politiska meriter som denne hade skaffat sig inom sitt parti. Teknisk kompetens räknas normalt inte som en politisk merit. På 1960-talet har alltså politik blivit den klart dominerande huvudsysselsättningen bland ledamöterna i riksdagen. Det innebär att politikerna får en lägre kompetensnivå inom de områden som inte är direkt knutna till politiken, och blir därför mer beroende av sakkunniga inom respektive område. Då fodras det att politikerna och de sakkunniga kan förstå varandra, och i varje fall när det gäller teknik är det inte helt självklart. Tekniker, precis som vilken annan yrkes kategori som helst, har ett speciellt sätt att tänka och uttrycka sig på, och den som inte är van vid detta kan riskera att missuppfatta innebörden.

Men oavsett politikernas och debattörernas tekniska kompetens pågår den tekniska utvecklingen i alla fall på sitt håll, och genom att tekniken ständigt presenterar flera nya alternativa sätt att tillgodose gamla behov, och dessutom ger upphov till ytterligare nya behov har tekniken i allt högre grad kommit att prägla samhället. Tekniken har på så sätt av sig själv blivit ett mäktigt debattinlägg, som liksom alla debattinlägg kan beaktas eller förbises. Det finns en djupt mänsklig tendens att ju mindre man kan gripa om ett område desto större benägenhet har man att applicera sin ideologi eller tro på det området, och desto större blir då risken för allvarliga och kostsamma misstag, och farligast av allt: rädslan att erkänna dessa.

Det är intressant att fundera över varför det aldrig hittills har gjorts några försök med att indela riksdagsrepresentationen enligt kompetens och bakgrund, de senaste årens politiska strömmar har ju snarare fokuserat riksdagsledamöternas kön, ålder och etniska ursprung, vilket tycks mig att mera vara en debatt om rent kosmetiska förändringar. Men det är i alla fall ett konstaterande att människor *är* olika, och kanske det här är de sätt som det är lättast att dela upp dem på, för hur gör man egentligen när man skall *helt rättvist* bedöma olika människors kunskaper när de har olika bakgrund? Genom den här uppsatsen har jag genomgående varit tvungen att försöka jämföra personers tekniska kompetens trots deras fundamentalt olika förutsättningar.

Hur skall man värdera tekniskt yrkeskunnande från olika tider? Kanske är det så att kunnande inom något speciellt område hittills inte har betraktats som meriterande till politiska uppdrag. Det är väl knappast att förvåna sig över att personer med politiskt intresse söker sig till politiska organisationer och utbildar sig inom ämnen som står politiken nära, för att sedan göra en politisk karriär. Inte är det heller särskilt förvånansvärt att personer med tekniskt intresse skaffar sig en teknisk utbildning och söker sig till tekniska yrken eller yrken med direkt anknytning till teknik. Till dessa yrken kan man knappast räkna politikerns.

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Debatt

Robert Angus Buchanan

The Poverty of Theory in the History of Technology [1]

Abstract

The history of technology is concerned with many complex technicalities of a mechanical, chemical and scientific nature. In understanding these concerns it is able to make good use of insights from economics, sociology and the other social sciences. But it remains essentially an historical discipline: that is to say, if it is to be successful in making realistic representations of events in technological history, it is obliged to work within strict historical rules which include respect for historical evidence and a willingness to suspend judgments until this evidence has been fully assessed. It is necessary to reassert these basic historical procedures because the history of technology has been vulnerable to the imposition of preconceived theories which have tended to distort the historical reconstruction. Even though it is readily admitted that initial theoretical assumptions must be made about any historical exercise in order to formulate particular questions about the past, it is argued here that the heavy use of theoretical preconceptions to dominate the enquiry serves to impoverish the history of technology.

*

Several years ago I wrote an essay in *Technology and Culture* under the title "Theory and Narrative in the History of Technology". The Editor chose to publish it along with two rejoinders, from Professors John Law and Philip Scranton, but until now there has been no reply from myself nor any other discernible response to what ought to be a promising theme for discussion amongst historians of technology, especially at a time when the discipline is struggling to assimilate the insights of the social sciences.[2]

In attempting here to develop this discussion, I must emphasize at the outset that I am not opposed in any way to the assimilation of anything that can usefully be learnt from the social sciences, provided that the integrity of the history of technology as an historical discipline is not compromised. But it seems to me that, in several recent instances, the legitimate boundaries of this provision have been breached, so that it has become necessary to call in question the use of theoretical methods in our discipline and to reassert the essential historicity of the subject.

My concern, now as in the initial statement six years ago, is for the restoration of critical narrative as the essential basis of the history of technology in areas in which the social sciences have made powerful claims to interpretive priority. These claims have come mainly from economists and sociologists, although the contributions of anthropologists, psychologists and, more recently, systems analysts, have also caused anxiety amongst those of us with a more traditional inclination. Still, a little anxiety is stimulating and is doubtless good for the soul, so I have no complaint on this ground. My main objections have been against economists who have pressed too hard to apply preconceived models, statistical analysis, and counterfactual methods in areas of the history of technology where they are not appropriate, and against sociologists who have been over-zealous in trying to fit the history of technology into the template and "empty conceptual boxes" of social construction theory. As far as the economists are concerned, I may be over optimistic in saying so but it is my impression that we have reached a *modus operandi* with an agreement to differ in some marginal areas: the problems of applying closely defined models and detailed statistical analysis to subjects for which the data-base can never hope to be adequate (eighteenth century steam technology, nineteenth century railroad development, etc.) have been recognized by most practitioners. The role of counterfactual analysis in explaining the transfer from water to steam power, or canals to railroads, remains a field of wary exploration, but at least nobody is as convinced of its general applicability as appeared to be the case a decade or so ago. For the most part, those economists who have approached the history of technology have accepted the basic role of critical narrative and have made several very distinguished contributions to the discipline.[3]

The current friction between exponents of theory and critical narrative historians of technology is thus limited mainly to the efforts which are being made by social constructionist sociologists to reassess the impact of key technologies. This is the ground which Law and Scranton have chosen to defend from my initial criticisms.[4] John Law's retort is particularly welcome, because I had made him the subject of strong criticism for his account of the technological aspects of the Portugese voyages of discovery in the fifteenth century. I am grateful that he has responded in such a courteous and constructive manner, and I find that I agree with much of what he has to say about the possibilities of using sociological insights to explore theoretically oriented questions. I agree especially with his view that "narrative history and social science theory are driven by different kinds of concerns and interests . . . they are simply different". But I still think that Law is mistaken on the main point at issue between us, namely his interpretation of the Portugese voyages of discovery. Like him, I make no claim to familiarity with primary sources in this field, but my experience with secondary authorities seems to have been happier than his so far as technological awareness is concerned. Cipolla's essay on *Guns and Ships*, which he does mention in a footnote, has been extremely illuminating in this respect. And I remain convinced that the abstruse terminology which he adopts, and which appears to be integral to his whole argument, obfuscates rather than clarifies. There may well be a case for reinterpreting the significance of the technological component in the great age of European expansion, but I do not honestly think that this is the correct way to go about it.

Philip Scranton's attack is less forgiving and less well-directed than that of Law. He has some fun mopping up my more light-hearted expressions such as "good old-fashioned narrative history", which it was probably unwise of me to use. But the phrase conveys an echo from the British historiographical literature with which he is possibly not familiar[5], just as I readily admit that I am unavoidably distant from some of the American sources he cites, other than those in *Technology and Culture* (although, incidentally, it is irksome as virtually a founder-subscriber to that worthy journal to be accused of not having read it "very closely in the past decade": to a degree, it is the fact that I *have* read it closely that has aroused my anxiety). It is a pity that none of us can be completely familiar with the corpus of transatlantic literature on the subject, although that is no excuse for not trying. I acknowledge that my position is influenced by the comparative weakness and isolation of the history of technology in Britain, in contrast with the robust quality of the discipline in the United States. In this position one is inevitably more embattled and combative than when one can browse in the luxurious pastures of disciplinary recognition. Nevertheless, the substantive point remains the same, whatever the position of myself and my critics: the history of technology is a branch of history and as such it is important, if it is to retain its disciplinary coherence and intellectual integrity, to observe certain rules about the study of history. This is not meant to keep anybody out and, indeed, history is an extraordinarily open-ended discipline. But is does require recognition of proper historical procedures.

Whether or not Scranton is correct in finding that my "distress at the character of recent work in the history of technology is palpable", I am certainly greatly irritated by his failure to grasp the central point of my argument - namely, that history is a different sort of discipline from the social sciences: as Law observes, "they are simply different". And by allowing himself to be carried away in the excitement of his chase for a phantom quarry he misunderstands my objection to the incursion of social scientists into the history of technology, which is *not* that they should not make the attempt, but rather that, when they make it they should observe the rules of historical procedure. I am far from advocating that both parties "fortify their borders", and positively welcome the interchange. I only insist that history should be studied as history, whatever conceptual systems and attitudes are brought to it.

Scranton also perversely misunderstands my summary of the concerns of the history of technology as a radical compression of the field "to the genesis, diffusion and impact of invention". These terms seem to me both to distinguish the subject from general history, and to present an extremely wide agenda: the "impact of invention", for instance, encompasses all the concerns of gender, political power and military development in which he professes interest. Similarly, the charges that I am guilty of the "privileging of individualism" and of reducing the history of technology to biography are wide of the mark, although I believe strongly in the importance of individual initiatives and decisions, and thus of accurate biographical assessments. These, however, can only be a part of any historical scholarship in the history of technology, and it seems to me that, despite Scranton's dismissal of them, they are prone to dangers of distortion by theoretical preconceptions which require careful treatment. But this is a rather special issue which I have dealt with separately elsewhere.[6]

The essential issues in this debate are four. In the first place, it should not be necessary to argue about the need for a measure of preliminary theory, without which no systematic investigation can be undertaken, in history as in any other discipline. I imagined that I had made this point adequately, but that does not prevent Scranton from accusing me of hankering after "a transcendent canon of objectivity". The historian must always start out his or her examination by raising questions which imply certain assumptions about the subject under review. This makes complete objectivity unattainable. Other historians will look at the same subject with different assumptions and from a different point of view. While such preliminary or "first order" theory is indispensable, however, it is not to be confused with the secondary theories which can be used in order to conduct the examination, and it is these latter thories which are the cause of current concern, and this leads on to the next point.

The second essential issue is that the application of theory to history is constrained - or should be constrained - by the need to accommodate facts about the past, so that second-order theoretical methods such as those of model-making and flow-diagrams are only of very limited applicability. One of the most important ways in which history differs from the social sciences is that it deals with a reality - the past - which cannot be subjected to conventional testing by polling or questionnaire, or even to comprehensive statistical analysis, partly because the "actors" are not accessible for interview, but mainly because it is never possible to control all the parameters and variables sufficiently to make their application meaningful. My fundamental objection to the "empty conceptual box" approach to history is that it can only be made to work by simplifying the records, by omitting facts which may be inconvenient, and by forcing the facts which are selected into patterns which may bear no relation to the circumstances of their origin. The result of such treatment must be the distortion of the historical account.

These considerations apply to any historical reconstruction, but the third essential issue is more particular to the history of technology. This is the fact that in the history of technology any theoretical method has an additional obstacle in the need to take account of substantial artefactual data. Some other branches of history recognize the value of physical evidence, and this is especially the case with archaeology, which has developed a range of techniques for examining and interpreting physical artefacts. But the history of technology is distinct in the weight which it places upon the understanding of machines, tools, processes and other techniques by means of which humankind has been able to make and do things, so that the physical survival of these artefacts is significant, requiring study and interpretation. Such study may involve the acknowledged techniques of archeological investigation, but it is unlikely to have much use for the more rarefied theoretical exercises of the social sciences. It is a measure of the earthiness of the history of technology that it must always address itself to the ascertained stock of physical artefacts.

The fourth essential issue is that the history of technology is part of a more general perception of society and that, for all its earthiness and artefactual content, it must in the last resort be interpreted within the context of its society. It is galling to have to say this, because it could have been assumed as axiomatic, and has certainly been taken for granted by most historians of technology, but the enthusiasm of the social constructionists for their "discovery" that technology is socially conditioned (as if it could have been anything else) makes a reminder necessary. The social circumstances which have to be considered in the history of technology include a complex variety of political, economic, administrative and personal factors which cannot be reduced to a series of simple - or even complicated - formulae: the parameters are too wide and are liable to constant adjustment. The only satisfactory way of approaching them is through the well-tried and reliable methods of critical narrative history, in which all the available evidence is surveyed and subjected to evaluation according to its authenticity and relevance, thus building up a picture of the past by what I have previously described as a process of "reticulation", in the manner of a surveyor or navigator.

The vaildity of this method is manifest in the classic works in the history of technology, which it would be individious and not a little tedious to catalogue, but a perusal of the contributions to *Technology and Culture* will demonstrate that most of them are similarly expressed in terms of critical narrative history. The social sciences have raised many pertinent questions and provided resources for deepening the understanding of historians of technology, but they have not supplied an alternative method of analysis, and attempts to demonstrate otherwise have failed to deliver. The history of technology is and must remain a branch of history, with all the difference from the social sciences which this entails.

Notes and references

1. This article was originally presented as a paper at the Oxford Conference on "Technological Change" in September 1993. It is printed here with small amendments, for the first time.

2. *Technology and Culture*, vol. 32, no. 2, April 1991, 365-376. The rejoinders by Law and Scranton follow at 377-384 and 385-393 respectively.

3. The work of economists considered in my original article included the classic statement of historical econometrics in Robert W. Fogel, *Railroads and American Economic Growth*, Baltimore, 1964; and G.N. von Tunzelmann: *Steam Power and British Industrialization to 1860*. Oxford, 1970.

4. The particular study of the social constructionists which generated my protest was Wiebe E. Bijker, Thomas P. Hughes and Trevor J. Pinch (eds): *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*. Cambridge. Mass., 1987. John Law's essay in this was: "Technology and Heterogeneous Engineering: The Case of Portugese Expansion", 111-134.

5. The phrase "good old economic history" was used by Professor Donald Coleman in a criticism of the "new" economic history, with its heavy reliance on sophisticated statistical methods.

6. See my contribution to the ICOHTEC Symposium on "The Place of Theory in the History of Technology", August 1993 - R.A. Buchanan: "Theoretical aspects of engineering biography".

Recensioner

Den sökande och uppfinnande människan

Bertil Agdur, *Homo Inventor. Innovationerna och vår historia*. Carlssons Bokförlag, Stockholm 1996. 141 sidor.

Förnuftet är frälsaren och naturvetenskapen dess bibel. Så länge detta faktum råder blir sakernas tillstånd bara bättre och bättre, trots att vi egentligen bara befinner oss i början av processen. Så kan man i korthet sammanfatta Bertil Agdurs bok.

Enligt författaren börjar mänsklighetens historia, åtminstone den del som är värd att omnämnas, med Aristoteles och det logiska tänkandet. Nästa milstolpe, vilken dröjde närmare 2000 år, var när logiken konfronterades med verkligheten. Detta inledde den naturvetenskapliga epoken. Att det dröjde så länge berodde på motståndet från kyrkan att acceptera den verklighet som experimenten representerar. Många var de som fick offra livet i kampen för sanningen och naturvetenskapens slutliga triumf.

När sedan logiken tillsammans med naturvetenskapen och tekniken (vilken författaren ser som utvecklad genom de nya kunskaper som naturvetenskapen givit) systematiskt kopplades samman, och motståndet från kyrkan bröts ner, lyckades vi på ett par hundra år fullständigt förändra betingelserna för vår existens. Huvudaktören i detta drama har varit och är Homo Inventor, den skapande människan, kämpandes mot ett i övrigt ofta konservativt samhälle. För att åstadkomma förändringarna har dessa utvecklingens hjältar haft ett vapen: uppfinningarna.

Det är väl egentligen här som Agdur presenterar sitt verkliga intresse, tillika bokens huvudsyfte, nämligen innovationsprocessen. Han har själv varit uppfinnare, forskare och entreprenör inom det teknisk-naturvetenskapliga området och därmed, enligt egen utsago, haft "närkontakt av första graden" med denna process. Nyckelordet för en förståelse av utveckling av innovationer är urval. Förloppet börjar med ett ifrågasättande av "det som är". Att innovera är därför detsamma som att reagera och ifrågasätta. På det sättet är innovationernas ursprung kopplat till människans överlevnad. Målet för idéerna är att bli till etablerade produkter. Men idéerna måste först utsättas för verkligheten. Mottagaren, den som avgör om idéerna ska förverkligas, är marknaden. Som begrepp är den svårgripbar, irrationell och avskyr ofta nya idéer, men det är ändå den som till syvende og sidst avgör urvalet och därmed utfallet av innovationsprocessen.

Men Agdur stannar inte här. Nej, hans modell av innovationsprocessen är giltig även för historiska processer, exempelvis naturvetenskapens framväxt och utvecklingen av religioner. Dessa komplexa historiska skeenden är helt enkelt resultatet av enskilda innovationer. I naturvetenskapens fall var dess framgång logisk då den erbjuder den bästa av lösningar i en verklighet av "entydig struktur" (vad nu Agdur menar med det). Religionens motsvarande misslyckande beror givetvis på dess problem att visa på just sådana "entydiga strukturer".

Jag antar och hoppas att det av min framställning av boken framgår att jag inte delar Agdurs synsätt. Kan verkligen världen vara så enkelt konstruerad: logisk, strukturerad och uppbyggd med människan naturligt i centrum? Där den ena boxen av "verklighet" i form av mätbara experiment självklart kan staplas på den andra tills en hel verklighet blir uppbyggd. Låter världen, verkligheten, naturen eller vad man nu vill kalla det sig fångas så enkelt? Det kan tyckas att jag pläderar för mystiken, men egentligen är det snarare komplexitet och möjligtvis även någon gnutta ödmjukhet jag eftersöker. Har Agdur själv aldrig ifrågasatt sin egen logik eller den "verklighet" han så självklart uppfattar omkring sig? Bildar de små boxarna av mätbara experiment tillsammans "Verkligheten"?

Min recension hade blivit positivare om Agdur istället för att förklara hela världshistorien och Sanningen dessutom, hade lagt mer kraft på de exempel på innovationer som boken avslutas med. I sin konkreta beskrivning av utvecklingen av ett lasermikroskop, en sedelmaskin och en ny typ av värmeplatta blir det uppenbart att författaren har insikt i hur idéer skall bli till färdiga produkter. Om boken utvecklat dessa fallstudier hade resultatet blivit intressantare och mer givande.

Att i det lilla formatet spegla de stora skeendena är en fortfarande hållbar devis för ett trovärdigt författarskap. Tyvärr är det inte Agdurs utgångspunkt. Det finns något pretentiöst i att skriva en bok vars syfte är att presentera sina egna funderingar om i stort sett hela mänsklighetens samlade historia. Som inledande bild och stämningssättare till tankarna har författaren valt ett foto av statyn Tänkaren. Detta tillsammans med att boken är en lång hyllning till Homo Inventor, utvecklingens fåtaliga hjältar av vilka Agdur själv som uppfinnare, forskare och entreprenör är en, gör att boken får något pompöst över sig.

Ett återkommande tema i boken är hur kyrkan under historiens gång hela tiden hindrat sann utveckling, symboliserat genom dess behandling av Galilei. Agdur själv lägger inte några funderingar över att naturvetenskapen under 1900-talet kan sägas tagit kyrkans roll som sanningsägare i det västerländska samhället. Istället agerar han på ett självklart sätt som en av lärans främsta profeter. Alla som inte lovsjunger den är motståndare till "den fria tanken". Blir allting bara bättre och bättre så länge det naturvetenskapliga idealet råder? Jag ifrågasätter det, eller snarare Agdurs självklara tro på det. Har inte naturvetenskapen bara ersatt de kristna dogmerna? Det är inte naturvetenskapen *per se* som jag vill kritisera utan Agdurs oreflekterade och okritiska förhållningssätt till den. Någonstans blir hans hyllning till "den fria tanken" och hans stämpling av alla som tycker annorlunda till en paradox. Är tanken bara fri om man tycker som författaren?

Naturvetenskapen behövs, enligt Agdur, för att lösa de problem som i allt snabbare takt hopar sig framför oss. "Men hur en fortsättning kommer att se ut beror i allra högsta grad på hur väl vi lär oss att förstå och tillvarata den bas för vår utveckling och framtid som naturvetenskapen och homo inventor utgör." Vad finns det egentligen att tillägga? Kanske ett halleluja och amen.

Ulf Andréasson

Ett kanonskott i Bath

Brenda J Buchanan (red.), *Gunpowder: The History of an International Technology*. Bath University Press 1996. 403 sidor.

The International Committee for the History of Technology (ICOHTEC) anordnade 1994 ett internationellt symposium i Bath. Ett av fyra huvudteman på symposiet, "The manufacture and marketing of gunpowder", hade lockat ett stort antal deltagare, betydligt fler än de 24 som presenterade egna forskningsresultat.

Arrangören av temat, själv internationellt etablerad forskare på området, visade sig också ha ett gott praktiskt handlag med krut. En mottagning vid University of Bath avslutades med en kraftig salut när Brenda Buchanan med hjälp av en lunta avfyrade en 1600-tals fältkanon, tillfälligt placerad på universitetets gräsmatta.

De 24 föredragen har nu publicerats, redigerade och försedda med noter och referenser till annan litteratur. Här får man en samlad bild av ett forskningsområde, som i förstone kan förefalla att vara något apart och isolerat, men som visar sig ha kopplingar åt många håll. Med svartkrutet i fokus kan man studera till exempel hur en kemiskt teknisk produktionsprocess har utvecklats under århundraden och i olika delar av världen, hur teknisk kunskap har förmedlats, hur statsmakten har sökt att styra en industriell produktion.

Att en blandning av svavel, salpeter och träkol i vissa proportioner kunde fås att explodera var känt i Kina redan under det första 1000-talet i vår tideräkning. Men det var först vid mitten av 1800-talet som de kemiska och fysikaliska processerna vid krutförbränning började klarläggas. Den tidiga militära användningen, först som krutraketer, senare i kanoner och handeldvapen, spreds snabbt västerut bl.a. genom mongolerna. Den civila användningen, framför allt i gruvbrytning, försvårades ofta av fukt, och först på 1700-talet började krutsprängning i Sverige att bli ett alternativ till tillmakningsmetoden.

Intressant är att följa hur produktionstekniken i krutframställning har utvecklats över en mycket lång tidsperiod. Råvarorna - svavel, salpeter, träkol - skall bearbetas till lämplig kornstorlek och sedan blandas. Det är alltså fråga om en mekanisk bearbetning inte helt olik malning av sädeskorn, som kan utföras genom att i ett "stampverk" stöta kornen i en mortel eller genom att klämma dem mellan roterande stenar eller valsar. Utvecklingen av kruttillverkning har genomgått liknande stadier som malning av mjöl, från rent manuella metoder till industriella processer drivna av hästvandringar, vattenhjul eller vindmotorer. Bokens omslagsbild, hämtad ur ett manuskript från 1450-talet, känt som *the Firework Book* i the Royal Armouries Library, visar rent manuell krutmalning i ett stampverk. Från Diderots *Encyclopédie* (c. 1768) har hämtats en illustration med samma process mekaniserad, där 24 mortelstötar ses drivna av två roterande kamaxlar. Redan i Vittorio Zoncas bok *Novo Teatro di Machine et Edifici* (1606) finns emellertid bilder, här återgivna på flera ställen, som visar ett tidigt annat utvecklingsspår inom kruttillverkningen.

Väsentligt ökad produktion kunde nämligen uppnås med en maskin där en stående kvarnsten i änden på en kort axel drevs runt i en cirkelbana på underlaget som också var av sten. Denna maskin, som jag inte funnit beskriven, vare sig i

Agostino Ramellis klassiska *Le diverse et artificiose machine* (1588; Dover 1987) eller i Alex Kellers *A Theatre of Machines* (Chapman & Hall 1964), är urtypen för den konstruktion av malmkross som betecknas "kollergång" och som används än i dag. Den enda skillnaden är att kollergången har två malstenar, en i var ände på den roterande axeln (bild i *Uppfinningarnas bok* 1928, del IV, sid 383). Även om denna malningsmetod inte medgav en helt kontinuerlig tillverkningsprocess, var den ändå ett första steg på vägen mot en flödesteknik. Stampverket och kollergången kom att jämsides leva vidare i krutfabrikationen i århundraden. Ett stampverk var lätt att bygga, medan den vattenhjulsdrivna kollergången krävde ett helt annat maskintekniskt kunnande.

Symposiebidragen har samlats i en huvudsakligen kronologisk ordning från 1400-talet till det slutande 1800-talet, men här finns också två studier av tidig kinesisk raketteknik och mongoliska skjutvapen på 1200- och 1300-talen. Naturligt nog behandlar fler bidrag krutets militära betydelse än dess civila; krutsprängning hade länge svårt att vinna insteg i gruvbrytning och tunnelsprängning. Risken för okontrollerade ras var större än vid den gamla tillmakningsmetoden och tekniken var svårhanterlig.

Kina, Indien, Europa, USA, Kanada och Australien finns representerade i den innehållsrika sammanställningen. Två bidrag är skandinaviska: Den norske bergshistorikern Björn Ivar Berg skriver om kruttillverkning och om tidig krutsprängning i silvergruvorna vid Kongsberg. Den svenske militärhistorikern Bengt Åhslund skriver om hur staten under stormaktstiden organiserade salpetertillverkningen i Sverige. Hela landet indelades i salpeterdistrikt, och särskilda uppsyningsmän tillsattes för att kontrollera leveranserna. Allt skulle tillfalla kronan och krigsmakten.

Jag föreställer mig att många av de forskare som möttes i Bath 1994 i dag ser tillbaka på just ICOHTEC-symposiet - och Brenda Buchanans kanonskott - som starten på de diskussioner som de nu säkert för med varandra på Internet.

Jan Hult

Ett möte på elverket

Henry Nielsen & Birgitte Wistoft, *"Industriens Mænd". Et Krøyer-maleris tilblivelse og industrihistoriske betydning*. Forlaget Klim, Århus 1996. 199 sidor.

> "hans namn är i synnerhet knutet till de danska sockerfabrikerna. Han anlade 1872 fabriken i Odense och senare flera andra. ... Vidare var han 1880-1902 en mycket verksam medlem af Köpenhamns kommunalrepresentation och blef 1902 direktör för den polytekniska läroanstalten. ..."
>
> (*Nordisk Familjebok* 1909 om Gustaf Adolph Hagemann)

> "Hans begåvning var lysande, frodig, outtröttlig, mångsidig, älskvärd och harmonisk. Han var stämningslyriker, gärna hågad för experiment. Som porträttör var han en kvick och fyndig fysionomist, som karakteristiker rask och skarpsynt, som målare övervann han med lätthet de största svårigheter. ..."
>
> (*Nordisk Familjebok* 1911 om Peter Severin Krøyer)

Skagenmålaren Krøyer, än i dag lika känd och älskad som för hundra år sedan, och ingenjören Hagemann, i dag okänd för de allra flesta, vad kan de ha haft med varandra att göra? Om resultatet av den skenbart osannolika kontakten mellan dem handlar denna fascinerande bok.

P.S. Krøyer var redan som 20-åring känd som porträttmålare. Studier i Paris och Madrid omsatte han senare i en naket realistisk målning *Italienska hattmakare*, som först väckte stor uppståndelse och debatt i Köpenhamn, men som senare kom att inrangeras bland hans mest betydande verk. Efter hemkomsten var han varje sommar bosatt på Skagen och blev så den romantiske friluftsmålaren. Välkända är de eleganta damerna med parasoll på sandstranden och, inte minst, gruppbilden *Hip hip hurra!* (1888).

Mindre allmänt kända är hans andra stora gruppmålningar, som också kunde kallas grupporträtt. Här finns *Musik i Atelieret* (1886), *Kommitteen for Den franske Kunstudstilling 1888*, *Fra Københavns Børs* (1895), *Et Møde i Videnskabernes Selskab* (1898) och *Industriens mænd* (1904), en målning beställd och bekostad av Gustaf Adolph Hagemann. Den blev Krøyers sista stora målning. Redan under dess tillkomst började den sjukdom bryta ut som skulle ända hans liv 1909.

Fysikern och teknikhistorikern **Henry Nielsen** vid Århus universitet, huvudansvarig för perioden 1800-1940 i *Skruen uden ende* (rec. i *Polhem* 1991/1) samt tillsammans med Hans Buhl redaktör för antologin *Made in Denmark?* (rec. i *Polhem* 1994/3), och **Birgitte Wistoft**, chef för Elmuseet i Tange på Jylland, medförfattare i *Elektricitetens Aarhundrede* 1-2 (1991-92) och även i *Made in Denmark?*, har tillsammans skrivit om tillkomsten av denna målning. Den finns sedan 1958 att se på Frederiksborgsmuseet.

Det som först väckte de två författarnas intresse var Hagemanns egen, tidigare försvunna, berättelse om tavlans tillkomst, som 1979 hade återfunnits i Rigsarkivet. De har också haft tillgång till en omfattande korrespondens mellan Hagemann och Krøyer. Därmed har de kunnat utarbeta en inträngande tolkning av tavlan med ett annat fokus än det gängse konsthistoriska.

Redan 1891 hade Hagemann fått idén att låta Krøyer smycka Köpenhamns Börs med fyra stora gruppmålningar visande lantbrukets, industrins, handelns och sjöfartens män. Börsens styrelse gick motvilligt med på att beställa en målning med handelns män, men därefter blev det stopp. Hagemann beslöt då att själv betala Krøyer för en målning med industrins män, och han gav konstnären bestämda instruktioner: bilden skulle visa ett antal, av Hagemann utvalda, framstående industrimän vid en sammankomst på det nyligen invigda Østerbro Elektricitetsværk. Hagemann överlämnade till Krøyer en lista med 55 namn, indelade i elva grupper, och skrev sedan ett cirkulärbrev till de utvalda, där de inbjöds att låta sig porträtteras.

I mars 1903 påbörjade Krøyer slutarbetet efter grundliga förstudier där de olika grupperna en i taget inbjudits att komma till elverket. I själva verket har inte alla någon gång samtidigt varit samlade på platsen.

Liksom de flesta av Krøyers tidigare grupporträtt utmärks bilden från elverket av hans skickliga ljusbehandling. Här är det det flödande ”nya” ljuset, alstrat på platsen, som fyller bilden och helt dominerar över dagsljuset i fonden. Det är dels det skarpa vita bågljuset från tre större lampor som hänger i taket, en vid varje ångmaskin med sin generator, dels ett stort antal mindre lampor av den nyare, mildare sorten, glödlampor.

När ”Industriens Mænd” visades på en utställning den 31 mars 1905 var kritikerna måttligt begeistrade. Några jämförde med hans tidigare gruppbilder och fann denna mindre intressant; enligt en anmälare gav tavlan ett ”noget forpakket og uroligt Indtryk”. Det var allmänt känt att Krøyer länge kämpat mot en tilltagande mentalsjukdom, och kanske anade man att han inte längre kunde prestera på samma nivå som tidigare.

Nielsen & Wistoft är emellertid inte ute efter att ytterligare kommentera målningens konstnärliga kvaliteter; deras syfte med studien är ett helt annat. De frågar sig: Varför är just dessa personer utvalda att porträtteras, och varför just här? Vilka maktstrukturer representerar de - och vilka är utelämnade? De har velat se målningen som en källa till förståelse av den tekniska och industriella miljön i Danmark kring förra sekelskiftet.

Deras tillvägagångssätt har varit att för var och en av de avbildade männen undersöka yrkesverksamhet, samhällsställning, medlemsskap i olika föreningar och sammanslutningar o.s.v. Alltsammans placeras in i två stora matriser av vilka man tydligt kan utläsa i vilka miljöer de har verkat och var och när Hagemann kan ha gjort deras bekantskap. Det sena 1800-talets industriella Danmark *var* helt enkelt till stor del just dessa personer. För Hagemann var målningen inte främst ett konstverk utan en symbol för den strålande framtid som han anade stod för dörren. Ingenjören Hagemann tycks i konstnären Krøyer ha funnit en själsfrände med samma fascination över allt detta nya.

Författarna visar med sitt arbete hur ett konstverk, använt som källmaterial, kan leda rätt in i en fängslande teknikhistorisk analys. Men boken bygger inte bara på denna enda tavla, bakom den ligger framför allt ett omfattande arkivarbete och - inte minst - en stark inlevelse i en tidsanda och ett händelseförlopp för hundra år sedan.

Jan Hult

ICOHTEC

Excerpts from New ICOHTEC Newsletter, No. 19: June 1997

Forthcoming Conferences, Symposia, Calls for Papers

The 1998 Annual Meeting of the **Society of German Engineers' Historical Commission,** Düsseldorf, **26-27 February 1998,** will be on the theme **Technology in Everyday Life**. Papers will focus on those parts of our technical environment which are often considered as unspectacular, but have a direct bearing on everyday life in industrialised countries.

Contact the Commission's chairperson Ulrich Wengenroth, Zentralinstitut für Geschichte der Technik, Technische Universität München, c/o Deutsches Museum, D-80806 München, Germany.
Tel: int+89 217 9408. Fax: int+89 217 9324.

The **Collegium Johann Beckmann** is organising a symposium on **Inventions: Historical, Theoretical and Practical Aspects**, Kassel, Germany, 7-8 March 1998.

Contact Hans-Peter Müller, Knesebeckstr. 13/14, D-10623 Berlin, Germany.
Tel: int+30 313 8863.

A conference on **Science & Society: Technological Turn** will be held in Tokyo, Kyoto and Hiroshima, Japan on **16-22 March 1998**. The purpose is to examine the reality and the problems raised by undergoing technological change.

Contact the conference office, c/o Prof. Shin-ichi Kobayashi, Graduate School of Information Systems, University of Electro-communications, 1-5-1, Chofugaoka, Chofu City, Tokyo 181, Japan.
Fax: int+81 424 85 9843. E-mail: sts@kob.is.uec.ac.jp.
Homepage: http://hostcinf.shinshu-u.ac.jp/stsconfjp.html.

The Fifth French Conference on the History of Computing will be held in Toulouse, France, in **March 1998**. It will focus on five major topics: 1) Informatics and Aerospace (Toulouse is a leading European center of aerospace research), 2) The teaching of informatics, 3) Man/machine/system communication (languages, software, peripherals), 4) Norms, standardization, patents, 5) Software industry.

Contact Pierre-E. Mounier-Kuhn, Centre Roland-Mousnier, Paris IV, Sorbonne, 1 rue Victor Cousin, F-75005 Paris, France.
Tel: int+33 1 4046 3192. E-mail: mounier@sorbonne.msh-paris.fr.

MAGHTECH '98, 3rd International Conference on Innovation: Problems and Perspectives for the MAGHREB, Sfax-Tunisia, **16-18 April 1998**. Organised by FSEG/Universities of Sfax (Tunisia), of Oran Es-Sénia (Algeria), of l'INSEA/Rabat (Morocco), the Laboratoire Tiers-Monde Afrique (University of Lille 1, France), the Friedrich-Ebert Foundation, the British Council. Main Themes (the proposed themes are of the macro as well as the micro type):

1. Innovation Policy and Economic Policies
2. National Scientific and Technological Potentials
3. National Systems of Innovation
4. Innovation and Territory
5. Sectoral Dynamics of Innovation
6. Innovation and the Firm
7. Innovation and Training
8. Research and Development
9. Financial Innovation
10. Organisational Innovation and Human Resources
11. Innovation and the Cultural Dimension
12. Co-operation and Innovation.

Participants: The Conference is open to university lecturers and researchers from the public and private sectors, to Government policy-makers etc. from the Maghreb region as well as from outside the Maghreb.

Countries investigated by empirical work are all the Maghreb countries: Algeria, Tunisia, Morocco, Mauritania and Libya, but case studies from elsewhere are also accepted.

The MAGHTECH '98 Conference will be hosted by the Faculté des Sciences Economiques et de Gestion of Sfax in Tunisia. The organisation team is under the coordination of Prof. Riadh Zghal, Chairman of the MAGHTECH Committee/Tunisia in close cooperation with the Scientific Committee of MAGHTECH and the co-ordinator Professor Abdelkader Djeflat.

Contact Prof. Abdelkader Djeflat, Faculté des Sciences Economiques et Sociales, USTL, F-59656 Villeneuve d'Ascq cedex, France.
Tel: int+33 320 337 103. Fax: int+33 320 436 655.
E-mail: abdelkader.djeflat@univ.lille1.fr

The **20th World Congress of Philosophy** (general theme: Paideia: Philosophy Educating Humanity) will be held in Boston, MA, USA, **10-16 August 1998**.

Contact American Organizing Committee, Inc., 745 Commonwealth Ave., Boston, MA 02215, USA.
Fax: int+1 617 353 5441. E-mail: paideia@bu.edu.
Homepage: http://web.bu.edu/WCP.

The Unit for the History and Philosophy of Science of the Faculty of Sciences and Technology of the New University of Lisbon, Portugal, is organizing the **25th Symposium of the International Committee for the History of Technology (ICOHTEC)**, to be held in Lisbon, Portugal, **18-22 August 1998**.

The general theme of the Symposium is **European Technology in a Global Context**. The main topics are:

- Technology and the Maritime Discoveries
- Technology and World Exhibitions
- Technological Identity and Institutions
- Clobalization Structures of Technology
- Technology, Science and Economy
- Technological Teaching: Comparative Perspectives
- The Technology and Application of Gunpowder in an International Context

Papers submitted to this symposium should take these main topics into account. However, ICOHTEC members are invited to suggest additional sessions which do not necessarily have a bearing on the general theme. A session should consist of a minimum of 5 papers.

Abstracts should be submitted before 31 December 1997, in an appropriate form which will be sent together with the second call. The second call will include the amount to be paid for the registration fee and the prices for hotel accomodation.

Registration should be sent together with the second call and returned to the Registration Office before 15 March 1998.

Language: The official language of the symposium is English. (Papers can be presented in Portuguese, Spanish, French and German, but no translation will be provided).

Contact Maria Paula Diogo, Secção Autónoma de Ciências Sociais Aplicadas/SHFC, Faculdade de Ciências e Tecnologia/UNL, Quinta da Torre, 2825 Monte de Caparica, Portugal.
Tel: int+3511 295 44 64. Fax: int+3511 295 44 61.
E-mail: sec-csa@mail.fct.unl.pt

A session on **Inventions, Innovations and Espionage: The Diffusion of Technical Knowledge in Early Modern Europe** will be held within the framework of the 12th International Economic history Congress in Seville, Spain, **24-28 August 1998**. Papers should examine topics related to institutions, rules and procedures governing the concession of privileges and patents; the economic area chiefly affected by the introduction of manufacturing processes or products; the impact of new processes or products and resistance to them; patent holders and their social framework; the protection of industrial secrets by guilds and states and the culture of secrecy. Proposals for papers should be received by 15th December 1997. To submit proposals or for more information

Contact Marco Belfanti, Dipartimento di Studi Sociali, Università di Brescia, via S. Faustino 74/b, I-25121 Brescia, Italy.
Fax: int+39 30 240 0610. E-mail: belfanti@master.cci.unibs.it

Planning is underway for a major conference on **Aviation/Aerospace History**, at Wright State University, Dayton, Ohio, USA, **1-3 October 1998**. Focusing on the first century of powered flight, conference organizers are seeking individual paper and panel proposals reflecting the following thematic areas: Flight and Society, Flight and Public Policy, Flight Technology,

Paper/panel proposals are due 1 November 1997; notification of acceptance will be made by 1 February 1998. Conference organisers plan to publish proceedings.

Contact Conference and Events, Rm. E 810 Student Union, Wright State University, Dayton, OH 45434-0001, USA.

Grants, Fellowships

The **Smithsonian Institution Libraries/Dibner Library Resident Scholar Program** offers two short-term grants for 1998 designed to encourage study of the history of science and technology. Selected scholars will be able to use the resources of the Dibner Library of the History of Science and Technology of the Smithsonian to do research. Terms range from one to three months with a montly stipend of $1,700. Historians, librarians, bibliographers, doctoral students, and other scholars are encouraged to apply. All scholars selected for the program are expected to be residents at the Smithsonian Institution.

The collections are especially strong in the physical sciences, mathematics, engineering, applied sciences and technologies, including electronics, railroad engineering, the chemical industries, textiles, tunnelling and bridging, and also microscopy, pharmacy, and modern physics, and rage in date from the fifteenth to the nineteenth centuries.

Deadline for applications: **1 December 1997**. Awards will be announced in early 1998. For application materials write to Resident Scholar Program, Smithsonian Institution Libraries, NHB 24, Mail Stop 154, Washington, DC 20560, USA.
Tel: int+1 202 357 2240. E-mail: libmail@sil.si.edu

Miscellaneous/National Reports

The **VTI Project**, a new interdepartmental, multidisciplinary graduate program in the humanities and social sciences, is taking place in **Stockholm and Uppsala**, Sweden [the acronym VTI stands for the Swedish: Vetenskap-Teknik-Industri].

The general aim of the project is to study the problem of **scientific research - technological change - industrial renewal** from both historical and contemporary perspectives. Four disciplines are involved: history of technology, industrial marketing, industrial heritage research, and history of science. The project's aim is to be achieved by establishing an inter-departmental and multi-disciplinary graduate program with its main departments at Uppsala University (business studies and history of science) and the Royal Institute of Technology in Stockholm (industrial heritage and history of technology). The project will last for 10 years. During this time four batches of graduate students will be admitted at the same time every second year by the four disciplines involved in the project.

To give the program an international orientation, regular two-way exchanges are intended in which arrangements for more extensive international co-operation are made. In the spring of 1998, four new graduate students will be admitted to the VTI Project, a four-year program beginning in the fall of 1998. The students will be admitted simultaneously, but separately, by the four disciplines involved.

For further information contact the Department for History of Science and Technology, Royal Institute of Technology, S-10044 Stockholm, Sweden, which issues the **VTI Newsletter**. This Newsletter is published twice a year in the spring and the fall and is distributed free of charge. To receive it, please write to the above department or send an e-mail to VTI@tekhist.kth.se

The **London Centre for the History of Science, Medicine and Technology** was formed in 1987. It brings together three leading academic centres of research and teaching in the subject, making it perhaps the single largest concentration of expertise in Britain. The centres are: Centre for the History of Science, Technology and Medicine, Imperial College; Department of History, Philosophy and Communication of Science, University College London; and the Academic Unit for the History of Medicine, University College/Wellcome Institute for the History of Medicine. The London Centre is also closely linked to the Science Museum.

The main role of the London Centre is to run the MSc programme in the History of Science, Medicine and Technology. The Centre offers courses which lead to the following degree titles: History of Science, History of Science and Science and Medicine; History and Philosophy of Science; History of Technology and History of Science and Technology. This is now the largest taught MSc programme in the country, attracting some 20 students each year.

Contact Dr. David E.H. Edgerton, Centre for the History of Science, Technology and Medicine, Sherfield Building, Imperial College, London SW7 2AZ. Tel: int+44 171 594 9354. Fax: int+44 171 594 9353.

Notiser

Insänt

Did Professor Popov send a samovar as a wedding gift to G. Marconi?

Dear Professor Hult,
I hope you remember our interesting discussion in the beginning of 1997 at Chalmers University of Technology about history of radio, and particularly about personal contacts between Guglielmo Marconi and Alexander Popov. The starting point of the discussion was publication of a paper by Susan Aldridge in *New Scientist* (20 May 1995, p. 46). She wrote:

> ”Nor has anyone suggested that Popov himself ever claimed priority over Marconi. The two men met in 1902 and became friends. Popov even sent Marconi wedding presents of a samovar and a sealskin coat.”

I agree with the first phrase that Popov never claimed priority for himself, but I was sure that Popov and Marconi had never met and become friends. The *New Scientist* published a photomontage of Popov and Marconi accompanied by a caption boldly printed: ”The two ‘rivals’: Popov on the left, Marconi right, met and became friends”.

I think it is misleading to play up the ”rivalry” between Popov and Marconi. It would be accurate to say that Popov and Marconi respected each other as engineers and scientists. However, they were not friends.

Through the editor of *New Scientist* I wrote to Mrs. Aldridge with a request to acquaint me with the source of information about Popov's present to Marconi. Mrs. Aldridge referred me to Dr. Rulf Barrett who was interested in the history of radio and delivered lectures on this subject. I wrote to Dr. Barrett. He was kind enough to give a quick reply. In his reply on 18 May 1996, Dr. Barrett wrote me about the samovar. The information had been taken from the book by Marconi's daughter Degna Marconi. Dr. Barrett wrote that Degna Marconi was a lady of advanced years. But she was very active and Barrett himself had had a friendly correspondence with her.

Thanks to Barrett, I found the book *My father Marconi* by Degna Marconi, McGraw-Hill Book Company, New York, 1962. There are two events described concerning Popov and Marconi in the book.

1) The author writes about the visit of [the] Italian cruiser *Carlo Alberto* to Kronstadt, Russian Navy base, on July 12 - July 21, 1902. On board of *Carlo Alberto* was Marconi's first floating wireless laboratory. On page 132 one reads: "One day a Russian caller arrived at the foot of *Carlo Alberto*'s gangway and said to an Italian sailor who helped him aboard: 'I want to pay my respect to Marconi, the father of wireless.' That caller was Alexander Stepanovich Popoff, the Russian scientist ....."

2) The author writes about Marconi's wedding in the spring of 1905. On page 169 one reads: "Presents poured in: silver, jewels, linens and laces, plates enough for banquets, and glasses enough for routs. Popoff sent a sealskin coat and a silver samovar from Russia."

My colleague and friend Dr. Larisa I. Zolotinkina, Director of the Popov Museum at the Electrotechnical University, told me that neither of the two events described in D. Marconi's book have been corroborated by documents or other memoirs and consequently should be regarded cautiously.

What historical facts are available for supporting the statements in the book written by D. Marconi? From 1888 to 1901 Popov worked at the Kronstadt Navy Torpedo School and lived in the town of Kronstadt. In 1901 he was elected Professor of Physics at [the] Electrotechnical Institute in St. Petersburg (now Electrotechnical University, where I am now). On 25 September 1901 Popov moved to his new flat in St. Petersburg. There is no evidence that Popov visited Kronstadt in July 1902. Morover, the Popov Museum at the Electrotechnical University is in possession of documents that state that the cruiser *Carlo Alberto* was visited by [the] Admiral of [the] Russian Navy S.O. Makarov. The admiral visited Marconi's laboratory on board the cruiser and had a conversation with Marconi about naval applications of wireless. One may suppose that somehow the names of Makarov and Popov were confused. This may have resulted in the legend about personal contacts between Popov and Marconi.

As a Professor of [the] Electrotechnical Institute at this time. Popov received a salary of 3000 roubles per year. The institute salary was the only income Popov received during that period. The silver samovar and the sealskin coat would have been very expensive. I personally doubt that Popov had enough money to give such splendid presents.

I wrote to Dr. Barrett again. I claimed that the question about personal contacts between Popov and Marconi is a very important point in the history of radio. I asked him to use his personal contacts with Degna Marconi and try to investigate whether the silver samovar is still in her possession, and what kind of settlement there was concerning the samovar. On 21 August, I received a letter from Dr. Barrett. The letter contained the reply of Degna Marconi to the question about the samovar. She wrote:

> "The Popov who gave the samovar and fur coat was not Popov, the scientist. It seems that this other Popov was a rich Russian industrialist, which my parents met, I am not sure where."

In the book of Degna Marconi, the paragraph about the wedding present to her father does not contain any words about Popov the scientist. The legend about friendship between Popov and Marconi seems to be an identification error. We are indebted to Degna Marconi for helping us to correct this error.

In concluding this letter I would like to cite a short passage from an article by the American science historian I.E. Mouromtseff ("Who is the True Inventor?", *Proc. IRE*, Vol. 38, No. 6, pp. 609-611, 1950):

> "It is hardly possible to establish with certainty on which particular day either inventor conceived his final idea of wireless communication. Is it, however, necessary? From all evidence it is clear that Russia learned about wireless and obtained it in practical form through the knowledge and ingenuity of the sedate scientist Professor Popov; the Western world unquestionably received all that through the energy and ingenuity of the young Marconi, and his unabatable faith in the great future of radio."

The help and attentive attitude to the problem of Dr. Barrett is gratefully acknowledged. I am grateful to Prof. Erik Kollberg and Prof. David Rutledge for useful discussions and some critical remarks.

Orest G. Vendik, D.Sc.Eng., Professor
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Chalmers tekniska högskola

Sektionen för teknikens ekonomi och organisation bedriver forskning och utbildning om utformning, förverkligande, drift och förändringar av industriella och andra tekniska system. Detta sker med utgångspunkt i kunskap om teknikens möjligheter och begränsningar, och under hänsynstagande till enskilda människors förutsättningar, behov och önskemål samt ett hushållande med naturens resurser.

Området Människa-Teknik-Samhälle (MTS) har funnits vid Chalmers sedan början av 1980-talet. Chalmers förstärker nu detta temaområde och söker därför en

PROFESSOR I TEKNIKHISTORIA

Ämnet omfattar det vetenskapliga studiet av teknikens och industrins historiska utveckling ur ett samhällsvetenskapligt och humanistiskt perspektiv samt denna utvecklings växelverkan med den samhälleliga och ekonomiska utvecklingen, med särskild inriktning mot förutsättningarna för och betydelsen av innovationer.

Professuren tillhör Institutionen för teknik- och industrihistoria som ingår i temaområdet MTS. Detta svarar för undervisningen inom MTS-området vid Chalmers olika utbildningsprogram. Området kommer också att förstärkas med två forskar/lärarbefattningar.

Ytterligare information lämnas av professor Jan Hult (tel: 031-772 38 86, e-post: jahu@lib.chalmers.se) eller av dekanus, professor Hans Björnsson (tel: 031-772 24 94, e-post: hansbj@mot.chalmers.se).

Välkommen med Din ansökan som skall ställas till Rektor för Chalmers tekniska högskola och vara inkommen till personalavdelningen, Chalmers tekniska högskola, 412 96 Göteborg senast den 20 september 1997.

I ansökan skall finnas en kortfattad redogörelse för vetenskaplig och pedagogisk verksamhet samt andra meriter som kan vara av betydelse. De tio viktigaste publikationerna skall särskilt anges och bifogas ansökan. Även den pedagogiska skickligheten skall dokumenteras. Dessutom bör referenser lämnas. Samtliga ansökningshandlingar skall inlämnas i fyra exemplar, fördelade i separata paket.

Facklig företrädare: SACO Christian Högfors, TCO Anders Olausson och SEKO Lars Gustavsson, tel 031-772 1000 (vxl).

Nyutkommen litteratur

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*

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Universitetslektor, fil.dr. Kenneth Awebro
har utnämnts till docent i teknikhistoria/historia vid Luleå Tekniska Universitet. Bland hans publikationer märks först doktorsavhandlingen *Gustaf III:s räfst med ämbetsmännen 1772-1779 - aktionerna mot landshövdingarna och Göta hovrätt* (1977). Härefter har följt ett stort antal arbeten inom området bruks- och bergshistoria, såsom *Luleå silververk* (1983), "Från malm till mynt" i *Studia Laplandica* (1986)" och Ädelmetall till varje pris" i *Älvdal i norr* (1990). Tre arbeten har publicerats i *Polhem*: "Sjangeli - en fantasieggande plats i Torneå lappmark (1990/2), "Upptäckten av Lapplands malmrikedom - gruvfältet på Junkatjåkkå (1992/1) och "Upptäckten av Lapplands malmrikedom - svernskt inträngande på samiskt område under 1600-talet (1992/3).

Andra arbeten behandlar samisk historia, miljöhistoria (bl.a. om flodpärlmusslan och dess betydelse som långtida miljöarkiv), kulturhistoria och arktisk historia (bl.a. om Grönlandskompaniet, inrättat på 1750-talet för fiske i arktiska vatten).

Universitetslektor, fil.dr. Staffan Hansson
har utnämnts till docent i teknikhistoria vid Luleå Tekniska Universitet. Bland hans publikationer märks, förutom doktorsavhandlingen *Porjus. En vision för industriell utveckling i övre Norrland* (rec. i *Polhem* 1994/4) flera arbeten om tidig industrialisering i Norrbotten, såsom *Norrbottnisk gruv- och järnhantering under 300 år* (1981), *Från Nasafjäll till SSAB* (1987) och *Att vilja men inte kunna. Om försök att införa ny teknik i bottnisk järnhantering* (1994). Andra arbeten behandlar lokalhistoriska studier, t.ex. *Luleå under 1600- och 1700-talen* (1988) och *Gruv- och metallindustrins betydelse för Luleås befolkningsutveckling åren 1880 -1980* (manuskript 1997).

Ett kompendium baserat på Staffan Hanssons föreläsningar i teknikhistoria vid dåvarande Tekniska Högskolan i Luleå utgavs 1985 som ett specialhäfte av *Polhem* (1985/4b) med titeln *Teknik och samhällsutveckling*. Kompendiet har senare utvidgats flera gånger och utgetts i bokform, senast 1996 under titeln *Teknikhistoria. Om tekniskt kunnande och dess betydelse för individ och samhälle* (Studentlitteratur), rec. i *Polhem* 1996/2.

Författare i detta häfte

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Författaranvisningar

Manuskript insänds i ett exemplar. Anvisningar för utskrift med ordbehandlare tillhandahålls av redaktionen:

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