

MORE ABOUT ENGINEERS

André Grelon

Even today, little is known about engineers. They are a multifarious group difficult to define. Engineers came into existence in the Middle Ages and performed many different types of work over the years ; but it was in the nineteenth century, when industrial development really took off, that they structured themselves as a group. But can engineers really be said to constitute an independent group within industrial firms and within society? Recently, special efforts have been made by researchers to try and answer the many questions concerning engineers. This issue of *Culture Technique* is a part of the process. To gain a better understanding of what engineers really are, the articles deal with many differing aspects: the «image» projected by engineers, the work and function of engineers, their relationship to innovation, their logic, their ideological/political attitudes, their structural organisation, questions relating to the training of engineers and the current problems facing them. These themes are not treated exhaustively, but in all cases the authors' intention has been to open up new paths, suggest new lines of thought, provide new and unpublished information so that we may improve our understanding of this important socio-professional group.

THE WORD : ENGINEER

Hélène Vérin

The hesitations of the French language concerning the definition of the word engineer are indicative of the difficulties in defining a form of activity which is essentially inventive, the processes of which are little understood. In the Middle Ages, the «engignour» was so called because he had the gift of «engin» (cleverness); because he used his «engin» (inventiveness); and because he produced «engins» (machines and instruments). In modern times, an engineer is an officer and mathematician capable of *applying* geometric principles to war-faring and to war machines, and more recently to the art of civil engineering, all arts exercised to strengthen the power of Princes and, later, of the Republic. The definition of the engineer is called into question at the beginning of the nineteenth century with the appearance of civil engineers. This definition remains uncertain even in the twentieth century and even today an engineer in France can only be defined by the «Grande Ecole» or engineering college from which he graduated. Recent research into the scientific knowledge and education of engineers has only deepened the controversy.

THE ENGINEER IN THE POPULAR NOVELS OF THE LATE NINETEENTH CENTURY (1850-1900)

Michel Gillet

Discovering the industrial revolution long after Haussmann, the authors of these popular novels filled their books with engineer-inventors creating marvelous and extraordinary machines. The mingling of engineers and factory directors produces a history of inventions which is not a proletarian history. The article refers to the works of Richebourg, Montepin, Sales, Ninous, etc... but does not deal with science fiction.

ENGINEERS: GENIUSES OR MERELY INGENIOUS?

Françoise Curutchet-Jullian

The engineer, that knight of modern times, fills the scientific adventure novels of the nineteenth century with stories of his exploits and machines. Co-existing with but different from excentric scientists, he is the symbol of practical science and the guarantor of its morality. He is seen as learned and industrious but modest, re-investing all his profits for the sake of his fellowmen. He extends man's control over space and time and gives a reassuring picture of scientific progress and inventions when properly used. He is a leader of men rather than a factory manager, exploits nature (and not men) on the road to progress and sees industry's goal as the conquest of universal happiness.

THE ENGINEER, A MAN WITHOUT AN IMAGE

Claude Maury

In the society of today in which communication is all-important, it is vital for a profession to have an «image». Unlike doctors, managerial workers, agricultural labourers or industrial workers, it is impossible to associate engineers with a typical standard appearance. Two explanations come to mind: engineers, who do not have direct contact with raw materials, are not clearly situated in a company's power hierarchy, and do not have a clear image of themselves. Further, they are disinclined to communicate, preferring relationships with things rather than people. In a society which heralds technology as a saviour, this situation must change. Slowly, engineering firms and colleges are creating the engineer's image and re-valorising his social status: a young man, somewhat unconventional but well integrated in society, a modest dominator of machines and machinery.

THE ENGINEERS BELONGING TO THE CORPS DES MINES. EVOLUTION OF THE RESPONSABILITIES DEVOLVED TO ENGINEERS BELONGING TO A STATE CORPS IN THE 19TH CENTURY

André Thépot

The Corps des Mines (Mining Engineers Corps) was first set up by the «Ancien régime» and given its final status in the law of 21st April 1810 and the decree of 10th November 1810. These texts bestowed on the engineers administrative tasks: surveillance of mines, assessment and receipt of mining dues. These activities were not universally accepted and the very existence of state engineers was soon contested. The mining engineers reacted by seeking additional activities to add to their tasks in order to reinforce their prestige as technicians and thus justify their existence.

THE TRAINING OF TELECOMMUNICATION ENGINEERS

Thierry Vedel

Recognition of the corps of telecommunications engineers — born at the end of the nineteenth century out of the corps of telegraph engineers — was very slow in forthcoming.

Following the merging of the Post Office and Telegraph Service in 1897, telecommunications engineers were placed under the authority of the Post Office for the next fifty years. It is only recently that the idea of the engineer-administrator has been fully recognised by the French Post Office — before they were thought of as technicians only.

With the ending of problems relating to the telephone and the arrival of new communications technology, telecommunications engineers have been given a prestige and status second only to that of engineers from the *Ecole des Mines* and the *Ecole des Ponts et Chaussées*.

But the corps of telecommunications engineers is different from these other two corps in that its members tend to be concentrated together and not scattered around the country; also it devotes a much greater part of its activities to research.

ENTREPRENEURSHIP, PAST AND PRESENT

Georges Ribeill

The author sets out to assess to what extent being an engineer, through specific training or professional experience, is an advantage or a handicap to «entrepreneurship». The author goes back to the beginnings of the industrial revolution in France and sets out a typology

of talents and abilities based on the type of training received — from engineers graduating from the Ecole Polytechnique right down to self-taught engineers. He also sets out an explanatory table in which he correlates social background, type and standard of education, and career in engineering. It emerges from these findings that those who are the least privileged in terms of social background and education (there is a close correlation between the two) are not necessarily the least entrepreneurial.

ARE ENGINEERS ORDINARY BOSSES LIKE ANY OTHERS?

Jean Saglio

An engineering diploma is the best way of getting to the top of industrial firms for those who are not lucky enough to be the proprietors. Should we then conclude, as most ideologists do, that the authority of such persons remains subordinate to and dependent on proprietors? An analysis of industrial firms and of the different ways of reaching top managerial status would suggest not; indeed, founders and their descendants are found to be in opposition to qualified engineers. The success and legitimacy of founders of firms resides not so much in their owning capital as in their ability to mobilise the various resources available. As for qualified engineers, they tend rather to rely on good organisation and rationalisation of working methods. And this opposition remains strong even though, in some cases, the evolution of jobs held by engineers leads them to occupy positions and adopt the strategies typical of skilled workers and technicians.

ENGINEERS AND THEIR WORK

Georges Benguigui and Dominique Monjardet

A person may be defined as an engineer by his training and recognised as such by his status. Is this sufficient to understand the position and role played by engineers in industry and society? The authors think not and indeed go on to make a detailed analysis of the work of engineers. By studying how engineers use their time at work, they were able to pinpoint marked differences in their professional lives which naturally had an influence on their career, position in hierarchy, opinions and attitudes, and behaviour in and outside work. Indeed, they draw a picture of a group not as homogenous as might be expected.

THE STORY OF MINING ENGINEERS DURING THE OCCUPATION

Evelyne Desbois

The article describes the events which marked the working life of mining engineers in the coal mines of Northern France during the period 1932-1947: introduction of rationalised working methods, the 1936 strikes, the German Occupation, the Liberation, the trials for collaboration, the nomination of Communists as ministers, the nationalisation of the coal industry, the «Battle of Coal», and the setting up of a mining engineers trade union affiliated to the C.G.T. The text has been compiled from an analysis of what engineers told us about their experiences and their views of the events in which they were involved.

ENGINEERS OR EXECUTIVES ?

Didier Delamare

Four men — some would call them engineers — tell the story of their lives by describing their work and responsibilities within their respective firms. Jean-Louis S... has little technical training but has managed to create two new products and, consequently, two business firms. Jean-Marie D... is typical of the engineer at the outset of his career. Christian P... is a graduate of the Ecole Centrale and has spent his entire career in a chemical firm belonging to a large industrial group. Jacques Dubois is undoubtedly the least typical. He is a physicist turned product director and is full of praise for the «Californian revolution.» They all make the same references: America, the French administration, May 68, etc... but above all they have the same ambitions (successful to varying degrees) to be leading executives rather than engineers.

ENGINEERS AND NEW METHODS OF WORK ORGANISATION FROM WORLD WAR I TO THE TIME OF THE POPULAR FRONT

Aimée Moutet

Our purpose is to show how the widespread introduction of new working and manufacturing methods in factories from World War I onwards changed the position of engineers within the firm; what role technicians played in the rationalisation of manufacturing methods; to what extent this activity was the basis of renewed ideological and political activities on the part of industrial engineers. Wartime stands out as being the period in which rationalisation plays a major part in the activities and conceptions of

engineers. During the twenties, rationalisation tends to be little more than a technique which gives the production engineer a more important position in the firm. With the recession, these illusions of power evaporate. Economy becomes the central interest of engineers wishing to have a political (in the widest sense) role to play.

ENGINEERS AND CYBERNETICS IN THE FIFTIES

Philippe Breton

Cybernetics was an integral part of the innovatory impulse of the fifties. However, its actual influence seems in retrospect to have been greatly under-estimated, or indeed entirely ignored. Most of the main themes of cybernetics were of immediate concern to engineers. They implicitly contained an attractive re-definition of the basic functions of technology. The relative waning of interest in cybernetics in the sixties and the parallel disappearance of cybernetic machines signalled the end of the attraction which this field exercised over engineers and engineering.

GASPARD RICHE DE PRONY (1755-1839). ENGINEERS' TRAINING IN THE NINETEENTH CENTURY

Antoine Picon

Yves Chicoteau

Catherine Rochant

Prony entered the *Ecole des Ponts et Chaussées* (College of Civil Engineering) in 1776 and was quickly spotted by Perronet who made him responsible for directing construction work of the Concorde Bridge (then the Louis XVI Bridge). In 1791 he was head of the French National Cadaster and remained there until 1798 when he was appointed Head of the *Ecole des Ponts et Chaussées*. He introduced educational reforms which are an accurate reflection of the spirit of the nineteenth century. Until his death in 1839, Prony remained head of the *Ecole des Ponts et Chaussées*, exercising a determining influence on the role and importance of engineers graduating from his school

Poised between the eighteenth and nineteenth centuries, Prony helps us understand the mutations which were occurring at that time and realise the importance of what was at stake. Scientific calculation continued to progress and gradually the engineers' overall goal with regard to nature and society became apparent. Through his many theoretical and technical essays, Prony paints an excellent picture of the main ideas guiding the engineering profession in the nineteenth century.

MATHEMATICAL STRUCTURES AND THOUGHT PATTERNS IN ENGINEERS: EXAMPLES

Jean Dbombres

Mathematics are omnipresent in the education received by French engineers. In the interest of ordered logical thought, so they say. But also (claimed Pascal) because mathematics, being based on clear hypotheses, teach people to start from clearly-defined starting points and not to beat around the bush with words. Mathematics, which can provide the model for a well structured language (claimed Condillac), are conducive to successful intuitions such as can be seen at work in engineers. Indeed, some people claim that mathematics encourages intellectual honesty and, one might even say, an aescetic approach to work which gives engineers a desire to build and construct, a taste for efficiency and an appreciation of work well done.

TECHNICAL DRAWING AND DIVISION OF LABOUR

Jean-Pierre Poitou

Technical drawing as a conceptual tool and means of communication is linked to progress in the technical and social division of labour. Various examples are given, one concerning the Italian Renaissance and the use of perspective in architectural drawing (events related to a new form of division of labour and new organisation of construction work). Another concerns technical drawing in the field of mechanical engineering from the nineteenth century to the present day. The trend towards ever greater precision is due not only to the increasing complexity of products but also to developments in the Taylorian organisation of manufacturing. The article concludes with considerations on present transformations induced by computer-aided design techniques.

TRADE UNION MEMBERSHIP AMONGST ENGINEERS AND EXECUTIVES: A HISTORY

René Mouriaux

The history of trade union membership amongst engineers and executives is marked by four main periods. Up until 1914, working-class rejection of engineers tended to draw a veil over the role of the first technicians' associations. From 1918 to 1936, move-

ments of technicians and intellectuals were in competition with each other and independent of trade unions. The June 1936 upheaval contributed decisively to the setting up of engineering trade unions which appeared almost as they are today by the end of the war. However, in the late fifties, the doctrine of the new working class, supported by the Neyrpic conflict and the May 1968 events, heralded a new black era which the present economic recession has made blacker still.

ENGINEERS AND TRADE UNIONS

Guy Groux

The article is the result of an inquiry into the role and importance of engineers within a large French trade union: the C.F.D.T. After examining the various historical transformations in engineers' relationship to trade unionism, the author goes on to study the attitudes of C.F.D.T. engineers to new technology in industry. According to the author, these attitudes should not be seen as dictated purely by ideology. They can often be explained by the engineers' place and status in the division-of-labour hierarchy. They also reflect their practical and varied experience of trade unionsim. These diverse, not to say conflicting, attitudes specifically influence new trade union policy on technological innovation in industry.

DRAFT THESIS ON «FRENCH ENGINEERS AND THE DEVELOPMENT OF ORGANISATIONAL STRUCTURES IN INDUSTRIAL FIRMS»

Henri Lasserre

The author begins by setting out the problem: the gradual disappearance of traditional attitudes of fidelity and loyalty and the emergence of new «professionalistic» attitudes. He discusses the meaning of «professionalism»: are the so-called «professionals» technocrats or are they a new breed? He goes on to consider the results of his own investigations amongst a cross-section of engineers from two large industrial firms in the Lyons area. He examines in turn their conceptions of what an engineer's work entails, their ideological/political leanings, the influence of the company's organisational structure and of social background. He compares his own findings with those concerning trade union membership of engineers. He concludes that certain engineers are becoming increasingly integrated into the social and ideological world of salaried workers.

SOURCES OF LEGITIMACY FOR FRENCH ENGINEERS

Stephen Crawford

This article examines the attitudes towards industrial authority of 114 engineers at two French firms, a traditional metal-working company and an electronics firm. It finds that in both firms, most engineers view the existing authority system as useful for achieving their own work tasks and career goals. Dependent on numerous other specialists and workers, they especially value the coordinating and representational roles that supervisors can perform. For these reasons, and contrary to theories of proletarianization, professionalization, and a new working class, engineers appear disinclined to question the legitimacy of bureaucratic authority.

ENGINEERS IN THE SOVIET UNION

Gilles Darnois
Bernard Mandagaran

From the very first days of the October Revolution which placed the Soviets in power to the terrible military-technical complex which constitutes the U.S.S.R. today, the question of the technological intelligentsia (and hence of engineers) has always been of major importance.

Forced to choose sides (red or white), engineers in the twenties and thirties were first the subjects of and then the participants in political struggles which often took the form of debates on technology.

Gradually, during the Stalin era, a new social being without precedent in history — the Soviet engineer — emerges. Were not Brejnev and Kossiguyn both trained initially as engineers?

Socialist realism and Soviet literature has granted technology and engineers a status which they do not have in the West. Even dissidents, first Kravtchenko then Soljenitsyn, choose engineers as the heroes of their novels, thus confirming that one of the keys to Soviet society is the relationship of technology to politics.

IS ENGINEERING A CAREER FOR WOMEN?

Josette Cachelou

The personal (intellectual and physical) qualities required to make a successful engineer do not depend on a person's sex. Society, however, assigns different roles to men and women, though these roles change over the years. It is this social pressure (which changes as attitudes change), together with the needs of the economy, which condition the presence (or absence) of women in

a particular career, and their relative influence in that field.

In France, three periods are important for women engineers:

- 1900-1940: the pioneers.
- the post-war period which saw an influx of women into certain areas of engineering.
- the present period, in which women engineers share a common life-style ideal which corresponds better to women's aspirations than in the past.

Present trends give a good idea of what women engineers may be like in the future.

FICTIONAL WRITINGS BY ENGINEERS

Georges Ribeill

The work currently being carried out to compile a bibliography of the extraordinary writings of engineers serves to outline some characteristic features of the dreams, fantasies and ideologies of a social group defined by their extremely rationalistic training and education: a tendency towards positivism and «universalism», a desire for physical harmony and social equilibrium. Their attitudes to the conflicts and contradictions of empirical physical and social reality — often confused and chaotic — are logical and conciliatory.

FROM MANUAL WORKERS TO ENGINEERS: THE DEVELOPMENT OF THE *ÉCOLES D'ARTS ET MÉTIERS* AND THE ROLE PLAYED BY FORMER STUDENTS

C.R. Day

The *Ecoles d'arts et métiers* were set up at the beginning of the nineteenth century (Châlons 1803, Angers 1811) for the purpose of training workers and foremen. As industrialisation in France proceeded, other schools were set up in Aix-en-Provence (1843), Cluny (1891), Lille (1900), Paris (1912), and Bordeaux (1964). During the second half of the nineteenth century, many former students were promoted to engineers in the workplace but the formal title of «arts et métiers» engineer achieved by passing a diploma was only instituted in 1907. In 1945, the Arts et métiers schools were given university status, and in 1974, the Ecole Nationale Supérieure d'Arts et Métiers (E.N.S.A.M.) became a «grande école». Numerically, E.N.S.A.M. is the largest engineering school in France with over 700 graduates a year. The Association of Former Students (1847), with approximately 25 000 members, has always been a great protector of tradition.

«Gadzarts», is an association of mutual assistance but most of all a pressure group seeking to raise standards and hence enhance the prestige of these schools.

THE TRAINING OF ENGINEERS IN GREAT-BRITAIN AT THE END OF THE NINETEENTH CENTURY: TWO EXAMPLE IN MANCHESTER

Anna Guagnini

In the nineteenth century the most prestigious institutions of higher education in England were strongly non-vocational. There was no tradition, for example, of theoretical engineering comparable with that of France. Yet, from about 1860, a few institutions of very different character began to be established, most notably in the provincial industrial towns. How did these new institutions define their status and role within the social structure of the industrial areas, and how did they develop their internal structure in an attempt to provide a suitable kind of education for the industrial professions of the future? Manchester, where two institutions of higher education were founded in the mid- 19th century (Owens College and the Manchester Technical School), offers an interesting opportunity for examining the evolution of the internal structure of the new generation of schools, their developing relations with the local community, and the process of specification and differentiation of the aims and characteristics of the institutions themselves.

FROM SPECIAL SCHOOL TO TECHNICAL UNIVERSITY

Peter Lundgreen

The history of technical schools in Germany prior to 1870 is marked by the conflict between education leading to employment in the civil service and education leading to employment in the private sector. Prussia adopted the French model of the special schools set up in the XVIIIth century, whereas the rest of Germany opted for polytechnic colleges. During the 19th century, the raising of standards in science and the efforts made by the German Association of Engineers gave technical studies advanced education status, leading to a State diploma in technology. After 1870, the new advanced technical colleges began to resemble universities more and more and finally obtained the right to award doctorates. This assimilation has culminated in the present technical universities which include social sciences in their courses.

ENGINEERS, DESIGNERS AND THE OTHERS... WHO WILL CREATE AND DESIGN THE INDUSTRIAL PRODUCTS OF THE FUTURE?

Jean-Louis Monzat de Saint-Julien

Who creates new products? There is no easy answer. Depending on the industry, the conception and design of new products is of greater or lesser importance. However, it is a question of fundamental importance for the economic future of any country. In France, there is a deep chasm between «culture» and «industry», between creation and production. Whereas, in fact, they should be thought of as the first two steps of a dialectic movement leading towards global «reunified» culture. The author concludes by making some suggestions to help achieve «reunification».

HOW ENGINEERS UPDATE THEIR SCIENTIFIC AND TECHNICAL KNOWLEDGE

Jean Michel

The importance which engineers accord to keeping their knowledge (both individual and collective) up to date is obvious from a study of the history of the training and professional practice of engineers. The example of the engineers graduating from the Ecole des Ponts et Chaussées shows how a system for updating knowledge, based on confrontation of individual experience, reciprocal teaching and self-education, works. This system involves the whole Corps of engineers, thus strengthening its unity and identity.

Recent years have seen the development of «ongoing training» (formation continue) for engineers. Ongoing training is now an integral part of their general education and is based, too, on engineers' mutual responsibility for collecting and diffusing new knowledge, and for acquiring this new knowledge.

Present controversy centres on the relations which should be established between the productive sector (industrial firms, engineers at work) and the teaching establishments (colleges, instructors, student engineers...), and on what the training of engineers should actually be.

THE PARADOXES OF THE ENGINEER

Jean-Louis Le Moigne

The concept of the engineer remains surprisingly unchanged over the centuries, in spite of the many varying definitions of engineers put forward. The method of opposing paradoxes constitutes a useful diagnostic tool for seeking out the range of possibilities open to the engineer of today or tomorrow : this conceptual liberation has many consequences in educational, cultural, technical, social, economic, administrative and political fields. They all require a renewal of the epistemological frameworks of reference enabling the «great creative science» which is the «Art of the engineer» (according to the apt and paradoxal phrase coined by E.T. Dyton) to develop freely : an epistemology which frees the «Sciences of Design» from the analytical straight-jacket in which «applied positivism» has held them for over a century.

THE ENGINEERING PROFESSION IN THE PAST AND PRESENT. A DOCUMENTARY STUDY ON THE TRAINING OF ENGINEERS, AND THEIR PLACE IN INDUSTRY AND SOCIETY

Annick Ternier

The first part of the article refers to works on the subject and is intended to guide readers in how to use the bibliography given at the end. The general theme is treated under three headings :

1. The social identity of engineers throughout history and in relation to other senior executives.
2. The training of engineers.
3. Engineers at work.