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Abstract

This article questions the adoption in some recent British publications of the German term *Technik*. This term is interpreted in Britain as 'third culture between science and the arts' to be taught at school. By means of a brief comparison of the historical roots of the education of engineers in Great Britain and Germany in the nineteenth century, the author shows the theoretical and institutional differences of the origins of technical education in the two countries. In particular, the German attempt at an institutional and conceptual synthesis of the two logics – of academic science and technical efficiency – is emphasised as the real background of the terminological differences. In the light of this analysis, the particularity of German *Technik* is given a different accentuation: in Germany, *Technik* is not a third culture, but the guiding concept of professional training (including higher education). The results of the comparative analysis, however, change the perspectives of educational policy-making inasmuch as it refers to the new concept of *Technik*.

1 The Terminological Problem and its political critique in Education

On 18 October 1976, the then Prime Minister, James *Callaghan*, declared in a now famous speech at Ruskin College, Oxford:

> "I am concerned [...] to find complaints from industry that new recruits from the school sometimes do not have the basic tools to do the job that is required. I have been concerned to find that many of our best trained students who have completed the higher levels of education [...] have no desire or intention of joining industry [...] There seems to be a need for a more technological bias in science teaching that will lead towards practical applications in industry rather than towards academic studies".[1]

A paper published in 1977 by the Department of Industry attributes this disturbing development to a "cultural peculiarity" of the British:

> "Britain has a two culture system based on the distinction between arts and science, whereas continental society distinguishes a third culture in Technik (or the art of making things). Partly because of the lack of a separate technical culture in Britain,

> ‘pure’ science has a higher status then ‘applied’ science, and academic work a higher status than vocational”.[2]

The train of thought in which the extraordinary use of the German term *Technik* appears as a continental phenomenon is further clarified in an article published in Higher Education Review in 1979, significantly entitled: “Technik – the relevance of a missing concept”.[3] In this paper the authors – an Englishman and a Swede – question the way the closely related terms ‘science’ and ‘technology’ are generally used as common collective term. This close connection leads, in their view, to a lack of terminological clarity, giving rise to a misunderstanding of what used to be referred to as “the useful arts of manufacture”. From an educational point of view, however, the vagueness of the term leads to false conceptions in the professional training of engineers.

To avoid terminological misunderstandings, the authors propose the introduction of a neologism

> “which would help improve understanding of the activities and policies connected with manufacturing, engineering and the educational process which is suitable for work in both”.[4]

The new term is the German word *Technik*.

The term *Technik* is intended to cover the area in between ‘science’ and the ‘arts’ although the authors do point out that the semantic field of the German term does not entirely correspond to that of the English. The German *Technik* encompasses the functioning and manufacturing of things (artifacts) whilst including the (scientific) principles of the functioning of the artifacts. In this respect it differs from the English term ‘technique’, which denotes mere skill as opposed to scientific principles. The English term which apparently corresponds most closely with the German is the word ‘technology’, but this in its turn requires clarification.

German has its own literal equivalent to ‘technology’, i.e. *Technologie*, which orginally comprised the ‘theory and study of *Technik*’, just as sociology comprises the study of society and biology the study of living things. However, the word *Technologie* is seldom used in this sense except perhaps in the sphere of scientific theory where it may refer to a system of rules derived from explanatory theories.[5]

Instead, the inescapable influence of American culture has led to the applying of the American sense of the word ‘technology’, meaning ‘technical process’, to the German word *Technologie,* although this contradicts the logic of the language. As Fores & Rey ironically remark, no-one expects a sociologist to create a new society or a biologist a Frankenstein monster; why, then, should a technologist have to *produce* machines?

Many German users of the word *Technologie*, meaning 'technical process', justify this linguistic usage in terms of the increasing complexity and the scientific nature of the technical processes. The connection and interaction of a large number of individual techniques, the combining of which is increasingly based on scientific theory, gives rise to the need for a new term since the word *Technik* is insufficiently academic[6]. *Technologie* is then defined as "system-oriented rational *Technik*" or "methodologically rational processes of system control".[7]

Fores & Rey regard this development as an example of the regrettable spreading of conceptual poverty and lack of precision in the use of English. For them, the German use of language is closely related to a different understanding of general culture (*Allgemeinbildung*). In German, the division is made not so much between 'science' and 'humanities'– both can be summed up in the term Wissenschaft – but rather between science (*Wissenschaft*), *Technik* and art (*Kunst*) as three separate areas of culture and education. Thus, from the start, a rash of amalgamation of *Technik* and science is less likely. However, any amalgamation of *Technik* and science that might be implied by the morphological form of the word 'technology' is liable to result in the thus designated subject matter being degraded to a mere appendix of the natural sciences, to a second class science. This, the authors consider, has directly negative repercussions on the contents of engineering courses and, one may well add, on the teaching of technology at secondary school.

This way of thinking is not simply philological or terminological hair-splitting. The excerpt from the Department of Industry publication quoted earlier shows the direct application of those ideas to educational policy-making. Yet it is possible to quote further from the range of texts which make reference to this train of thought. For instance, the 1980 Finniston Report on the state of the engineering profession in Great Britain says at one point:[8]

> "There is no cultural equivalent in Britain, and hence no basis for according similar esteem to the European concepts conveyed in German by 'Technik'– the synthesis of knowledge from many disciplines to devise technical and economic solutions to practical problems. The 'third culture' (alongside science and art), which underlies the concept of the engineering dimension, is well understood in Continental Europe, Japan [...] There is too the misleading national tendency to regard engineering as a subordinate branch of 'science' to be corrected. Action to this end is needed in the educational system".[9]

It would be possible to reflect further on the amazement a specialist in comparative education feels at a comparison between Germany and Britain which deduces such a direct connection between terminology, culture and economic prosperity. Instead, however, I shall investigate this hypothesis by making a

historical and comparative analysis of the training of engineers in both countries. The investigation aims at correlating the postulated "cultural peculiarities" with the concrete educational structures of the two countries, thus contributing towards making the explanatory model more exact. Over and above this specialised viewpoint, the analysis may serve as an example for the way in which a more precise comparison of phenomena in the sphere of educational research can shed significant light on the assumptions of educational policy-making.

2 The Establishment of Engineering Training in Germany

During the nineteenth century in Germany, the *Technische Hochschule* (technical university) could be seen to be developing on the lines of the *École Polytechnique* in Paris. By the end of the nineteenth century there were nine such *Technische Hochschulen* in Germany.

The growth of Engineering as an independent field of science ran parallel to the growth of the *Technische Hochschule*. This development was not a matter of course and took place in the face of bitter opposition from the 'classical', neo-humanist orientated universities, which themselves integrated the sciences into the domain of the Faculty of Philosophy, without much difficulty. This explains why members of the university regarded the newcomer with distrust and displeasure, for the institution which had originally been conceived of a higher technical school was developing not simply into a specialised technical college – as was partly the case in France – but into a *universitas scientiarum technicarum* despite the fact that it was more closely associated with economic applicability than *Humboldt's* concept of the university would permit.

The dispute was decided in 1899 when the Emperor himself insisted that the *Technische Hochschule* should be granted the right to award doctorates, a right which finally guaranteed its status as an academic institution. This intervention on the part of the monarch symbolized the outlook of the political leader of the time expressed by a high-ranking Prussian civil servant as early as 1824:

> "Where science is not introduced into trade and is not made the basis of production, there will be no progress".[10]

What this actually meant for the state within the framework of liberal economic system induced another Prussian state official to make a statement which has been frequently quoted:

> "In view of the danger of for ever being restricted by the efforts of the more advanced west European industrial countries the assistance which can be proffered by the state is contained in one single word: education".[11]

In the meantime the state pressure had only managed to achieve the upgrading of the *Technische Hochschule* because representatives of the engineering sciences had succeeded in finding a theoretical basis to prove their discipline was both a specifically technical and scientific subject and a synthesis between scientific theory and empirical experience; more particularly, they had defined the limits dividing it from the applied sciences. It is in this point that the German development clearly differs from the concept of the *École Polytechnique* in Paris, which was committed to the paradigm of the natural sciences or, to be more precise, of mathematics. However, towards the middle of the century, German engineering scientists such as Redtenbacher and Karmarsch had already been calling for equal treatment to be given to mathematical and scientific knowledge and methods, on the one hand, and to technical and constructive learning, on the other. From the 1860s on, these demands were offset by the desire to make the study of engineering more academic in order to ward off the despicable nickname "mechanics' academy" (*Schlosserakademie*) – towards the end of the century, however, the technical sciences were again becoming noticeably more self-confident and refusing to let the scientific basis of their subject be judged by the amount of mathematical theory. Instead, the development of independent, experimental methods differing from those of the natural sciences and more in line with the necessities of industrial practice was stressed.[12]

This emphasis on the "academic" side enabled German engineers to achieve a relative degree of social recognition though, owing to the unchanging monopoly of the legal profession within the German economy and administration, their social position never reached that of engineers from the *Grandes Écoles* in France.

3 Engineering training in England in the nineteenth century

In comparison with developments in Germany and France engineering training in England remained somewhat informal during the nineteenth century. It took place outside the universities and was more a vocational than a professional training. Extensive theoretical knowledge was not regarded to be imperative.[13] Technical universities on the lines of those in France and Germany did not emerge, and the classical universities were hesitant in opening the universities to the natural sciences. The foundation of new universities which cautiously introduced the applied sciences was an attempt to bypass the resistance of the traditional universities. Efforts were made to meet industry's growing demand for a scientifically trained workforce – a demand made yet more acute by the emigration of scientists to the dominions – by attracting an "influx of trained scientists from the continental countries particularly Germany"[14].

At the beginning of the twentieth century there were eight times more students in science and technical departments in Germany than there were in England.[15]

The fact that the second industrial revolution which set in at the end of the nineteenth century was based on scientific technology (chemistry and electrotechnics) caused English social historians to conclude:

> "Britain 'won' the First Industrial Revolution decisively, but it can be argued that she 'lost' the Second. The key to this may be found in the fact that 'the output of technological progress was a function of the input of scientifically qualified manpower...'".[16]

For the authors, the answer to the question posed in the title of their book was: "The 'English sickness' or 'British disease' was educational in its roots"[17].

4 The epistemological interpretation of the divergence in the historical development

Is it possible to relate this assessment of British social historians to the above mentioned terminological issue? This question can be answered affirmatively if one takes into consideration the difference in approach between scientific and technical thinking.

The primary object of *science* is the investigation of the cause and effect relation or, as *Humboldt* put it, the search for *truth*. The primary object of *Technik*, however, is the search for the economically optimal relation between the end and the means, in other words for optimal effectivity. By the end of the nineteenth century at the latest these two systems of thought had entered a complex relationship of give and take. Areas arose where the two systems overlap, as in the engineering sciences in Germany and in the applied sciences and technology in Great Britain. These overlapping areas do, however, retain their own specific national characteristics and it is here that the key to the understanding of the different socio-economic developments is to be found.

Whilst in Germany the *Technische Hochschule* suceeded in achieving a synthesis between these two systems of thought at an institutional level as early as the nineteenth century, British attempts to reach a direct integration of technical and applied ideas were faced with great difficulties in the academic structure of the universities.[18] As was the case at the classic, *Humboldt*-type university in Germany,[19] the autonomous British universities attached great value to their freedom from economic purpose. The promotion of advanced technical education, which was emphatically demanded by the Percy Commission at the end of the war, was forced to revert to another line of tradition, to the technical college.

This institution was, from the very start, intended to be a direct answer to the needs of industry.[20] It is not possible, however, to compare this pattern of advanced technical education, in which the modern Polytechnics are embedded, to the German *Technische Hochschule*. Amongst other things, it does not enjoy the autonomy which characterises the universities; nor is its relation to the scientific system (i.e. to basic research) very highly developed.[21] Its problem of academic and social prestige are, thus, predetermined.[22]

The academic recognition of the *Technische Hochschule*, which eventually occurred, was not so much a question of the "cultural" upgrading of the position of *Technik* in society, but rather the result of adjusting the *Technische Hochschule* to correspond to the academic standards of the university. This was particularly true in the basic science subjects, which strove to disperse the impression that they were second class 'applied sciences'. In contrast to the situation in France, the upgraded German *Technische Hochschule* continued to retain its relation to the system of ideas comprised in *Technik*.

That the apostrophising of German *Technik* as a 'third culture' is, in this form, a misunderstanding on the part of the British authors can be shown very simply. Presuming that culture and the objects of general (school) education are closely connected to one another, any foreign observer of the German school system must be struck by the fact that the alleged 'third culture' (*Technik*) either does not appear at all on the West German secondary school curriculum or is merely allotted an entirely marginal position. The amazement of German colleagues at the exaggerated esteem the term *Technik* enjoys in British publications is matched by the amazement of English colleagues at the enthusiastic praise of specialists in technical studies at how widespread 'school technology' is in English schools. The envy they have come across among members of the profession in German has led English specialists to the surprising conclusion:

> "In spite of what we hear and read about German *Technik* it does not in fact have a strong tradition in the German schools...".[23]

The confusion can be resolved somewhat if one considers where *Technik* is taught in West German schools and what function it fulfils. It can be found in the 'practical' type of secondary school, the *Hauptschule* (the equivalent of the former English Secondary Modern School), where its role is not so much to promote 'culture' as *pre-vocational socialisation*, as is made plain in the name given to the subject 'labour studies' (*Arbeitslehre*).

Once this has been clarified our explanatory model for interpreting the observed phenomena can be further differentiated. *Technik* is, as a matter of course, a theoretical frame of reference for the productive sector of society as well, in the extended sense, as for the entire economic system. Up until now,

primary and secondary education in the Federal Republic of Germany has adhered solely to the 'scientific' or 'academic' school of thought, i.e. it has been stressed that learning at school is to be free of all economic ends or purposes. These reference structures have not, as yet, been shaken despite the pressure of the engineering sciences, which are striving to convey their own synthesis of science and *Technik* from the universities to the schools by introducing school technology. A similar synthesis of *Technik* and science (the balance between the two elements differs) can be found as a reference structure in the field of vocational training. As far as a system's theory is concerned, this is an area where the school system and the economic system overlap and it is here that *Technik* plays a key role as a term of reference, though not in the sense of 'culture', but as an organisational system within the production process.

Thus, at the end of this analysis, we may conclude that the term *Technik*, so highly recommended by British authors, does not actually represent a "third culture" in Germany though it is an important conceptual point of reference for the professional training of engineers and for the whole of the vocational education system. The structure and position of these in Germany does, indeed, vary significantly from the situation in England. The new light thrown on the terms of reference by means of a more precise comparison also produces a change in the perspectives of educational policy making programmatically connected to these terms. In other words, for the present case the comparison point to the educational policy-making problem of the institutions providing vocational qualifications rather than to the problem of changing national mentality.

Notes

1. Published (1976) in *The Times Educational Supplement,* 22.10.1976.
2. Department of Industry (Ed.). (1977). *Industry, Education and Management.* London, quoted from: School Technology Forum (1980), occasional paper (3). *Technology and the Core Curriculum*. Nottingham: NCST.
3. Fores, M. & Rey, L. (1979). Technik: the relevance of a missing concept. *Higher Education Review*, (11), 43–57.
4. Fores & Rey 1979: 43.
5. Cf. Ropohl, G. (1977). 'Was heisst "Technologie"? Terminologische Bemerkungen zu einem umstrittenen Begriff. *VDI-Nachrichten*, (6), 9.2.1977, 11.
6. On the level of educational policy-making the substitution of *Technologie* for *Technik* is obviously intended to raise the prestige of the practical contents of the educational system as well as of those providing vocational qualifications: in France this was made quite clear in the 1971 Framework Act on vocational education system, which tried to turn *enseignement technique* into the more dignified *enseignement technologique*.
7. Lenk, H. (1971). *Philosophie im technologischen Zeitalter* (p. 134). Stuttgart.

8. Cf. also Musgrave, P.W. (1967). *Technical Change, the Labour Force and Education: a study of the British and German iron and steel industries 1960–1964* (p. 226). Oxford.
9. Secretary of State for Industry (1980). *Engineering Our Future. Report of the Committee of Inquiry into the Engineering Profession* (pp. 24 ff.). London: HMSO.
10. Quoted from Manegold, K.H. (1981). 'Die Akademisierung der Technik. Bildung und Ausbildung des Ingenieurs im 19. Jahrhundert. In P. Lundgren (Ed.), *Zum Verhaeltnis von Wissenschaft und Technik. Erkenntnisziele und Erzeugungsregeln akademischen und technischen Wissens* (S. 101) (Report Wissenschaftsforschung, 7). Bielefeld: Klein.
11. Quoted from Manegold 1981, as above.
12. Cf. Manegold 1981: 119.
13. Roderick, G.W. & Stephens, M.D. (1978). *Education and Industry in the Nineteenth Century: the English disease?* (pp. 130 ff.). London; cf. also Musgrave op. cit.: 99. The difference in the formal qualifications of engineers becomes immediately evident in a comparative investigation of business structures (hierarchy of labour force), cf. Maurice, M., Sorge, A. & Warner, M. (1980). Societal differences in organising manufaction units: a comparison of France, West Germany and Great Britain. *Organisation Studies*, (1), 59–86.
14. Roderick & Stephens 1978: 106.
15. Roderick & Stephens 1978: 107 state the ratio to be 3000:25000.
16. Roderick & Stephens 1978: 153 with reference to Hobsbawm, E.J. (1974). *Industry and Empire*, (p. 174). Harmondsworth: Penguin.
17. Roderick & Stephens 1978: 172.
18. Burgess, T. & Pratt, J. (1970). *Policy and Practice: the colleges of advanced technology* (p. 9). London.
19. Cf. Manegold op.cit.: 104 and Musgrave op. cit.: 125.
20. Cf. Burgess & Pratt op. cit.: 1.
21. Cf. Burgess & Pratt op. cit.: 4.
22. Cf. Musgrave op. cit.: 168, 239.
23. The German Technik-school technology in Germany (1982). *School Technology*, *15,* (4), 10.