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Edited by - Robert Fox and Anna Guagnini

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## Introduction

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*Robert Fox and Anna Guagnini*

This volume treats the development of higher technological education and its relations with industry in some of the main industrialized and industrializing countries of Europe between the mid nineteenth century and the Second World War. Already, by the beginning of this period, virtually all countries made some provision, often of an elaborate kind, for the preparation of engineers, chiefly for service in the Army and both the private and public sectors of mining and construction. But what was new about the second half of the nineteenth century was the emergence of institutions and courses that aimed specifically to prepare technical employees for posts in manufacturing. In this period, as several of the following chapters show, it is impossible, and it would be misleading, to separate completely the burgeoning world of the new breed of engineers from the older traditions of military and civil engineering: the threads of continuity are simply too strong. Nevertheless, here, it is the former that receives more attention.

Essentially, the contributions to *Education, Technology and Industrial Performance in Europe* were written with two main objectives. The first was to show how the common task of providing for advanced technical instruction in universities and other institutions was broached in a number of very diverse economic, political, and social contexts. In doing this, all the contributors were wary of the trap of analyzing the interaction between education and industry in terms of simple causal relationships. They sought instead – and this was their second objective – to insist on the complexity of the circumstances in which education and industry have related to each other since the mid nineteenth century and to stress the often conflicting roles of professional bodies, governmental authorities, and other mediating agencies.

Although most of the contributions are concerned with individual countries, the organization of the volume emphasizes its comparative character. There can be no suggestion that this is a novel approach. But the collective thrust of the essays is somewhat different from that of most earlier studies. For well over a century, the comparative method has been

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Excerpt

[More information](#)2 *Education, technology and industrial performance*

used predominantly to bring out the distinctiveness of different national patterns in education, often for the purpose of identifying the causes of economic success or failure. We believe that there is a dangerous one-sidedness in this way of handling the evidence. To counter it, we have all given serious consideration to the similarities in the conditions in which advanced technical education developed in our various countries from the later nineteenth century. As we would insist, the existence of these points of similarity is not at all incompatible with the palpable diversity of the results that were achieved, but it does serve as a reminder that this diversity can only be explained by reference to the complex interweaving of multiple circumstances, rather than to a single root-cause.

The similarities to which we refer were nowhere more evident than in the near-simultaneity of attempts to reform technical instruction in the forty years or so before the First World War. All the contributions touch on this period, in which the quest for modernization and the advancement of technical education were seen, throughout Europe, as two sides of a single coin. Everywhere – and Arthur Donovan’s ‘transatlantic perspective’ shows that this was true of the USA as well – the late nineteenth and early twentieth centuries were a period in which the welfare of industry was routinely stated, and widely believed, to depend on the availability of courses and institutions capable of preparing large numbers of potential employees for careers in industry and commerce.

The case for technical and commercial education was put most vociferously by educationists, for reasons (by no means all of them economic) that are easily identified. In all the cases discussed here, concern with the state of education at every level grew to an unprecedented pitch during the second half of the nineteenth century. In contexts as diverse as the German states, Italy both before and in the early stages of unification, and France under the Second Empire and then the Third Republic, education assumed a central role in movements for political unity and economic and cultural renewal, and there was no country in which educational reform did not have its vociferous champions. One consequence of this was a marked expansion of the teaching profession at just the time when industry entered its own phase of dramatic change. As the growth of the profession gathered momentum, a new generation of teachers in the universities and other sectors of higher education was only too ready to consolidate its position and future prospects by seizing the opportunity of serving what they eagerly advanced as the needs of industry. In a complementary vein, the spokesmen for the institutions that employed these teachers honed a scarcely distinguishable rhetoric justifying the proliferation of industrially relevant courses, schools, and institutes for teaching and research.

Cambridge University Press

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Excerpt

[More information](#)

It is not hard to understand why the rhetoric of the educational lobby struck a responsive chord in the main industrial nations, those we characterize in part I as the pace-makers: Britain, France, and Germany. But it is one of the most important conclusions to emerge from this book that the needs of industry were invoked just as confidently and with no less a response in the four smaller nations discussed in part II. The cases of two of these nations, Belgium and Sweden, which industrialized intensively from an early stage though on a necessarily lesser scale than the 'giants', make the point clearly enough. But even more striking instances were the manufacturing regions of Spain and northern Italy. In both of these regions, despite some moves towards modernization in the mid-century, industrialization was in no sense advanced, and the demand for technical manpower remained modest, even in 1900. Nevertheless, educational initiatives were made there as promptly as anywhere.

The similarities between the different countries were as apparent in the impediments to industrially related education as they were in the factors leading to growth. Among the constraints that were felt everywhere, the most pervasive was cultural prejudice, expressed in values inimical to manufacturing and trade and hence also to vocational instruction. In a considerable secondary literature on this theme, Fritz Ringer's analysis of the influence of the purist academic culture in European education is particularly notable.<sup>1</sup> It treats the failure of the new departures in technical and commercial instruction to win the status associated with curricula founded in the classical languages or abstract mathematics. In Ringer's view, the situation only began to change about 1930, when what he calls the 'late industrial phase' in the relations between education and the economy began to emerge. Even in the 1980s, however, the argument about the retarding weight of high literary culture has recurred, being used with special force in discussions of Britain. Here, Martin Wiener and Correlli Barnett have both founded their explanations of Britain's industrial decline since the later nineteenth century on the power of an anti-utilitarian bias in British culture which, as they argue, has persistently condemned new industrially oriented courses and institutions to an inferior place in public esteem.<sup>2</sup>

The evidence emerging from this volume leaves no doubt that Britain, in this respect, was far from unique. Similar considerations are relevant not only to most other European countries but also, as Donovan's account of American trends to 'academization' shows, the USA. Cultural prejudices, it seems, were ubiquitous and they necessitated some reaction from those who resented their influence. In Italy, the prevailing cultural style, promoted in the higher secondary schools through the emphasis on the study of the ancient languages, was seen by many critics

Cambridge University Press

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Excerpt

[More information](#)4 *Education, technology and industrial performance*

as at least partially responsible for the poor state of the country's scientific and technical education.<sup>3</sup> The same was true in France, where the influence of a high academic culture founded on Latin and philosophy was challenged only by the variant favoured in some of the most advanced classes of the *lycées*. In these classes, the emphasis was placed on the equally 'pure' pursuit of mathematics, studied mainly as a means of entry to the most prestigious technical *grandes écoles* but also as a training for the mind and a foundation for careers which, if successful, would be administrative rather than technological in character.<sup>4</sup> Even in Germany, the advocates of modern forms of technical and commercial (or 'realistic') education had to struggle against the other-worldly values of the 'mandarins' of the late nineteenth and early twentieth centuries, who wielded their high neo-humanist culture in defence of the dominant position they had come to occupy in the German universities and the learned professions.<sup>5</sup>

Another circumstance that affected the new departures in technical education lay in the need to incorporate, or at least take account of, the older traditions in the training of civil engineers and others destined for the public services, the Army, or private consultancy. In some cases, as in Belgium, Sweden, and the Italian states before unification, adjustment was achieved through the piecemeal modernization of existing institutional structures; in France and Spain, on the other hand, completely separate structures had to be created. But whatever route the advocates of change chose to follow, they normally had to face indifference or even (where vested interests appeared to be threatened) hostility. Their adversaries included governments, institutions, or interest-groups that saw the training of engineers for civil and military appointments as a more important or nobler activity – certainly one that should remain unsullied by the confusingly different requirements of the industrial sector.

It must be said that, on this score, Sweden emerges as something of an exception. Göran Ahlström's account of the fruitful integration of academically qualified engineers in Swedish industry, especially in 'big' industry, points to the high social standing enjoyed both by technical education and by the engineering profession. A more common picture is that presented by André Grelon, whose chapter demonstrates the enduring and damaging consequences of the defensive demarcations between different types of engineering education in France: as Grelon shows, the established privileges of the various technical *corps d'état* bred a profound suspicion of the new industrial engineer. Where, as in Britain, there was no tradition of a powerful state corps of engineers, the friction took a different form. In this case, it was a strong 'aristocracy' of mechanical engineers that remained most stubbornly loyal to the traditions of

Cambridge University Press

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Excerpt

[More information](#)

apprenticeship. They were conspicuously slow to accept the methods of training favoured by academic engineers, and it was only just before the First World War that degrees became accepted currency in Britain in the *cursus* leading to membership of their institutions.<sup>6</sup>

Despite the powerful and essentially similar impediments to change that had to be faced everywhere, the seeds for a major readjustment were too widely sown to allow the reform movement to fail. Yet, as a growing body of case-histories confirms, the ways in which reform proceeded were extraordinarily diverse. It was consequently an obvious task for the contributors to *Education, Technology and Industrial Performance in Europe* to determine how the seeds of change came to fruition in such different ways and with such different degrees of success in the various contexts they chose to consider. In tackling that question, they turned to an examination of economic, political, and cultural contexts which they saw as crucial in fashioning not just the course of educational development but also that of industry. As they did so, it became increasingly difficult to conceive of education as having in any significant sense a direct causal effect on industrial performance. Likewise, the notion that industry had been a single or even a dominant driving force in the progress of technical education lost much of its plausibility. Instead, both education and industry appeared as the products of the same multi-faceted social and economic background that easy generalizations about the relations between education and industry all too frequently gloss over.

A clear illustration of the complexity that general conclusions in this area must accommodate emerges from the contrast between the results obtained in three national contexts that were characterized by persistent and deep-rooted political fragmentation: Germany, the USA, and Italy. As König argues, competition between the individual *Länder* of the German Empire fostered a constructive spirit of emulation. This helped to endow the *Reich* with the stimulatingly diverse network of *Technische Hochschulen*, *Mittelschulen*, and other lower-level technical schools that provided German industry with large numbers of technical staff at all levels. The pattern was not unlike that in the USA, as described by Donovan, where competition between the states was a powerful stimulus to the multiplication of opportunities for technical instruction. In the Italian peninsula, too, a long tradition of fragmentation created the conditions for the existence of as many as seven university-based engineering schools. As Anna Guagnini shows, these institutions were the fruits of the universities' determination to consolidate their engagement in the training of engineers. Here, however, unification did little to foster the modernization of the existing structures. Consequently, the growth of the schools about the turn of the century was seen not as a matter for con-

Cambridge University Press

0521381533 - Education, Technology and Industrial Performance in Europe, 1850-1939

Edited by - Robert Fox and Anna Guagnini

Excerpt

[More information](#)6 *Education, technology and industrial performance*

gratulation (as it was in the USA) but rather as an object of criticism: the schools were attacked for producing too many highly qualified engineers at a time when the opportunities for employment were severely limited. To explain this contrast between Germany and the USA on the one hand and Italy on the other, the detailed analysis of the ways in which the products of higher education were absorbed by the industries of the three countries is essential. As such an analysis would surely show, despite apparently comparable political conditions, Italian industry had not yet developed sufficiently to allow the exploitation of a relative abundance of educational provision that was, for Germany or the USA, a source of strength.

The two contributions to part III broach another aspect of the interaction between education and industry. Both of them are concerned with the exploitation of knowledge in important science-based sectors of manufacturing, and both of them illustrate the inability of education, in isolation, to stimulate industry. Robert Fox's study of the training and careers of French electrical engineers between 1880 and 1914 shows how little a plentiful supply of qualified manpower could do to advance an industry hamstrung by economic depression, excessive fragmentation, and crippling unfavourable legislation on tariffs and patents. In the electrical construction industry as in organic chemicals, France was so 'invaded' by foreign, in particular German, interests that the stimulus to independent innovation, which might have created a demand for scientific expertise, was simply not there. Mari Williams's essay also brings out the difficulty of harnessing the fruits of educational initiatives in the advancement of industry. As she shows, the lack of suitable education for recruits to the precision instruments industry in Britain and France was commonly cited, in the first decade of the twentieth century, as a cause of the failure of those countries to keep pace with Germany. But when eventually formal educational structures were established, the industry derived little benefit from them. The small size of British and French companies made it tempting for the owners to continue to rely on their own scientific know-how or on that of occasional external consultants and, even after the First World War, to staff their small design offices with men trained by the traditional route of a trade apprenticeship.

In drawing attention to the inevitable corollary that education and industry cannot be interpreted as two poles in an isolated relationship with each other, it is not our intention to depreciate the stimulus which, in certain circumstances, manufacturing was capable of exerting on the process of educational reform. It must be said, however, that even in Britain, France, and other countries that had long-established industrial traditions, such support for technical education as was voiced in entrepre-

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Excerpt

[More information](#)

neurial circles did not emanate from a coherent or united philosophy. What we see in these countries and *a fortiori* in those that were industrially less developed, is something far from straightforward. Superimposed on general national characteristics in the development of technical education, there were, in all nations (in the USA as in Europe), recognizable regional patterns.

Naturally, these patterns were more noticeable in some countries than in others. In Sweden, for example, where they do not appear to have been particularly marked, the institutional structure of technical education had an uncommonly unified character, with the Royal Technical University (KTH) in Stockholm, Chalmers in Gothenburg, and other technical colleges forming part of a 'total system', as Ahlström describes it. But where regional patterns in education were strong, these can be traced back to political and economic circumstances of a highly localized nature, which were often suffused with tensions, in culture as well as politics, between the national centres of administrative power and the rising seats of economic activity. In most countries, as a result, there were examples of educational initiatives that owed little, if anything, to support from central government and a great deal to carefully constructed pressure-groups of industrialists, municipal and regional councils, and teachers.

The strength of local initiatives and pressures is brought out well in the contrast between the vision of a national educational need emanating from Madrid and the very different objectives fostered in the manufacturing regions of Catalonia and the Basque region, which Santiago Riera i Tuèbols sees as so debilitating in Spain's struggles to enter the modern industrial world between 1850 and 1914. In France too, the pattern was remarkably similar. As both Grelon and Fox observe, the Ecole Supérieure d'Electricité was founded in 1894 by the independent Société Internationale des Electriciens in the face of governmental attitudes that never went beyond the most grudging and parsimonious support. It was part and parcel of this gulf between local enterprise and central lethargy that the Institut Electrotechnique at the University of Grenoble achieved its relative prosperity and high reputation after 1904 through the intervention of a local manufacturer and engineer, Casimir Brenier. It was Brenier who supplemented the modest core funding provided by the Ministry of Public Instruction with a huge personal donation and the support he was able to secure from the local Chamber of Commerce and the municipal and departmental councils of Grenoble and the Isère.<sup>7</sup>

Guagnini's studies of Italy and England provide ample evidence of a similar degree of dependence on local enterprise. The kind of alliance between entrepreneurial, academic, and administrative interests that allowed the Istituto Tecnico Superiore in Milan to expand its teaching in

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0521381533 - Education, Technology and Industrial Performance in Europe, 1850-1939

Edited by - Robert Fox and Anna Guagnini

Excerpt

[More information](#)8 *Education, technology and industrial performance*

industrial subjects in 1862 is a particularly good illustration, but it had its counterparts virtually everywhere. In different countries and different regions, however, the nature of the alliance was always slightly different. Jean Baudet's contribution shows how in Belgium, for example, the founding of certain institutions of technical education was stimulated by the growing assertiveness of the Flemish minority in support of its own language and distinctive culture. Here, the decisive alliance, of a peculiarly Belgian character, was one between the Flemish working-class community and the Catholic Church.

In placing such a consistent emphasis on the influence of specific local conditions, albeit with due reference to more general patterns in the economy, culture, or politics, the authors of this volume have been conscious of the danger inherent in the type of finely focused contextualization they have attempted. Contextualization can lead all too easily to the formless accumulation of disconnected studies. However, we believe that such an approach offers the only way of achieving a main purpose of our collaboration, which has been to offer both specific explanations and a more generalized warning against easy universal prescriptions – for example, about the necessarily damaging effects of traditional culture, the dependence of education on a buoyant industrial demand, or the capacity of education to stimulate economic growth.

Finally, all the contributors to *Education, Technology and Industrial Performance in Europe* recognize the loose ends that remain. We have placed the emphasis on the *higher* levels of technical education and only to a lesser extent on the middle and lower levels. And rather little has been said about the *content* of the various engineering disciplines. On this latter point, there can be no doubt that in the period we have covered, from the mid nineteenth century to the 1930s, the various specialities within engineering underwent profound internal developments. They all became more dependent on sophisticated and expensive experimental techniques. The impact of such changes on curricula and, through them, on the academic character of schools and departments of engineering has yet to be determined. But it is clearly an essential task for historians to integrate these 'internalist' disciplinary considerations with the currently more familiar sociological approaches. No one would doubt the importance of the quest for status as one cause of the widespread process of 'academization' in technical education. But equally we cannot pretend that this motive alone provides a complete explanation of the drive to raise academic standards and the emergence of what König sees, in the German context, as an 'overtheorization' of courses in the *Technische Hochschulen* and a consequent mismatch between those schools and the industrial sectors they purported to serve.



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Excerpt

[More information](#)

We appreciate that, quite apart from the loose ends, readers who are looking for uncomplicated explanations of success or failure in the development of higher technical education and its relations with industry may find this a disquieting book. For while we accept that education (not necessarily of a specifically technical nature) has been an essential condition for economic prosperity for the last hundred years, we have stressed that educational provision should not be conceived as anything but part of a much broader mosaic of inter-related factors. Each factor can be expected to have only a limited explanatory power when viewed in isolation, and it is only by trying to embrace all of them together that historians and the policy-makers and analysts who use their work will achieve any real conviction. It is emphatically on the condition of the mosaic, rather than on that of its individual parts, that economic prosperity has always depended and continues to depend in our own day.

### Notes

- 1 Fritz K. Ringer, *Education and Society in Modern Europe* (Bloomington, Ind., and London, 1979).
- 2 Martin J. Wiener, *English Culture and the Decline of the Industrial Spirit, 1850–1980* (Cambridge, 1981), and Correlli Barnett, *The Audit of War. The Illusion and Reality of Britain as a Great Nation* (London, 1986), pp. 201–33.
- 3 Luigi Besana, 'Il concetto e l'ufficio della scienza nella scuola', in Gianni Micheli (ed.), *Scienza e tecnica nella cultura e nella società dal Rinascimento ad oggi* [*Storia d'Italia. Annali*, vol. 3] (Turin, 1980), pp. 1165–284.
- 4 On the high levels of mathematical skill required for entry to the *Ecole Polytechnique* and the abstract quality of the syllabus, see Terry Shinn, *Savoir scientifique & pouvoir social. L'Ecole Polytechnique, 1794–1914* (Paris, 1980), especially chapters 2 and 4.
- 5 Fritz K. Ringer, *The Decline of the German Mandarins. The German Academic Community, 1890–1933* (Cambridge, Mass., 1968), especially pp. 25–61.
- 6 Robert H. Parson, *A History of the Institution of Mechanical Engineers 1847–1947* (London, 1947), pp. 47–8, and Anna Guagnini's comment in this volume, pp. 36–7.
- 7 On the early history of the Institut Electrotechnique at Grenoble, see 'L'Institut – son histoire', in *Institut Polytechnique de l'Université de Grenoble 1900–1950* (Grenoble, 1950), pp. 11–116.

Cambridge University Press

0521381533 - Education, Technology and Industrial Performance in Europe, 1850-1939

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Excerpt

[More information](#)

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*Part I*

Setting the pace