

## 10 Management Models and Technical Education Systems: Germany and the United States 1870–1930

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### Introduction

It has often been suggested that there is a link between the development of engineering and the emergence of a management ideology in the United States. The latest contribution in this literature is Shenhav (1999), who argues that the scientific management model and the ideology of rationality, systems, and organization were invented and advanced by engineers in order to promote their professional interests. Others have studied how these ideologies were transformed into hegemonic management models as American engineers came to be the first group to define the management function as a career and profession (Fligstein 1990; Guillèn 1994). What has been overlooked in such studies is that management, being a context-dependent function, has to be sustained by various kinds of arguments and competence. In most cases, it is not likely that managers may convince anyone about their superior abilities or legitimate their position in the long run by referring to a single source of management knowledge or by relying on one kind of competence, be it American engineers or any other professional groups. There may be a wide variety of sources of knowledge and personnel for managers to choose from, and the interesting question is what kind of management positions are legitimated by what kind of knowledge, and whether there is a trend toward convergence across social contexts in such matters. Rather than focusing on one profession in one country, then, one must study how paral-

lel development processes in different contexts—for example, how engineers in Germany and the United States—use knowledge in different ways in order to develop a common identity and legitimate their actions. It is not sufficient, then, to focus on the role of the American engineering profession in the construction of modern management, and then look at European cases mainly as a laboratory for diffusion of Taylorism and other engineering-constructed American concepts of management. There is a need to study how European and other regions each developed their distinct systems for knowledge formation and legitimation of authority in management and also how they selected and educated their top managers. The focus in this chapter is on the contrast between Germany and the United States.

Although differently positioned, German engineers were equally influential in the development of organization practices in industry, but they provided a distinctly different kind of legitimation for management. The German engineering-executives (*Unternehmer*) came to see themselves foremost as experts in a technical field and representatives of family traditions and servants of national interests, whereas the American executives were *general managers* and legitimated their social role by emphasizing their scientific and organizational *status* (Hartmann 1959; Byrkjeflot 1998). The American engineering ideology was universalistic and with a managerial purpose, whereas the German ideology was more particularistic and linked to the nation-state. The American engineering ideas could travel more easily than similar ideas developed in Germany.

It was increasingly a requirement for industrial leaders both in Germany and the United States that they have a higher degree in education, and the industrialists in both nation-states were keen to arrange for their offspring to acquire an engineering degree. This was one of several reasons for the strong growth in technical education and the formation of engineering associations from 1870 to 1930. There was a stronger tradition for guilds and craft communities in Germany, and the movement for technical education would take a more collectivist character than in the American case.

Professions and professional associations, as well as education systems, are strongly influenced by states. States set the stage for the professional struggles for recognition taking place both in the workplace and within professions and occupational systems. The worldviews and actions of civil servants and politicians are responses to worldviews and actions taken by teachers, academics, businessmen, and professional practitioners. Such actors all

influenced the construction of management models and technical education systems. I will put emphasis on differences in organizational resources and worldviews among such groups of actors. The conventional story tells us that educational systems develop in predictable ways, and that what needs to be “controlled for” are variations in technical and economic development. I will present some empirical data that has led me to question this assumption, and further move on to discuss alternative explanations that relate to the effects of contrasting worldviews, coalition-building, and strategies among the various actors. I ask what factors were most important in each case: educational philosophies and institutional arrangements within the education system, industrial structures and business interests, or professional and governmental strategies? The failure to develop a direct career-path from apprenticeships and vocational schools into engineering may be one of the major explanations for the “managerialist” worldview of American engineers and top executives. The German states, as well as other states in Europe, have developed a more comprehensive and multiple-layered system for technical education. I will discuss the reasons for this, and what may have been the consequences of this for management and organizational practices.

Why do I focus on Germany and the United States? These countries represent important contrasts in managerial models and professional ideologies. They also represent alternative international models for economic development, work organization, and education. The more recently industrialized countries in Asia and other European countries have emulated both systems. There has been a movement away from the traditional German model toward the American model of management in Germany and Europe. Ringer (1992: 36) has argued that the first educational revolution in the world occurred in Germany. Whereas the educational revolution preceded industrialization in the German states, it was taking place along with rapid industrialization in the United States. Both economies were large and their engineering-dominated industries were involved in international competition early on. Their internal markets and technologies, and their positions in the international marketplace and technologies, were not identical but similar enough to justify a comparison. Germany and the United States clearly took the lead in engineering education and research from 1910 on, both in numbers of patents and engineers. The engineers took very prominent positions in industry, a position that German engineers have continued to hold until the present. Until now, the most frequently compared cases have been Euro-

pean nation-states such as Germany, Sweden, France, and Great Britain. It may be useful to focus more on the contrasts between the German and American cases and between Europe and the United States (Müller *et al.* 1987; Ahlström 1982; Landes 1986; Torstendahl 1982, 1993; Lundgreen and Grelon 1994).<sup>1</sup>

The educational systems did not develop independently of each other. Germany was looked upon as a kind of “second mother country” in the United States because of the German university (Rheingold 1987: 130; Röhrs 1995). The “scientific” curriculum in German technical education was a model for American educators from around 1860. Likewise, as the American machinery industries demonstrated their competitive strength, the interest in the “practical” features of American engineering schools spurred a movement for closing the gap between theory and practice in German engineering (Gispén 1989: 115–121). Industrialists as well as teachers and academic entrepreneurs advocated a direct emulation of laboratory instruction and other practical teaching methods in American engineering schools. A comparison of the formation of systems for industrial education may therefore also give a better understanding of the processes of international borrowing of organizational models and reform ideas in education.

### Outline of the Problem and the Argument

The term *engineering education* as used in the United States around 1925 had no direct equivalent in continental Europe, where *technical education* was used as a more inclusive term for the training of all ranks of specialists in industrial and building technology (Wickenden 1930: 751). *Technical education* was in Germany used to describe a wide variety of training and education institutions qualifying for jobs and specialties at several levels of the industrial hierarchy. Three quite distinct categories of technical education developed: higher, middle, and lower (Wickenden 1930: 751; Ahlström 1982; Lundgreen 1994). The American system also had a lower “vocational” and a higher “professional” level, whereas it was difficult to recognize a middle level. There was thus no link between the lower and higher levels and no alternative educational pathways into the higher ranks of the firm.

In two to three years the new middle schools for technical training in Germany were expected to produce the “connecting link between the uni-

versity educated engineer, on the one hand, and the foreman on the other,” as argued by the Cologne chapter of the Association of German Engineers (Kocka 1981: 105). The most impressive fact about the German system was “its comprehensiveness; it is applied to every occupation in which it is better for a workman to have it than be without it” (Dawson 1919: 103). A vocational orientation penetrated the school and corporation from the lowest to the highest levels, and there was also a great deal of horizontal specialization at each level. A nonacademic practical type of engineer competed with the traditional academic engineer for the same type of jobs at the upper hierarchical levels. In contrast to in the United States, both types of engineers originated in a school culture.

Higher technical education in Germany was the exclusive province of the *Technical Hochschulen* requiring the *Abitur* (high school diploma) from a nine-year high school and typically providing an eight-semester curriculum. At the other end was lower technical training, based on *Volksschule* and made up of part-time vocational schools for blue-collar workers and foremen. In between was a separate set of schools that had filled the gap between vocational and academic schools after the early 1890s. *Abitur* was not required for these schools. *Realschule* was the preferred track in secondary school and it was a prerequisite for admission that the student had an extended period of prior practical experience (Gispén 1989: 216; *Datsch Abhandlungen und Berichte* 1910, 158–161). Employers had articulated a preference for the more practical and specialized nonacademic engineers. The teachers from these schools were involved both in the engineering association and the institutions associated with the development of technical education, and the influence of these schools in the German occupational and institutional structure was steadily increasing.

The American engineering education system developed later and the universities took a more active role. The “self-made” engineer-entrepreneur and mechanic therefore was able to establish a much stronger position in industry, and the conflict was more between a “shop” and “school” tradition than between various types of educated engineers (Calvert 1967; Layton 1986; Noble 1977; Meiksins 1988). Whereas industrialization led to a divide between practical and academic engineers in the United States, the nonacademic engineers educated at the middle level provided a link between manual and academic labor in Germany. The two kinds of engineers were also organized in the same major professional association. This meant that

manual, administrative, and conceptual tasks were not separated into different cultures and careers to the same degree as in the United States (Wickenden 1930: 751; Chamberlain 1908: 8).

The Germans tended to dignify and even glamorize the engineer as a force for social unity and nationalism (Sorge and Warner 1986: 189; Locke 1989: 267; Lawrence 1980: 97, 1992: 89). *Technik* symbolized a common language that made it possible for people in various functional specialties and hierarchical positions to communicate and develop common understandings and identities. The notion of management and the discourse and metaphors attached to *system* and *rationality* may have played an equivalent role in American society (Shenhav 1999; Lawrence 1996: 21). The American engineers may have undermined their own power base by putting so much emphasis on the management function, however. If top management jobs were not about technology, manufacturing, and product development but a more general people-oriented and financial skill, then accountants, lawyers, and sales personnel could also do the job. The idea that management was a profession in itself opened the field of management to other professions, and it was particularly those with a background in law and business administration that would later take up the battle with engineers to enter the top positions (Byrkjeflot 1998).

Engineering education in the United States was based on the idea of a distinction between technology and art; the implication was that engineering (and management) was a collection of abstract principles and techniques that could be applied in industry. However, it was not established as a clear hierarchy among schools as was the case in France, where the theoretical approach to technology was linked to a hierarchical system among engineers in the workplace (Kranakis 1997: 258), and in Germany where it was developed as a hierarchy not among particular schools but among categories of schools. The aim was the same in Germany as in France: to establish a clear correspondence between workplace hierarchies and educational hierarchies (Kocka 1980: 104).

American engineers did not want to be associated with the notion of vocational training, since they feared that this would lead to a degradation of status. Progressive U.S. reformers had filled the concept of vocational education with a particular pedagogical and social meaning; the purpose was to improve motivation, recruitment, and career prospects for manual jobs. Manual training, accordingly, was associated in the public mind with the

rehabilitation of criminals (Fisher 1967: 78–79). In Germany, on the other hand, the concept of vocational training was linked to the notion of industrialization and *Kultur*. Germany was much more of a “late industrializer” than the United States in the sense that civil society and the education system were much more penetrated with a “catch-up mentality” vis-à-vis Britain and the other more industrialized countries (Veblen 1954; Gerschekrohn 1962).

### Organization of Presentation

I will discuss why the organizational fields of technical education in Germany and the United States developed in their distinct ways. The model presented in Figure 10.1 will structure the chapter.

The four relevant actors in this scheme are (1) states, (2) business interests, (3) academic entrepreneurs and teachers, and (4) professional associations. The state is important both as a direct and indirect variable because it defines the interaction pattern among education, profession, and industry.

### Different Perspectives on National Models of Technical Education

Let me present four conjectures about how the fields of technical education were shaped, and then discuss to what extent each conjecture may explain the various outcomes and ideologies in technical and industrial education.

1. It may be argued that it was the state apparatus and the strategies of actors linked to the state that most decisively set the pace for the development of technical education systems.
2. According to a more functionalist argument it will be assumed that it was industrial demands and particularly the increasingly powerful *business interests* that were the decisive forces behind the transformations and renewal of the existing educational systems.
3. Such patterns of transformation and renewal may have been driven by internal factors, that is, dynamics and conflicts within the education system itself.

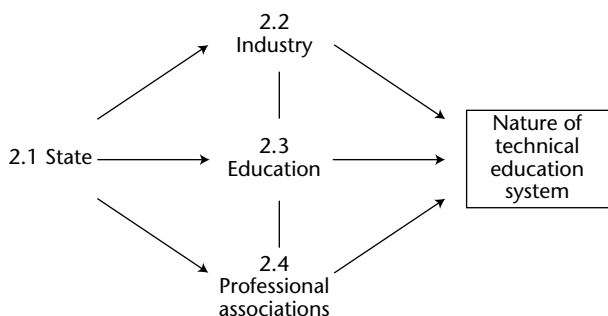


FIGURE 10.1 Actors influencing the formation of technical education systems

4. It may have been the technical and professional associations and strategies associated with the new professions that have most decisively influenced education systems.

Within the industrial argument one should be aware of how different industries with varying needs perceived of their interests in a given period, and to what degree industry developed internal education and training systems instead of attempting to influence the education system. According to the argument from education the important actors are those involved in scientific development, academic institution-building, and teaching. In the professional perspective it is important to be aware of the relationship among different segments in the profession, to what extent the profession was unified or diversified, and its program for technical education. Clearly, there is a great deal of potential for internal conflicts within each major group of actors, and this creates room for political actors and states to influence the shape and content of self-interested strategies and problem formulation among the major actors.

#### *The State-Centered Argument*

The special character of the state is that it has the power to define or “institutionalize” the relationship between the other organizations and actors in a society. “All the actors involved depend on the state,” Burrage *et al.* (1990: 222) argue, and “the decisions and policies of the state towards professional knowledge and professional services are therefore a subject of

particular importance.” The state is a privileged actor because it may take legal and political action and thereby pick the winner and loser in conflicts over conception of control and governance structures in a given sector or organizational field (Campbell and Lindberg 1990; Fligstein and Byrkjeflot 1996). Legal traditions and certification procedures are important; for instance, whether it is possible to create cartels in industry, or whether an education institution or a professional firm must satisfy certain requirements in order to remain in business. The fundamental difference between Germany and the United States was that the German states promoted cooperation and cartels in industry, whereas the American states promoted competition and had several types of cooperation outlawed. This had important consequences for the educational system also, since the early American universities were corporations, and since the various academic groups were directly affected by the restrictions on cooperative arrangements in product and labor markets. The laws relating to cartels and industrial relations may also have had important consequences for the strength of industrial, occupational, and educational associations.

In continental Europe control over higher educational institutions was vested in ministries of higher education, which were assigned broad powers, including the right to determine who should be admitted, be allowed to teach and be promoted, and who should practice in the professions. The state in Germany did not see any reason to issue individual licenses for engineers, probably due to the strength of its technical civil service and the public status of technical education (Lundgreen 1990: 74). The major governance method was to bring the partners together in cooperative organizations and promote compromises between them. In the case of the United States the federal authorities and the states took another and less active role. Individual states started to require licenses from engineers employed in public service from around 1920 (Rothstein 1969: 83). In 1934 all American states still would allow a person to become registered without having graduated from an engineering school (Grayson 1993: 132). There was no agreement among the professional associations on licensing, and the state did not make any attempt to bring the partners together in order to establish a standard. The idea behind the emerging system of education in the United States was that the professions ought to set the standards for their own activities. The federal and state levels were more actively involved in the establishment of engineering schools than in law and medical and dental schools, however. The

engineering schools would function at both the undergraduate and graduate levels as integral parts of the academic and administrative structures of the university (Grayson 1993: 26). National engineering societies were for the most part established after their respective curricula, and this means that the states and schools took a more active role in the formation of the engineering profession than in the legal and medical professions (Grayson 1993: 51).

The agencies that developed in the United States were of a more collegial kind, in contrast with the corporatist structures in Germany. There was a dramatic increase in the number of institutions offering university degrees between 1860 and 1920, and the American higher educational institutions gradually developed a unique but complex system known as *accreditation*.<sup>2</sup> The Association of American universities was engaged in such activities from 1914 on, and the Flexner report on medical education (1910) has been given much credit for the strong growth of accreditation associations (Zaret 1967: 178). The American Council of Education (1918), of which the the Society for Promotion of Engineering Education (SPEE) was among the founding members, was another pioneer in accreditation activities. SPEE was the major governance agency in American engineering, at least until the establishment of the Engineers' Council for Professional Development (ECPD) in 1932. The establishment of ECPD was partly a result of the need felt by engineering societies to create their own accrediting agency. These two associations arguably took on some of the same tasks as educational ministries and governmental committees in continental Europe.

The industrial and state elites in Germany did not develop the same aversion against vocationalism and practical training as the British and the French elites (Sorge 1979: 52–53). The German states dominated at the higher levels in the technical education system, associations at the lower levels. The state was rather predominant at all levels in France, in contrast to the United Kingdom, where it was much weaker. This relates to the distinction between state-centered societies and stateless societies (Nettl 1968; Birnbaum 1988). Such a distinction may also be relevant in a comparison between Germany and the United States. It would be misleading, however, to argue that the formation of technical education in Germany was an outcome of state policies, and that the United States was a copy of another stateless society: Great Britain. Dawson depicts the development of technical education in Saxony as a social movement based on traditional craft and guild values, whereas Gispén argues that the engineering profession in Germany

was a new and more liberal kind of profession, shaped in a struggle against the “old order.” It is thus indicated that the state’s role may have been indirect also in Germany, and that state actions may matter almost as much in nation-states with “weak” states (Gispen 1988: 568; Dawson 1919; Evans *et al.* 1985).

The state agencies in the United States took a greater responsibility for higher technical education than the British. The land-grant colleges developed as a direct response to a state initiative (the Morrill Land-Grant Act of 1862). The dislike of state involvement in vocational education was strong also in the United States, however. Fisher (1967: 114) notes that the corporation schools’ association in the USA had a “rather astounding blind spot; until 1917 when the Smith Hughes bill (on vocational education) was passed, they hardly mentioned federal aid to vocational schools.” The basic difference between the German and American states, at a federal and regional level, was that the German states were more instantly involved in the development of higher technical education and in agencies related to this purpose. The American Government was more inclined to let the professions, the industrial associations, and the educational institutions govern their own matters. This lack of state involvement was a problem according to a report on technical education from 1930, since “the leaving of all initiative to individual institutions, with no coordination of policy, has resulted in the failure to work out a well-rounded national system of technical education in its several natural divisions” (Wickenden 1930: 823). In Europe the stratification in the school system was “public, legal, and taken for granted” (Rubinson 1987: 523). The U.S. policy was to provide everyone with the same introductory education and leave the tracking decisions to the students:

Our technical education is conceived as an aid to the progress of individuals of varying needs and tastes, and only secondarily as a process of recruiting well defined callings. Not so in Germany or elsewhere in Central Europe; there technical education is a definitely organized arm of the body economic, controlled by the brain of the system—the state. (Wickenden 1930: 997)

#### *The Argument from Industry*

It has been commonly assumed in the social sciences that change in industrial and economic arrangements cause educational change. Function-

alists of various kinds have argued that schools merely develop the skills and attitudes needed at work; as work requirements change, so do schooling practices and the structure of education (Garnoy and Levin 1985: 3). In this perspective cross-national differences are explained simply by pointing out the contrasting industrial structures and growth patterns. Differences in industrial output, size of national markets, and position in the international trade would inevitably lead to different education systems. The larger markets and associated strategies for mass production in the United States indicated a higher demand for managerial-technical manpower at the higher end and more unskilled labor power at the lower end. Struck (1930: 91) argued that "specialization in industry had, by 1905, already progressed to the point where it had almost killed apprenticeship in all but a very limited number of skilled trades such as the machine shop, printing and building trades."<sup>3</sup> American industrialists were driven by market demands and it was rational for them to develop a top-heavy polarized technical education system as opposed to the Germans, who needed more skilled workers on the middle level and on the shop floor.

A prominent place in functionalist lines of argumentation is assigned to the increase in output from education systems, since these numbers are supposedly a function of the growth rate in industrial production. Tables 10.1 and 10.2 provide some support for this argument. The explosion in engineering education in the United States came between 1900 and 1915, with an increase from 17,000 to 55,000 engineering graduates. In the same period the production index jumped from 675 to 1,250 points. Germany did not match this growth pattern with an increase from 464 to 714 points only. Its population of engineers did not grow as fast (from 41,000 to 65,000, nonacademic graduates not included). The most rapid growth in engineering and production in Germany came a few decades earlier. The slower growth in engineering education in France as compared to Germany might also be "explained" by the comparatively slow production growth. What cannot be explained is why the number of graduates in the United States was so much lower than in France and Germany until 1890.

The functionalist perspective of education does not specify by what mechanism education systems adjust to changing skill demands in the workplace. According to critical functionalists such adjustment follows from the increasingly powerful position business interests have in society. It is assumed that changes in the orientation of institutions take place because capitalists

TABLE 10.1 Industrial output in Europe and the US from 1860 to 1913

	Germany	Great Britain	France	United States
1850	100	100	100	100
1870	129	129	131	138
1900	464	232	254	675
1913	714	294	385	1,250

SOURCE: Thanheiser *et al.* (1976: 44).TABLE 10.2 Estimated number of engineers with degrees in France, Germany and the USA between 1850 and 1914<sup>1</sup>

	France	Germany	United States
1850	6,687	3,343	n.d.
1870	12,050	11,856	866
1880	15,994	24,452	3,125
1890	21,504	32,166	6,962
1900	28,829	41,657	17,392
1910	38,317	59,738	38,392
1914 <sup>2</sup>	42,850	65,202	55,392

SOURCE: Mann (1918: 6) (United States) and Ahlström (1982: 106–108) (Germany and France).

1. The data on the United States are based on cumulative data on numbers of graduates from engineering schools. Ahlström's methodology is somewhat different (see Ahlström 1982: 70–71). Nonacademic engineers are not included in the German case.

2. The basis year for the U.S. estimate is 1915.

impose their will on them as part of a strategy to control or discipline the working class (Rubinson 1987). An example of this kind of argument is Noble (1977), who tells the story about how engineering education was transformed into a “unit of the industrial system.” *America by Design* (Noble 1977) is among the most quoted studies of engineering education in the United States.<sup>4</sup> Noble argues that industrialists were able to impose their views on the profession and the education system in three ways: first, by

developing cooperative educational programs; second, by developing strong in-house training programs; third, he lists several new agencies that were created to coordinate activities between education and industry (1977: 169–170). I will now discuss these three arguments.

*Cooperative Programs.* Noble has put a great deal of emphasis on the introduction of cooperative programs between General Electric (GE) and Massachusetts Institution of Technology (MIT) between 1907 and 1920. His narrative centers on the actions of Magnus Alexander, who was in charge of the training department at GE. Carlson (1988), who has presented a more detailed study of this case, concludes that “it was not the leaders of GE who spearheaded the course but rather, Dugald Jackson, an “academic entrepreneur” at MIT. “From the outset,” he says “Jackson strove to shape the course to reflect his vision of the engineer rather than simply serve GE’s manpower needs” (550). “In Jackson’s engineering philosophy the vision of the engineer as a leader and expert was fundamental, . . . and he pursued it even when it ran counter to what big business wanted or needed” (546). Whereas Noble portrays an almost conflict-free relationship between the representatives of GE and MIT, Carlson thinks the process was marked by constant tension and conflict. On the one hand, it was Alexander’s purpose to educate “designer engineers and factory supervisors” that would fit in with General Electric’s immediate manpower needs. Jackson, on the other hand, advocated that the MIT cooperative program should produce men “of larger vision and finer training . . . for the distinctively higher executive positions,” and not just “better \$2000–3000-men” (Carlson 1988: 550).<sup>5</sup>

Noble and Carlson also disagree fundamentally about how successful the cooperative programs were and how much backing Jackson and Alexander got in their respective organizations. Carlson argues that neither the staff at MIT as a whole or managers at General Electric saw the cooperative course as an integral part of their institutional strategies (Carlson 1988: 557). The plans were postponed because of the recession, and the first cohort did not graduate until 1922. The classes were much smaller than planned, due to lack of support from GE. The course did not satisfy the firm’s demand for technical manpower. The graduates from the cooperative program were not regarded as better prepared for firm-specific jobs than other engineers and there was no special recruitment policy for graduates from the cooperative program.

By the mid-1920s the cooperative idea had been adopted by sixteen

institutions, or about 10 percent of all engineering schools (Carlson 1988: 548). Several of the cooperative programs failed, and the movement for cooperative education was not able to establish a position as the major model for American engineering education. If the cooperative idea was the industrialists' model for engineering education, then this case contradicts Noble's claim that industry was able to "take over" the engineering schools. One might, of course, argue that these programs represented a major ideological alternative in education and that most institutions adapted to the business demand for more practical education by incorporating major elements from these programs in their curricula. This does not seem to have been the case, however. Wickenden (1930: 232) argues that the plan had gained mainly by establishment of new schools and that it was rarely introduced in already established schools.<sup>6</sup>

*In-house Training Programs.* If the emergence of cooperative programs demonstrated industry's increasing influence, then the question is why they did not become more widespread along with the rise of industrial power. An answer might be that industrialists would not take the risk of sharing the costs with education institutions, that they preferred to organize their own proprietary programs. This is what one would expect according to an argument put forward by many that skills are not treated as collective goods in the Anglo-Saxon economies, and that the threat of losing skilled employees to competitors poses a serious obstacle for investing in skill-creation (Streeck 1989; Rieble-Auborg 1996). If this was a major problem, then one should expect that employers sought to prevent their own graduates from seeking employment in other corporations. But Wise (1979: 173) found that GE took twice as many engineers than its expected needs into its "test" classes every year, and that placement interviews were arranged for those who did not continue for a second year not only with company components but also with other organizations. The major purpose with these classes was "not to educate, but to initiate, indoctrinate and select" (Wise 1979: 171), and the students that left the company did turn out to be good customers. Large companies, like GE, accepted a division of labor between engineering schools and corporations, and they developed in-house programs in order to identify candidates for staff jobs and top management positions. GE expanded their in-house programs for graduate engineers in the 1920s. With the exception of the Depression years, some 400 to 600 men would enter "the test programs" annually (Wise 1979: 174–175).

A number of other large industrial enterprises, such as AT&T, General Motors, Chrysler, and IBM also developed schools of their own. Zaret (1967: 388) reports that the total enrollment for corporate schools was many times greater than that for all engineering technology institutes and engineering colleges combined, and that such schools were already an important and consistent part in the skill formation strategies of many larger American companies in the inter-war period. It is difficult to believe that these firms would be willing to develop such costly in-house engineering programs if they could fill their skilled manpower needs through development of joint programs with engineering schools and by participating in associations for accreditation in engineering education. Lazonick (1991: 217) argues that American firms traditionally have depended heavily on recruitment of lower-level technical specialists, which were subsequently rotated from one department and function to the other in order to enable them to gain the experience necessary to move up the corporate ladder. In the long run, then, it might have emerged to both parties that academics and educators should have the responsibility for the content and structure of education, but that it would be necessary for the employers to define the needs for further training and management development.

*Cooperative Agencies.* The most striking fact with the development in the United States in comparison with Germany is the lack of cooperative agencies in which state and industrial interests were directly represented. SPEE, an organization of men teaching civil, mechanical, mining, and electrical engineering, was founded in 1893. SPEE was by then the only professional society devoted solely to education (Grayson 1977: 254). This association of educational interests was "able in a few short years to gain complete control of curriculum, admission standards, and other basic constituents of engineering education" (Calvert 1967: 58). Although it maintained close relationships with the four major engineering societies, the organization's membership and leadership were largely engineering educators, not practicing engineers (Zaret 1967: 54; McGivern 1960: 116). McGivern (1960: 254) and Grayson (1977: 254) both argue that SPEE was able to keep the control of engineering in the hands of engineering educators. David Noble has presented another opinion on this issue, according to which the industrial interests gradually took control over SPEE and its offspring ECPD. The major evidence he presents for this is an editorial from 1912 stating that there is a "great increase in teachers and businessmen."<sup>7</sup> The occupational distribution

of the membership was published annually in *Bulletin of the Society for the Promotion of Engineering Education* (BSPE, later *Journal of Engineering Education*). These statistics show that the teachers continued to dominate the association between 1908 and 1923–1924, and that only 5–6 percent of the membership were “industrial officers.”<sup>8</sup> There was a slight increase in practitioners among the membership after 1910, but teachers may have regained some of this position as SPEE began to admit educational institutions to membership in 1914 (Zaret 1967: 87).

Higher technical education in Germany was established as a separate system, independent from the traditional university. This was a result of a compromise between the liberals and the conservatives in the 1820s, after which the Department of Commerce and Industry in Prussia was allowed to set up its own system of specialized instruction. This marked the beginning of an era with conflict about the status of engineering education in relation to traditional education. The technical education system was built in a single movement against “the old order,” represented by the state and the traditional education system. Modernization was thus achieved through a separate program of special education for private industry. Engineering education was only accepted as having the same status as the traditional academic education in 1899, when the *Technische Hochschule* was granted the right to issue doctorates.

The main conflict was between the state and the engineering professionals and educators before the 1870s and between the state and the professionals and industrialists after this decade.<sup>9</sup> A major compromise was reached around 1910, and as a result of this came DATSCH (*Deutscher Ausschuss für Technische Schulen*), the German Committee for technical education. This was an association in which educational institutions, professional associations, industrial associations, and state representatives participated and among which the German Engineering Association—*Der Verein Deutscher Ingenieure* (VDI)—took the central position (Wickenden 1930: 802). If there had been anything like DATSCH in the United States, then Noble’s argument that interests outside of engineering education were able to design the whole system in their image would have been more plausible. “There is no question that the managers of Germany’s large engineering firms dominated the DATSCH,” Gispén (1989: 211) argues. It was “through DATSCH, the managerial elite of the engineering profession was able to mold and subordinate the noneconomic functions of the engineering schools to its

own needs.” Gispen does not see any contradiction between this turn of events and VDI taking a commanding position, since he thinks that the industrial interests also were the predominant segment within the engineering association (Gispen 1989: 218).

A closer look at the membership lists and protocols of DATSCH and SPEE makes Gispen’s claim more credible than Noble’s in the case of the United States. Both DATSCH and SPEE had institutional as well as personal members. SPEE only granted educational institutions such membership, however, and the teachers were in overwhelming majority among the personal members. In the American context it is likely that the practitioners identified themselves more with the school they came from than their specialty and business. DATSCH was not primarily a voluntary cooperative agency or an accreditation institution as SPEE and later ECPD in the United States, but rather “a private body endowed with de facto public powers” (Gispen 1989: 212). Among the institutional members in DATSCH were the powerful association of the engineering industry, the VDMA, and the major technical and professional associations. Several state agencies participated although they were not listed as institutional members. The academics and teachers constituted a minority. As DATSCH developed further the representation of industrialists and state agencies expanded more than educational institutions. The implication of this according to Gispen (1989: 219) was that “the engineering society’s leadership had now emerged next to the Prussian government as co-sovereign in the determination of technical education policy.”

This remarkable *corporatist arrangement* is essential if one wants to understand how the German comprehensive system was governed relatively independently from the state. VDI took the initiative to DATSCH after having been urged to do so by the state. Using their own consultants and experts, DATSCH studied all forms and aspects of technical education. First on its agenda was the controversial question of non-academic engineering. This question had led to a split in VDI. Professor Riedler, along with a group of engineer-educators broke out and founded VDDI—*Verband Deutscher Diplom-Ingenieure*, which was explicitly meant to be an association for academic engineers only. This was a protest against VDI’s support of the nonacademic engineering schools in a period with overproduction of engineers. It was in the wake of this conflict that VDI reached a compromise with the state and the industrialists. The guidelines and recommendation following from the work of DATSCH became law almost exactly as proposed in

1910 (Gispen 1989: 215). After the successful resolution of this question, the DATSCH next turned its attention to academic schools and then to lower technical training. The result of this work was a nationwide coordination, consolidation, and standardization of a system for technical education. It was the reform program initiated by industrialists and VDI as part of a national movement for a more practical and specialized technical education that provided the guiding idea for DATSCH between 1908 and 1912. In the case of the United States there was no equivalent national agency for the governance of engineering schools and technical education. Different professional interests specialized in different fields. Industrialists were, for instance, more important in the association for promotion of industrial education than in engineering education (Fisher 1967). They also had an Association of Corporation Schools, set up to develop in-house apprenticeship programs and management training (Noble 1977: 170–185).

There are several indications that managers and industrialists in the United States actually wanted a more comprehensive type of education system similar to the German. Indeed, one of the most often repeated critical remarks in the trend-setting Wickenden report on engineering education was that the American system of technical education was “unbalanced and top-heavy.” It was necessary to look to Germany and develop a more comprehensive and rational system.<sup>10</sup> According to Elbaum (1991: 208) the decline of the apprenticeship system in the United States was “by no means due to lack of employer interest. Indeed, during the later nineteenth and early twentieth century U.S. employers often bemoaned the decline of apprenticeship and a perceived association with skilled labour scarcity.” The quality of engineering schools has been repeatedly criticized from a business viewpoint, and there has for the most part been a demand for a more practical orientation. This indicates that the prevailing inclination among American managers was not always to promote deskilling and to recruit “Taylor-made” engineer-managers directly from schools, as indicated by the trend-setting works by Braverman (1974) and Noble (1977). There are other ways of explaining the American industrialists’ strategies than by referring to their Tayloristic attitudes. It is, for instance, possible that constant immigration of skilled personnel from Europe, and the abundance of engineering dropouts ready to take the position of technicians, was an important reason for the exclusive focus on academic education among American businessmen. If immigration was that important, however, then their strategies should have changed in the

1920s when immigration of skilled technicians was down to 51,000 from 180,000 in 1905 (Struck 1930: 68).

So far I have not found much evidence for Noble's theory of a corporate "takeover" in American engineering education. It is not possible to identify a clear program for this among American industrialists, who were less organized than German industrialists at the time. It rather seems like the traditional employers in the United States wanted a more stratified and vocational system like the one in Germany, the problem being that they were not able to get the politicians and the new engineering professionals on their side. "What was different" in the United States in Europe, according to Rubinson (1987), "was not so much the interest of the capitalist class but its ability to impose those interests." Could it be the case, then, that Shenhav (1999: 135) is quite to the point arguing that engineers had developed priorities that were different from capitalists or government and that they were better organized to impose their interests than either the state or the traditional capitalists? One may assume, contrary to the class imposition argument, that there is always an element of choice in managerial and professional strategies. The choices that are eventually made will depend, for instance, on the professional background and worldviews predominant among managers and professionals. American employers and managers may have lacked the organizational capabilities that would allow them to take the lead, and also a clear conception of what kind of engineering education they wanted. These organizational capabilities and conceptions may have been further developed in Germany. The academic brand of professionalism gradually won out in the technical associations in the United States in a period when *general managers* took over as role models in industry.

#### *The Argument from Education*

The argument from education is that educational systems develop autonomously from industry and professional associations. Schools have their own dynamics rooted in prevailing institutional and epistemological legacies and the associated political arenas. Cross-national variations, then, might be understood to be a consequence of different educational traditions and worldviews among academic institution-builders, scientists, and teachers. Their strategies are not determined but constrained by the respective institutional frameworks and available economic and ideological resources.

These elements can be seen as “building blocks” for educational entrepreneurs (Meyer and Rowan 1977: 26). According to common knowledge about these societies, there was more room for institution building and entrepreneurialism in the educational sector in the United States because of the lack of any national regulations or standards (Rheingold 1987). American society was also more multicultural and had developed a value system and a mobility pattern based on achievement and ascriptive values (Parsons 1991).

The early impact of industrialization on American higher education has to be understood in relation to the host of forces gradually seeking governmental support to defend their professional territory. Academic entrepreneurialism exploded in the decade after the introduction of the Land Grant Act in 1862, which provided for the allocation of public lands to the foundation and support of colleges. The number of engineering schools increased from about a dozen in 1862 to twenty-one in 1871 to seventy in 1872 to 126 in 1917 (Grayson 1977: 250). The most prestigious colleges that came to function as role models, such as Columbia, Harvard, and Yale, were predominantly initiated by donations from wealthy businessmen. After the dramatic increase in the 1870s the coming of the engineering school in the United States was more of a continual trend. Between 1870 and the World War I the number of engineering graduates swelled from 100 to 4,300 annually (Noble 1977: 24, 39). Just as remarkable, especially seen in relation to the high rate of organizational proliferation and entrepreneurialism, is the outcome of this process as reported in 1930:

It is surprising to find so little variety of types of instruction and of levels of entrance and completion among the one hundred fifty colleges of engineering, and so few substantial technical schools of any other type. Tradition, the influence of early modes and imitative growth evidently may impose even greater uniformity than bureaucratic authority. (Wickenden 1930: 1,000)

In order to explain this outcome it is necessary to take a closer look at what had happened in the previous decades. It appears that the origins of the larger number of American colleges cannot be attributed to the industrial revolution or the demands of the economy (Collins 1979: 121). Religious ideas and an emphasis on discipline and piety, the education of a democratic citizen, and equality of opportunity were more important than the demand from employers and professions for provision of practical skills and licensing of qualified labor power. This traditional model, however, faced a serious cri-

sis in the 1850s. Failure rates were high, the colleges too small, and financial difficulties were common. "Feverish entrepreneurship" in the educational sphere had founded perhaps 1,000 colleges before the Civil War, of which over 700 failed (Collins 1979: 121; Rudolph 1990: 219). The lack of any national regulations or standards and the variety in resources and ideologies continued to lure academic entrepreneurs into higher education. There were at least four types of actors involved: wealthy men of vision, pioneer educators, politicians, and college presidents (McGivern 1960: 164). Among these, the college presidents were most important until well into the twentieth century (Collins 1979: 120).<sup>11</sup> It was due to their administrative gifts and the unifying power of the ideology of professionalism and "science" that a system in crisis and disarray came to be stabilized and entered into a phase of expansion and consolidation.<sup>12</sup>

Wickenden locates a formative stage in American engineering education in the decades before 1870. This phase was marked by the creation of new and distinctive schools and programs: "its dominating personalities were more often scientists and publicists than engineers; and its chief aim had been the training of civil engineers" (Wickenden 1930: 818). Given the fact that the most preeminent institutional entrepreneurs did not have a practical background and that they imported a "science" model, it was no wonder that they alienated their clientele in the industry and the profession. The historical dominance of a shop culture in industry made the cooperation between the colleges and the elite in the professional associations difficult. The early academic entrepreneurs had to orient themselves toward practical and administrative engineering in order to gain acceptance for their graduates in the business community and in the professional associations.

The same type of crisis did not shake the German education system. This must be explained by the strength of the "old order." Whereas the industrial revolution and the development of a technical education system antedated the creation of large civil services in the United States, in Germany the situation was reversed. All the academic technical schools were state institutions, and the proprietary middle-level technical schools, which mushroomed between 1890 and 1910, were also gradually brought under state protection (Gispen 1989: 216–217).

The stability in the number of academic engineering education institutions was exceptional in comparison with the United States. The total number of technical universities and universities in Prussia increased from thir-

teen in 1875 to sixteen in 1920 (Lundgreen 1983: 151). In order to say something about the “impact” of the industrial revolution on higher education in Germany, it is therefore necessary to concentrate first on the processes of *internal diversification* in the technical universities. Second, it is necessary to study the development of separate educational institutions at a lower level, such as the nonacademic engineering schools. In contrast, it is the institutional proliferation of institutions at the academic level that is most striking about the American case. There was an increase from four engineering schools in 1860 to 126 schools of college level in 1918. Among the 126 schools in 1918 were forty-six land-grant colleges operating under the Morrill Act, forty-four professional schools in universities, twenty schools attached to colleges, and sixteen independent institutions (Mann 1918). As other American professional schools, these schools adopted the same degree structure as the classical university departments (B.A., M.A., Ph.D.). The inclusion of engineering schools in comprehensive universities became the dominant model, in contrast to what was the case in continental Europe, where there was a tradition for general, separate technical universities (Clark 1978; Collins 1979; Lundgreen 1990: 60).<sup>13</sup> Whereas horizontal differentiation within institutions (curricula, chairs) and vertical differentiation among types of schools (lower versus higher technical education) were the common pattern in Germany, competition also took place among different institutions at the same level in the United States (Lundgreen 1983: 49; Herbst 1982: 205). The curricular diversification within German technical universities took place at a quite early stage. Until about 1870 there were fifty to sixty technical and scientific teaching subjects in institutes of technology. The number increased to more than 100 by 1880, nearly 200 by 1925, and by 1900 there were more than 350 at the Berlin technical university (Manegold 1978: 153). Herbst (1982: 205) argues that the diversification among colleges in the United States initially tended to hold back curricular diversification within them, but that American universities later diversified also internally. The major difference was that the American universities were more oriented toward general education and teaching and that they were organized according to more egalitarian principles.

The need for setting qualifying standards in engineering education was supported by reports of the high failure rates among students in the United States compared to Europe. The Mann report published in 1918 revealed that 60 percent of freshmen failed to obtain their degrees (Mann

1918: 32–33). Accordingly, a large group of American technicians distinguished themselves from academic engineers not by type of schooling but by their failure at achieving a degree. This must have strengthened the trends toward relying on degrees and school ranking as criteria for a new status hierarchy in engineering (Collins 1979: 171). In the longer run the academic engineer was the only type of engineering graduate, and the strong drive toward standardization in engineering education strengthened the influence of the elite schools.

The major institutional framework in German and American technical education was in place around 1870, except the technical middle schools in Germany, which mainly were established from the 1890s. Growing from a few hundred in the 1830s and 1840s, the enrollment in the higher technical schools in Germany fluctuated between 1,000 and 2,000 in the 1850s. By the 1860s, enrollments shot up rapidly, reaching a total of nearly 5,000 in the academic year 1871–1872, and over 6,600 in 1875–1876 (McClelland 1980: 241). It then increased to 12,576 in 1903–1904 before leveling off at about 11,541 in 1914. At the same time, student numbers in the nonacademic engineering schools increased from about 1,400 in the late 1880s to almost 11,000 by 1910 (Jarausch 1990: 18).

State responsibility for higher education in Prussia gave professors autonomy from private funds and professional contributions. This meant that they depended on the state and that they as civil servants were obliged to implement state policies. One might then have expected that the established civil service and *Bildung* ideal would have penetrated the early engineering schools in Germany. As mentioned above this was not necessarily the case. Engineering was developed as a science before industrialization took off. The dominant status group in Germany, at this early stage, was not the entrepreneurs as in the United States, but the academics, the state engineers, and other civil servants that predominantly had a legal education (*Bildungsbürgertum*). Industrial engineers and engineering professors were not usually allowed to advance into the German civil services. It was for this reason that they had to turn their attention to commerce and business occupations with a lower status: the *Wirtschaftsbürgertum* (Lash 1989: 70). It was their strategy to increase the status of the engineer through academization of technology and industry (Manegold 1978), and the struggle for approval of the *Technische Hochschule* as equivalent with the traditional universities continued after it had been granted the right to educate doctors in 1899. But as

the industrial revolution took off in Germany, these engineer-educators encountered an increasingly strong reform movement among practitioners, teachers, and industrialists. Apparently they did not see it as a realistic and appropriate model for academic engineers to claim a monopoly on all qualified technical positions within the firm, and they gradually had to accept the formation of a new brand of technical schools at a middle level.<sup>14</sup> It was partly for this reason that German engineering gradually developed into a more practically oriented profession than its American counterpart.

The engineering-educators in the United States did not meet resistance from a broad movement of this kind, and the state had basically allowed for the engineering associations to govern their own matters. Like the engineering pioneers in Germany, the American engineers also aspired to establish their science as a pathway to elite positions in society. It was in confrontation with traditional industrial entrepreneurs and an elite of “gentlemen” from the shop culture in the professional associations that they established their own brand of *managerial professionalism* (Shenhav 1999). The conflict between shop and school had begun already in the late 1860s as the first engineering schools for mechanical engineers were set up. This conflict intensified until 1890 but was followed by a period of self-examination and compromise that led the school forces to get an upper hand from 1905 (Calvert 1967: 281).

The period from the 1860s through the 1920s was a golden age of prestige for the American engineers, precisely because so many of them were entrepreneurs. The men who founded the professional associations in the United States were secure in social status, and their associations served to lend the occupation of mechanical engineer the status they already possessed as individual entrepreneurs. It was a classical attempt to defend status by transferring economic capital into cultural capital (Calvert 1967: 131, 1972: 49; Bourdieu 1984). But this was also the start of the golden age for the large industrial corporation and the application of science to industry. The original entrepreneurial ideology was therefore increasingly outdated, and it was necessary to develop educational institutions. In Germany the renewal of the engineering tradition had to take other directions. The status of the entrepreneur had always been low, and the engineers had been actively pursuing a scientific agenda since the 1850s.

In the United States private funds were important in the establishment of a technical education system, but as was the case with the politicians in

Prussia, the providers of these funds seem not to have been able or willing to control the development of the school system. A parallel to the entrepreneurialism in higher education in the United States was found in lower technical education in Germany. There was one difference, however. The major institution-builders in Germany were not individual entrepreneurs but collective actors, such as associations and local state authorities. Dawson reported in 1912 that “disregarding altogether the regular schools—primary, continuation, middle, and higher—there were in this comparatively small country (Saxony), no fewer than 515 special schools exclusively engaged in imparting technical knowledge of one kind or another” (Dawson 1919: 105). He noted that there were a variety of schools and interests supporting them. The trade schools (*Handelsschulen*) were in the hands of the merchants and manufacturers’ associations, differently named. The Industrial Schools (*Gewerk- und Gewerbeschulen*) had for the most part been established by trade guilds and other associations, among them several municipal and state associations. Chamberlain (1908: 9) also noted the role of guilds and corporate associations, which “may organize, equip and foster schools of such character as train directly for their particular lines of work.” Such institutions for lower level technical education were not very developed in the United States. It was estimated by the Douglas Commission of Massachusetts in 1905 that technical education at the high school level was fifty times as extensive in Germany as in the United States (Struck 1930: 91).

#### **Technical Education as Part of a Strategy for Professionalization**

The argument from the profession, eventually, is that the formation of two models of technical education may be understood as part of a professionalization project among the new middle classes, and most preeminently among them the engineers. The implication of the argument from industry is that a profession in order to be a “real profession” should not identify too strongly with industrial interests. In the argument from the profession, however, a professional association is never exclusively an agent for an external principal, such as a business association or an educational organization, even if one segment may be predominant in its internal affairs. Since professional associations are coalitions of their respective competing segments, and since their leaders are elected, their policies tend to be a com-

promise between dominant coalitions and the leadership's interest in promoting their own interests. I will compare the collective strategies and the organizational resources among engineers in order to explore this argument. It follows that the policies and structure of professional associations may be of major importance. The success of these associations will depend on their agenda, their ability to unify distinct interests around this agenda, and to what degree other and more powerful organizations are engaged in the same issues and organizational fields. I have earlier noted that there was less opportunity for the corporate managers in the United States to influence higher education directly, since the states had left it to the educational institutions to develop standards and cooperative programs. It was the professional models advanced by these educators that won out in the United States, not those preferred by the employers or the "shop" models fostered by the early engineering associations. The American pattern of professionalization was school-based (Burrage *et al.* 1990: 219; Burrage 1993: 180).

The prevailing professional model among German engineers had its base in the professional associations, but was modified by the advancing industrial interests. The traditional brand of professional professionalism oriented toward occupational closure partly "lost out" when it was faced with a strong reform movement among practitioners and industrialists. One reason for this failure was the historically weaker status of the German engineering profession in comparison with the American engineer-entrepreneurs. The status of German engineers increased, however, whereas it may seem as though the status of the American profession may have decreased as a consequence of academization. By focusing on the distinct role of *engineering associations* I want to account for the emergence of the new educational models and technological cultures. I will explore the impact of the professional associations—whether they acted as a force for unification or polarization in the workplace and how they influenced the self-perception (*leitbild*) of engineers.

The question of engineering professionalism has been subject to controversy in the literature on professions. There was a lot of interest for this in the wake of the perceived Soviet scientific advantage or the so-called "Sputnik" shock in the 1960s, and a discussion on whether engineers qualified as a profession has been a standard exercise in the field of the sociology of professions since then. It has been argued that the engineering profession is an "open profession" (Rothstein 1969), a "profession without a

community” (Perrucci and Gerstl 1969), and that it was a *weak profession* in comparison with the archetypal lawyers and physicians. Burrage *et al.* (1990: 214) argues that neither collective organization or ideology have been effective strategies for strengthening the engineering profession:

It appears, in fact, that the upward, managerial “exit” route is the Achilles’ heel of the profession, undermining both their solidarity and their ideology. . . . Strong professions on the other hand have no alternative career outside the profession, no such exit.

Similarly, Layton has argued that American engineers painted themselves as an industrial and managerial profession and that this accounts for their subordinate status. Business interests in the United States have favored technical societies built around single industries. A count in 1963 listed 130 national engineering and allied societies (Layton 1986: 56). The nature of engineering work itself is also used as an explanation for its weakness. Engineers do not have individual clients, and the engineering profession is one of the most occupationally assimilative of any profession” “its higher-level segment tends to merge with that of managers in general, its lower group into the class of skilled craftsmen” (Collins 1979: 174). But engineering can also be perceived of as the core occupation in the technical division of labor among craftsmen, technicians, and engineers, a perception that may be used to bolster the position of engineers, as the German case illustrates. This gives credibility to another perspective on professions, putting less stress on the nature of the work itself and focusing instead on the division of labor within organizational fields. This division of labor takes a different shape depending on what society we are talking about. It might be polarized or integrated in a hierarchy or skewed toward the managerial or the craft end of the continuum (Abbott 1988, 1991: 33; Armstrong 1984; Meiksins and Smith 1996). What is interesting about the suggestion that strong professions have “no exit” is that it implies that the strength of the engineering profession will vary with the degree to which they have successfully gained access to and occupied the managerial dimension.

Let me assume that *status* is a good indication of the strength of a profession. Evan (1969: 127) finds that the status of engineers decreases with the progress of industrialization and that it is higher in less industrialized societies. This thesis fits in nicely with the observed development pattern in the United States wherein engineering was increasingly defined as a preparation for a more prestigious but separate profession: management (Wickenden

1930; Rae 1955). The chances of ending up as a manager decreased as the number of engineers increased dramatically from 1900 to 1930. Professions with a background in accounting, finance, and business administration posed a challenge to the engineers' position in the field of management knowledge (Fligstein 1990). The perception of engineering as a preparation for management survived at the same time as the chances of reaching the top decreased. The engineers had sought to strengthen their position by "colonizing" the managerial function, but this strategy turned out to be an "Achilles heel" as they were losing out in the competition for control over the management function. The engineers in Germany and Japan may have been able to avoid status degradation because of their success in creating an overlapping identity between engineers and managers. At the time of Evan's study the lower level of industrialization in Japan and Germany was commonly thought of as an explanation for the higher status of engineers in Germany and Japan. This kind of argument clearly does not have the same kind of credibility today. Let me instead suggest the following alternative hypotheses:

1. The "exit" option was not used as frequently in Germany; engineers did not advance into management to the same extent.
2. Engineers did advance into management, but they were more successful at defining management as a technical dimension and a value-based calling, as opposed to a general management profession in which marketing and financial knowledge would matter more than technical knowledge. A career from technician to engineer to manager, then, was not perceived as an exit from the profession to the same extent as it was in the United States.
3. The one-sided emphasis on the academic engineering end of the technical spectrum in the United States and the neglect of the other occupations and specialties involved in technological development weakened the status of technology as such and therefore also engineers.

Hypothesis 1, that engineers did not advance into management to the same extent in Germany as in the United States, is apparently wrong. Academic engineers, indeed, were even more successful in management in Germany. The other two hypotheses, however, are supported by a great deal of literature (Hartmann 1959, 1967; Lawrence 1980; Locke 1984, 1989; Byrkjeflot 1998).<sup>15</sup>

Burrage's hypothesis about the relationship between an exit option and weak professions, then, has to be modified. Engineers are weak when they have to leave the engineering profession and enter the managerial profession as they climb into leadership positions, whereas they are stronger when it is possible to identify as manager and engineer at the same time. The engineering profession, then, is weak or strong depending on the social context. This modification actualizes the recurrent criticism against the literature on professions that it is too time and context-bound. Engineers are not weak everywhere because they are weak in the United States and Britain.

The major engineering association in Germany was the *Verein Deutscher Ingenieure* (VDI), which was established by engineering graduates at the technical institute in Berlin in 1856. None of the founders of VDI were industrial entrepreneurs. The purpose of the association was to promote "intimate cooperation for the intellectual powers of German technology for their mutual encouragement and continuing education in the interest of the whole of German industry" (*VDI-Zeitschrift* 1857: 4, quoted in Gispén 1989: 51). Gispén (1989: 55) reports that these early founders conceived of technology as "an autonomous intellectual-practical and national achievement, not an activity tied to profit or money." It was this conception of their role in society that drove the engineering professionals in VDI to unite with teachers and see education policies as a major strategy for professionalization. The initial marginality of both the engineering association and the technical school system in comparison with the state bureaucracy and the traditional university gave them a chance to develop alliances, and it has been argued that the VDI had a strong group-formative effect on German society.

The engineering professors who were predominant in the German engineering association until the 1870s promoted a conception of engineering as a science, and they also saw a classical secondary education as a precondition for becoming an engineer. They identified with quasi-aristocratic measures of social honor and sought to develop an honorable image of engineering. In contrast to the situation in the United States these engineering-professors had arrived on the scene well before the breakthrough of industrial society (Gispén 1989: 16). The various segments of the American associations were much more in conflict with each other. There were no membership criteria, and this meant that the industrial entrepreneurs were predominant. Calvert (1967: 55) classifies the Association of Mechanical Engineers (ASME) as a "gentlemen's club."

TABLE 10.3 Membership in VDI 1856–1920

1856	172
1860	367
1870	1,821
1880	3,959
1890	6,925
1900	15,245
1910	23,952
1920	23,917

SOURCE: Ludvig and König (1981: 562).

TABLE 10.4 Foundation date and membership distribution among the four “Founder Societies” in the United States

	Founded	Membership	
		1900	1916
Civil engineers	1,852	2,227	7,909
Mining engineers	1,872	2,661	5,234
Mechanical engineers	1,883	1,951	6,931
Electrical engineers	1,884	1,273	8,212

SOURCE: Mann (1918: 19).

Only 866 engineers had graduated in the United States before 1870. There were 179 members of the American Society of Civil Engineers, as compared to the 7,374 listed as engineers at that date. McGivern (1960: 108) concludes that 88 percent must have received training by the apprenticeship method. This supremacy of the “shop culture” could well explain why there was a lack of interest in formal engineering education among the engineers themselves, and why technical education during the first half century developed independently of the engineering associations, which did not engage in educational matters.

As noted, there was one engineering association (VDI) that clearly took the lead in Germany, whereas there was a power balance between four

associations in the United States (Tables 10.3 and 10.4). The more unchallenged status of VDI was one of the reasons for its strong influence in educational and professional matters. Wickenden wrote about the German association that “its publications on educational matters probably equal those of all the engineering societies of France, Great Britain and America combined” (Wickenden 1930, 802).

### Conclusion

The focus of many studies of management and management knowledge is on the diffusion of American management concepts and practices to Europe. In this chapter, however, the focus is on the formation of systems for management knowledge and legitimation of management positions in Germany and the United States. The engineering professions took a central role in both cases as practicing managers and in the development of the knowledge that managers used in governance of firms and in the legitimation of their position in society. The institutions that provided managers with knowledge in Germany and the United States were structured very differently. American engineers developed a separate system of academic engineering schools and an ideology of managerialism and professionalism to advance their common interests. They distanced themselves from craft workers and other technical workers. They developed a managerial mentality and wanted to be at the core of a new managerial class. This strategy backfired, as they gradually lost out in the battle to colonize the managerial function. German engineers developed an ideology of technical competence and patriotism and saw themselves as representatives of the whole field of technical education and industry. They were more successful in management positions, probably because they did not develop an identity that separated them from other technical workers and engineers. The knowledge base of German managers was different from that of American managers, much less formalized and much less focused on defining management as a separate function and competence. German management knowledge was much less codified and much more embedded in local contexts, and it was for this reason less vulnerable for local colonization (that is, being attacked by alternative professions) and more vulnerable for distant colonization (that is, import of codified management concepts from the United States). The last kind of colonization did not take place in the period dealt with in this chapter, however; so let me concentrate on

outlining the relationship between technical education systems and concepts of management in each case.

I have explained how the boundary of the field of technical education was drawn differently in Germany and the United States. German states developed a multilayered “estatist” system of technical education, whereas the American system for technical education was heavily centered on academic engineering education and oriented toward management. The movements for establishing technical education at a lower level were much weaker in the United States, and the ideology and the arguments of the associations involved in such activities were more individualistic and oriented toward uplifting of the disadvantaged. Missionaries, philanthropists, and social reformers were interested in vocational education in the United States, not artisans, state politicians, and industrialists, as in Germany. Manual training was developed for cultural and social reasons, not to serve industrial purposes. Although the industrial education system in Germany developed at a time when apprenticeships were still strongly supported by trade associations and guilds, it was presumed that the apprentice system was dying in the United States.

Secondary vocational schools and apprenticeships were not perceived as units in a system for technical education as they were in Germany. The failure to develop realistic career paths from apprenticeships and vocational schools into engineering might be one of the major explanations for the persistent and unbroken trend toward management dominance in American engineering. Engineering education in the United States was built on top of an existing, generalist model for secondary education. It is thus not a coincidence that the American education system “for all the talk of its vocational emphasis, is still the most massively non-vocational system of education in the modern world” (Collins 1979; 162).

In Germany a sharper line was drawn between the traditional university and technical and industrial education. The rise of the more technically oriented secondary schools and middle and top-level education institutions was part of a movement for industrialization and improvement of the status of industrial elites and professional middle classes in relation to traditional professionals and civil servants. A system of institutions was built up from the ground to serve this twin purpose, and the outcome was probably the most comprehensive and vocationally oriented technical education system in the world.

Each of the four actors presented above—professional associations, the state, the educationalists, and the industrialists—contributed to distinctive development patterns. The stronger state and the influence of the civil servant as a role model in Germany gave the professional association a powerful position in educational matters, since this association could serve as a mediator among industrial interests, academics, and workers. Wickenden (1930) argued that the industries provided the “motive power,” while the technical professions were guiding the movement. The German engineering association took a central role. The emerging consensus among industrial, professional, and state elites around 1910 was the result of a long process of political negotiation and adjustment.

Wickenden put a strong emphasis on education in the American case:

In no other country have the engineering schools been so free from outside domination. They owe little to statecraft other than the provision of means for their extension and support. They owe little to the organized engineering profession except the benefits of occasional criticism of their aims and methods. They owe little to the industries except an ever-widening field of employment for their graduates. (Wickenden 1930: 823)

The discussion above supports his argument. In the United States the industrial interests could not take the lead in the same way as in Germany, since they lacked the organizational arenas and resources provided by corporatism in Germany. The state legislated initiatives that spurred the development of engineering schools, but they left it to these schools to govern their own matters once they were established. Educational and professional entrepreneurs took the lead in associations for coordination and standardization. Professional associations were weakened by the emphasis on functional fields and specialized curricula among the early engineering schools.

In this account I have emphasized the different institutional framework and political constellations and the differences in organizational resources among academics, practitioners, states, and business interests. The boundary of each organizational field was drawn differently. The academization process started much earlier in Germany. It was for this reason that the industrial revolution was bound to have a different impact on the development of technical schools. The rise of the large corporations in Germany increased the influence of the practitioners and the industrialists in the educational system, not the teachers and academics, as in the United States.