Chapter 5
Engineering Ethics and Engineering Identities: Crossing National Borders

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Abstract This article describes and accounts for variable interests in engineering ethics in the United States, France, Germany, and Japan by locating recent initiatives in relation to the evolving identities of engineers. A key issue in ethics education for engineers concerns relationships between the identities of engineers and the contents and responsibilities of engineering work. These relationships have varied significantly over time and from country to country around the world. One methodological strategy for sorting out similarities and differences in engineers' identities is to examine who counts as an engineer, or what makes an engineer. The significant interest in engineering ethics in the United States has been linked to difficulties in adding professional identities to corporate employment. While engineering ethics has attracted little interest in France and formal education in the subject might very well be seen as insulting, German engineering societies have, since the conclusion of World War II, demanded from engineers a strong commitment to social responsibility through technology evaluation and assessment. In Japan, recent flourishing of interest in engineering ethics appears to be linked to concerns that corporations no longer function properly as Japanese "households." In each case, deliberations over engineering ethics emerge as part of the process through which engineers work to keep their fields in alignment with their changing images of societal advancement.

Keywords Engineering education • Ethics • History • United States • France • Germany • Japan

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Introduction

Professional ethics has become a well-established dimension of engineering education and practice in a number of countries – and may even be described as undergoing a process of globalization. Since the mid-1980s the U.S. Accreditation Board for Engineering and Technology (ABET) has increasingly required engineering programs to include the teaching of professional ethics – a requirement given new specificity in 2000, with the stipulation that 1 of 11 demonstrable outcomes should be "an understanding of professional and ethical responsibility." That same year the Japanese Accreditation Board for Engineering Education (JAABE) likewise began to require accredited programs to have an "understanding of … engineers' social responsibilities (engineering ethics)." Other expressions of commitment to engineering ethics can be found in the *Charte d'Éthique de l'Ingénieur* [Charter of Ethics of the Engineer] published by the Conseil National des Ingénieurs et Scientifiques de France (CNISF or National Council of Engineers and Scientists of France) in 2001, and the *Ethische Grundsätze des Ingenieurberufs* [Fundamentals of Engineering Ethics] issued by the Verein Deutscher Ingenieure (VDI or Association of German Engineers) in 2002.

Despite the obvious similarities of these initiatives, however, such emergent interests in engineering ethics are the products of distinct historical trajectories and have significantly different implications locally. For example, in issuing its new criteria, ABET, which traces its history back to the 1930s, was concluding a decade-long modification of its accreditation system. By contrast, JABEE, which was only created in 1999, was introducing the concept and practice of accreditation for the first time. In the French case, the *Charter for Engineering Ethics* was a new document issued by an engineering alumni organization, with no direct implications for any educational curriculum. The German *Fundamentals of Engineering Ethics* likewise has only indirect educational import, yet derives from a history that goes back to a post-World War II revival of professional engineering.

Such initial contrasts suggest that any real understanding of the global dimensions of engineering ethics requires further considerations of ethics in relation to differing trajectories of engineers' identities, including self-understanding (Downey and Lucena 2004). Ethical responsibility is a dimension of position and identity. Although similarities exist among lawyers, physicians, and engineers across national or cultural boundaries, there are often insufficiently recognized differences. For researchers and teachers interested in engineering ethics and students learning about professional practice in engineering, efforts to appreciate such differences can enhance their own self-understandings as well. In addition, the extent to which engineering ethics in different countries are now influencing one another, for example by the dissemination of ABET-like criteria around the world, depends in part on how national differences originally developed and how well such developments are appreciated.

United States: Engineers and Private Industry

As historian Edwin Layton (1971) has shown, engineers in the United States have long struggled with the fact that, unlike lawyers or physicians, they have been professionally divided into civil engineers, mechanical engineers, electrical engineers, and a host of other discipline and class specific groups. For instance, the American Society of Civil Engineers (ASCE, founded in 1852), adopted high membership standards and became an elite organization sometimes at odds with business interests. By contrast, the American Institute of Mining Engineers (AIME, founded in 1871) was more egalitarian and regularly allied itself with business interests in the mining industry. In response to ASCE professionalism and AIME commercialism, there appeared the American Society of Mechanical Engineers (ASME, 1880) and American Institute of Electrical Engineers (AIEE, 1884), attempting different blends of autonomous professionalism and economic pragmatism. The subsequent formations of the Society of Automotive Engineers (SAE, 1904), American Institute of Chemical Engineers (AIChE, 1908), and Institute of Radio Engineers (IRE, 1912) only intensified the fragmentation typical of professional engineering in the United States.

In response to these centripetal movements, there emerged a series of centrifugal efforts to unite the professional engineering community. In 1880 it was the creation of the Association of Engineering Societies for a national engineering congress. In 1911 it was formation of the Joint Conference Committee. Similar efforts can be found threaded through the Committee on Engineering Cooperation (1915), the American Association of Engineers (1915), the Engineering Council (1917), the Federated American Engineering Societies (1920), and the Engineers Council for Professional Development (ECPD, 1932) – the last of which has had a life longer than any other, eventually being transformed in 1980 into ABET. The very multiplicity of these efforts nevertheless indicates their weakness and attests to the fact that engineers in the U.S. are mostly not self-employed professionals, in contrast with physicians and lawyers, but employees of larger firms that benefit from engineering fragmentation. The individual engineer is typically not an autonomous or consulting engineer but one whose professional identity is defined in terms of the economic interests of private industry.

Parallel with such institutional efforts to unite the engineering profession were others to conceptualize the unique ideal that engineers pursue for the common good. The classic 19th century definition, that of the British engineer Thomas Tredgold (1788–1829), described engineering as "directing the great sources of power in Nature for the use and convenience of man" (Institution of Civil Engineers 2012/1828, p. 4). But in comparison with the ideals that inspire the practice of medicine and law – i.e., health and justice – "use and convenience" would seem to be lower-level goods subject to determination more by a client than by a professional. The dominant external interpretation of "use and convenience" in the U.S. has been the low cost and mass production of goods and services – an interpretation that the professional community has been challenged with since late nineteenth century (Downey 2007).

One influential but failed effort to articulate an ideal that would justify more professional independence for engineers from business interests focused on efficiency as promoted by the technocracy movement (Akin 1977). From the perspective of the technocratic ideology, what business actually wanted was not so much low cost but high profits. Low-cost-based design and manufacturing shortcuts coupled with manipulative advertising offended the engineering ideal of technical efficiency. In 1928, at the height of this dream of expanded engineering influence, on the basis of his public service achievements in post-World War I relief and the 1927 Mississippi River flood, Herbert Hoover was elected the first professional engineer president of the United States.

But the efficiency ideal was problematic on two counts. First, its elevation of technical expertise to public decision-making leadership tends to be at odds with locally-dominant images of democracy. The major European totalitarian philosophies of the mid-twentieth century, communism and fascism, often justified themselves by appeals to efficiency. Second, as a ratio of outputs over inputs, efficiency was context dependent, subject to multiple interpretations depending on how the inputs and outputs themselves are defined. Engineers, as employees, remained subordinate to commercial interests that defined efficiency in terms of economic profits.

In another approach to the enhancement of professional unity and autonomy, U.S. engineering societies began in the early decades of the twentieth century to formulate codes of professional ethics. Initial attempts at code creation, for instance, prohibited the engineering criticism of other engineers in ways that would undermine unity, and as part of its unifying mission, the ECPD was tasked with drafting a code of ethics to bridge those of different member organizations. The first ECPD code of 1947 actually constituted a watershed in U.S. engineering ethics development by explicitly introducing responsibility for public safety, health, and welfare as a basic consideration. Then in a 1974 revision, the first of seven fundamental canons became: "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties."

Over the next two decades, high-profile cases such as two major DC-10 crashes (Paris in 1974 and Chicago in 1979) and a series of fatal accidents with the Ford Pinto automobile (manufactured from 1971 to 1980) – both associated with problematic engineering designs – conspired to raise public concerns about engineering safety. Beginning in the 1970s, the U.S. National Science Foundation promoted collaborative research between engineers and philosophers to better analyze engineering ethics issues – such as those associated with whistle blowing, autonomy, and the "paramountcy clause" – and to develop appropriate materials for teaching engineering ethics. When the Challenger shuttle launch disaster of 1986 further revealed limitations on engineering independence, ABET was thus able to draw on existing work to promote more strongly requirements for ethics education as a component of all accredited engineering programs. Yet more recent attempts to integrate issues of sustainability and social justice into engineering ethics discussions have proven less successful, likely because employers tend to judge them in conflict with a dominant normative commitment to maximize sales and profits.

The engineering profession in the United States has been a world leader in promoting engineering ethics code development and associated educational activities. But this leadership has grown out of a long, and continuing, struggle and desire for professional unity and autonomy.

Japan: Engineers and Households

In Japan the promotion of professional engineering ethics instruction began in the late 1990s, stimulated in part by some high-technology accidents such as a sodium leak at the Monju fast-breeder reactor (1995) and a disastrous criticality accident at the Tokaimura reactor (1999). In this respect, there are similarities to the situation in the United States, where DC-10 crashes and the Challenger accident contributed to the rise of ethics education to promote professional autonomy. But for the Japanese engineering community, it was not so much autonomy that was at issue as reforming a disordered household and meeting the perceived challenges of internationalization.

To understand the distinctive features of engineering ethics in Japan, it is important to appreciate the role harmony plays for Japanese engineers in both domestic and international professional relations (Luegenbiehl and Fudano 2005). A key concept here is that of the 家 (*ie*, pronounced ee-aa, commonly translated into English as "household.") *Ie* has multiple meanings and can refer both to a physical home or family estate and to a family genealogy. It can also involve economic and socio-religious implications. As described by anthropologist Dorinne Kondo, in Japan a distinctive vision of the *ie* marks it as a basic social phenomenon and a site of obligation and responsibility. "The *ie* is not simply a kinship unit based on blood relationship, but a corporate group based on social and economic ties." Personal identity does not exist prior to or independent of the household but is defined by one's position within it "Subordinating one's individual desires to that of the household enterprises takes on the character of moral virtue," Kondo observed. "Pursuing one's own plans and disregarding the duties toward the household smacks as selfish immaturity" (Kondo 1990, p. 131; see also Traweek 1993, p. 401; Lanham 1979, p. 5). The household serves as a center for attachment, or *uchi*.

Students begin competing to demonstrate their appropriateness for corporate household attachments long before entering higher education, in kindergarten or even pre-school. The country is widely known for what the Japanese call "examination hell," the extended preparation for higher education entrance examinations that determine life career paths (Vogel 1971). But examinees are not just revealing individual achievement so much as demonstrating a mature other-directedness developed through the disciplined acceptance of hardship. In this sense preparation for the exam is about "polishing the heart" [*kokoro*]. As Kondo puts it,

> In Japanese society generally, hardship is considered one pathway to mature selfhood…. [E]ndurance and perseverance are among the most frequently cited virtues in Japanese society.... Learning to stick to a task, no matter how difficult or unpleasant, thus strengthens the *kokoro*. (Kondo 1990, p. 109)

Those who achieve the highest entrance examination scores are able to enter engineering programs at prestigious national universities. But in contrast with engineering students in the United States, once matriculated they need to do little more to warrant good employment. Typically, Japanese students regard their university years as a well-deserved vacation from hard work. Although those in engineering work more than others, even for them university life constitutes something of a time-out from household duties. Having departed from the family household of origin, they are transitioning to the corporate household that will serve as the basis of identity and obligation for the balance of their working lives.

This distinctive approach to reckoning identity and responsibility through household-like social groups has a long history, one nodal point of which was establishment of the Japanese nation state under what is known in the West as the "Meiji Restoration" (1866–1869) (Chizuko 1996). Undertaken in response to the challenge of the West – as manifested, for instance, by U.S. Commodore Matthew Perry's forced opening of Japan to world trade in the 1850s – the new imperial government explicitly restructured Japan as a "family state" (Shibata 2004, p. 76). Survival could best be assured through the fulfillment of obligations to a family state that has made possible an unusual openness to adaptations from the West such as industrialization, provided such imports are subsequently given a Japanese form.

One key example of an import followed by a process of Japanization was technical education. In 1868, Yozo Yamao, who had been studying abroad in Glasgow, returned to become vice minister of education with the goal of establishing an engineering school. The Imperial College of Engineering was founded in 1873 with Scotsman Henry Dyer imported to serve as head. The government then systematically replaced British professors with Japanese graduates until finally, in 1886, the College was merged into what became the University of Tokyo.

The University of Tokyo engineering program in turn has been a major source for managers and directors of the most powerful technology-based corporations (Morok and Nakamura 2003). One of the first replacement faculty members, Fujioka Ichisuke, helped found Toshiba. Hitachi had 11 directors prior to 1941, all but one being engineering graduates from the University of Tokyo. Other graduates founded Toyota and Nissan (Odagiri 1998, pp. 143–146). Although the post-World War II occupation authorities dismantled the militaristic hierarchies of the Japanese *ie*, their practices also stimulated new forms of household formation, including those that included university-corporation partnerships for the development of science and technology. As Prime Minister Suzuki Kantaro already proclaimed shortly after Emperor Hiroito announced Japan's surrender in 1945: "It is essential that the people should cultivate a new life spirit of self-reliance, creativity and diligence in order to begin the building of a new Japan, and in particular should strive for the progress of science and technology, which were our greatest deficiency in this war" (Morris-Suzuki 1994, p. 161).

During the postwar period, according to Kondo, the "company as family" became the basis of the Japanese employment system, which has been characterized by welfare paternalism, seniority promotions, lifetime employment, and worker identification with the firm. But the great post-war success of the new corporate *ie*, which extended corporate households beyond the boundaries of the nation, also raised certain challenges. Extended household loyalties weakened and public scandals occurred as individual self-interest took precedence over harmonious service to a common goal. Given the household model, traveling down such a path risks, to invoke Kondo's terms, "disregarding the duties toward the household," failing to demonstrate "moral virtue," and even "selfish immaturity" (Kondo 1990, p. 131; see also Luigenbiehl 2004, p. 9).

Actions by professional engineering societies attempted to respond to such challenges. When working engineers attend continuing education classes in engineering ethics, they receive a booklet documenting their accomplishments. But these professionals are not being trained to become whistle blowers who risk job and career in the name of individual honesty and autonomous judgment (Wokutch and Shepard 1999). Although more than one commentator has described engineering professionals as learning "to judge what they should do or not to do according to the engineers' ethics" (Ohashi 2000; Kawashima et al. 2004, p. 101), there are subtle ways in which professional attachment is being emphasized as much as individualism. In the course of promoting ethical decision making, professional engineering societies are also offering themselves as *uchi*, new centers of belonging responsible for defining the identify of engineers in order to help them struggle with change. Ethics is also a means "to secure international acceptance of engineers' qualifications" (Kawashima et al. 2004, p. 101).

The JABEE criteria for engineering education that include explicit mention of engineering ethics further support this interpretation. In first place among the eight new standards for assessing engineering education programs is teaching "the ability and intellectual foundation for considering issues from a global and multilateral viewpoint." Second place goes to an ethics-related standard of learning to appreciate "the effects and impact of technology on society and nature, and of engineers' social responsibilities." In this image of the Japanese engineering curriculum, what is primary is the development neither of abilities in mathematics and science nor of skills in engineering analysis – the first outcomes listed in the ABET accreditation scheme – but learning to consider issues from a point of view that rises above self-interest, overcomes selfish immaturity, and locates one's concerns and interests in relation to those of others engaged in the general pursuit of harmony.

Further evidence for the importance of *ie* in the new engineering professionalism can be found in the 1999 action by the Japanese Society of Civil Engineers to replace its "Beliefs and Principles of Practice for Civil Engineers" with a new "Code of Ethics for Civil Engineers." The "Beliefs and Principles" had not been updated since 1938 and had been of relatively little consequence since its formulation. Although the new "Code of Ethics" admonishes engineers to "adhere to the ethical principles of self-disciplined moral obligation when applying advanced technology" it also repeatedly stresses responsibilities to society at large. The first provision, for example, states that the civil engineer shall "[a]pply his/her technical skills to create, improve, and maintain 'beautiful national land,' 'safe and comfortable livelihood,' and 'prosperous society,' thus contributing to society through his/her knowledge and virtue with an emphasis upon his/her dignity and honor." A sense emerges of the professional engineering society as a household through which obligations can legitimately be formulated and fulfilled for the common good.

The national movement to promote professionalization and ethics among engineers may thus be read as an innovative move to establish the viability of a new household, the engineering profession, that functions both as an aid to corporate households and retains a primary obligation to the national household – one that may also serve as a pathway for engineers to work around those corporate households that have failed to fulfill their obligations at the national level (Wokutch and Shepard 1999). As Hideo Ohashi eloquently put it,

> We need a revolution of our consciousness, from ignoring to respecting professionals … The recovery of competitiveness should not be the final target. We dream of a society whose keywords are safe, reliable, healthy, peaceful, and heart-warming. (Ohashi 2000)

France: Engineers and Social Order

As noted, the French Charter for Engineering Ethics was not meant to become part of standard engineering curricula. The CNISF, which did not create even the first version of this charter until 1997, coordinates the activities of alumni associations for engineering schools and has no oversight responsibilities for practicing engineers. Indeed, there is little evidence that most engineers in France have ever heard of CNISF (Didier 1999, 2000). At the same time, it is notable that this Charter explicitly links engineering with the concept of progress, describing engineers as the source of innovation and the engine of progress: "L'ingénieur est source d'innovation et moteur de progrès" – a view that is undoubtedly held by many engineers in the United States, although this is not a statement that would ever be thought appropriate to an ethics code.

The key to understanding the larger disinterest in ethics in engineering education in France rests with the longtime elite status of French engineers (Alder 1997). Unlike in the United States, engineers in France do not have to struggle for social respect. As the French journalist Jean-Louis Barsoux (1989) explains: "In France, engineering education does not play second fiddle to medicine, law, or architecture – it is the recognized way to the top, both socially and professionally." Barsoux is referring to a special category of so-called "state" engineers, i.e., those who work as high-level civil servants in the national government. Although state engineers have been in the minority at least since 1900, their status has cast a favorable glow over all French engineers.

The ethics of French state engineers is both established and demonstrated by their participation in a rigorous exam system. Students who aspire to become engineers have first to complete a *baccalauréat*, or high school diploma, with appropriate emphasis in mathematics and science. They then undertake two years of math-intensive study in *classes préparatoires*, often held in the same buildings in which they completed the baccalaureat. At the conclusion of this process, prospective students compete for positions in the elite schools, the so-called *grandes écoles*, by sitting for the *concours*, a combined written and oral exam whose scores are published in local newspapers and determine who will be granted admission to which schools. In this respect, there are similarities with the Japanese system.

But in what sense is one's morality demonstrated by successful completion of this process? Important clues lie in the fact that the process of gaining entry into one of the elite schools is not called "admission" but "promotion," and that eventual graduates will forever identify themselves as cohorts based not on the year of graduation but on the year of matriculation. Furthermore, the rankings continue throughout their studies, at the conclusion of which the highest-ranked graduates remain on pathways leading ultimately to senior positions in government ministries. By entering an engineering school, prospective state engineers join a system in which they serve as both leaders and embodiments of French society.

In contrast with the challenge of progress prominent in the United States – which aims for free market individualism maximized in the low-cost mass production of goods and services – since the Enlightenment the dominant view among French state engineers has been that the goal is rational social order achieved through sound mathematical principles. Such rational unification takes place best in government, protected from the diverse economic perspectives and interests of private industry. Examples of this commitment to rational planning are legion. As historian Cecil Smith writes, "Ever since the birth of the Corps des Ponts et Chaussées in the eighteenth century, French state engineers have promoted the complementary notions of rational public administration in the general interest and planning on a national scale." For instance, in the 1820s, when Corps des Ponts director Louis Becquey gained approval for a national system of canals in France, private companies applied to construct the projects, following the practice in Great Britain. But Becquey successfully "defended the interests of state engineers by arguing that the plans 'are in the public interest, for without [state engineers'] supervision, private companies would indulge in the meanest economizing'"(Smith 1990, p. 659). At the end of the century, a Corps des Ponts chief engineer successfully resisted the encroachment of private interests into plans for the electrification of France as "ignorant greed [which] threatens to squander a national resource" (Smith 1990, p. 685).

During the early twentieth century, a group of graduates from the most elite of the technical schools, the École Polytechnique (aka "*L'X*"), established the think tank *X-Crise* to promote an alternative philosophy to capitalism, communism, and fascism. They called it "planism." Among them was Jean Coutrot, an engineer-intellectual and founder of the Centre d'Études des Problèmes Humains [Center for the Study of Human Problems]. According to Coutrot, the leadership of engineers was rooted in engineering analysis: "It is to the engineers, today, that it falls to construct better societies because it is them and not the legalists or politicians who hold onto the necessary methods" (Clarke 2001, p. 81). As historian J. Clarke explains, for Coutrot and other engineers who were concerned about the dehumanizing effects of mass production, communist collectivism, and fascist centrism, "the central problem of their time was the question of how to organize a society that was both rational and human" (Clarke 2001, p. 84). In some respects, what French engineers achieved in this instance was the rationalist ideal of the technocracy movement that was growing in the United States during the same period.

After World War II, state engineers secured complete jurisdiction over electricity, train transportation, and atomic energy, all in the name of rational national planning in the general or public interest. As Smith explains, "they acted as planners, economists, urbanists – 'inter-ministerial generalists,' drafting legislation and then the decrees to implement it" (Smith 1990, p. 692). The influence of state engineers spread through a greatly enlarged "para-public" sector that included electric power, gas, coal, banks, airlines, telecommunications, Renault, and the French national rail system SNCF. "As true as it is that public engineers acted as an elite all too confident in the power of 'superior light' [lumières supérieures] to determine the 'general interest,'" Smith concludes, "it is no less true that for 250 years they sustained an ethos of public service rarely found elsewhere" (Smith 1990, p. 693). This is an ethos acquired at the *grandes écoles*.

Since their eighteenth century founding, engineering educators in the most elite *grandes écoles* – that is, the École des Ponts et Chaussées (1747), École des Mines (1783), and École Polytechnique (1794) – have placed the highest value on mathematical knowledge. As historian Wolfhard Weber explains, Gaspard Monge, the "father of the École Polytechnique," explicitly saw mathematical theory as the key for steering the present by enabling clear descriptions of the future. "Monge himself insisted that descriptive geometry was an answer to the French nation's requirements." This new science made it possible to represent three-dimensional objects in two dimensions, which was crucial for designers, and could fix the exact location of objects and the relations of their parts. By these means it "brought together a series of factors fundamental … for progress" (Weber 1986, pp. 21–22). The names of subsequent mathematician-engineers who taught at the top schools and served in the civil service constitute a virtual Who's Who of the engineering sciences: Joseph Fourier (1768–1830), André-Marie Ampère (1775–1836), Siméon-Denis Poisson (1781–1840), and Sadi Carnot (1796–1823), to name only a few.

For French engineers, demonstrating the ability, commitment, and discipline to become proficient in the mathematical foundations of engineering is to demonstrate that one has the moral character and reliability to warrant the trust of the Republic. Students who have been promoted into the national system of rational deliberation and action geared toward increasing social order have already demonstrated everything necessary to warrant a position of national leadership. They have mastered all the principles and values that constitute engineering ethics in France; indeed, one might find considerable support for the claim that rationalist engineering constitutes the dominant ethic of France. For students who have already demonstrated their character through their competence, to then have to enroll in a course in engineering ethics would seem ludicrous, if not insulting. It should be no surprise, then, that the annual military parade on Bastille Day, which publicly celebrates the accomplishments of the Republic, is led by second-year students from the École Polytechnique.

Why then did the collective organization of alumni associations feel pressure to formulate and disseminate a code or charter? This move may perhaps be understood as one of many efforts in and around French engineering education to adapt to the increasing value accorded the private sector as a measure of national worth after the end of the Cold War. A U.S.-led shift in the dominant image of international relations replaced a grand conflict between two philosophies of political economy with a model of economic competitiveness that pictures countries competing for economic dominance. This shift has forced other countries to adapt to a North American model of progress oriented toward the free market production of low-cost goods for mass consumption. In response, the *grandes écoles* reluctantly initiated international student exchange programs and new career pathways oriented more toward private industry. In particular, expecting engineers to participate increasingly in international workplaces beyond Europe, schools have also begun expanding the non-technical dimensions of engineering education.

It is in this context that "ethical reflection on the engineering profession" has gained a modest foothold. In 1995, the Commission des Titres d'Ingénieurs [Engineering Titles Commission], established in 1934 to protect the formal title "graduate engineer," updated its non-technical requirements to include "foreign languages, economic, social and human sciences and a concrete approach to communication problems as well as providing openings to ethical reflection on the engineering profession" (Centre d'Études sur la Formation des Ingénieurs 2000). This modest effort nevertheless did not generate significant concrete activity at the elite schools.

Germany: Engineers and *Bildung*

The *VDI* Fundamentals of Engineering Ethics stresses in unique ways that although engineers must "know the relevant laws and regulations of their countries" they should honor them only "insofar as they do not contradict universal ethical principles." Moreover, in cases of value conflicts, engineers are admonished to choose "the values of humanity over the dynamics of nature," "human rights over technological implementation and exploitation," and "public welfare over private interests." How did universal ethical principles become such a major commitment – one much stronger than the U.S. commitment to protecting public safety, health, and welfare – and what does it mean for the German engineers themselves?

The immediate interest among German engineers in the impacts and effects of technologies on humanity can be traced to the post-WWII period. Having been co-opted by the National Socialists during the 1930s, the *VDI* was revived in 1947 with an international engineering education conference on "*Technik als ethische und kulturelle Aufgabe*" [Technology as ethical and cultural task]. The problem for the members of the VDI was precisely that they had accepted the ideal of what engineer-historian Thomas Hughes (1980) calls "culture-determined technology," in which they failed to challenge Nazi cultural leadership. A major post-war task was thus to break free from such a determination, a project that began with this conference and continued through an active collaboration with anti-Nazi German philosophers in a series of four additional meetings between 1950 and 1955 on the general theme of technology and humanity. Indeed, a strong collaboration with philosophers is itself a distinctive feature of the lives and work of engineers across Germany.

As its contribution to this effort, the 1950 conference drafted an Engineer's Confessions that employed a distinctly religious rhetoric to offer a vision of engineering as a spiritual vocation (*Verein Deutscher Ingenieure 1950*). According to the Confessions, the engineer "should place professional work at the service of humanity … [and] should work with respect for the dignity of human life and so as to fulfill his service to his fellow men without regard for distinctions of origin, social rank, and worldview." To include an explicit commitment to humanity as a whole constituted a self-criticism by German engineers, who previously had understood themselves as advancing civilization by serving Germany. At the same time, a significant continuity was the idea of technology as a vocation, the understanding of which points toward the distinctive German notion of *Bildung*, formal education oriented toward spiritual growth and perfection.

In the mid-1800s, German culture and education became a major vehicle for the expression of German aspirations for unification. Indeed, already in 1807, philosopher Johann Gottlieb Fichte had argued in his *Reden an die deutsche Nation* [Lectures to the German Nation] the significance of *Bildung* as a means to unify and develop Germany. Germany could become great and contribute to human development through a *Bildung* that was, however, conceived as grounded in and an extension of Greek and Latin cultural life.

Throughout most of the nineteenth century, the professions of law, medicine, philosophy, and theology monopolized *Bildung* in this strong sense because of the preparatory curriculum they demanded in the elite secondary schools, or Gymnasia. Only those students who had mastered classical studies in Greek and Latin philology were thought able to manifest the *Geist* or spirit that was the perfection of human nature (Masschelein and Ricken 2003). The significance of this *Bildung* actually derived in part from its contrast with technical training and work. *Techniker*, or technologists, who actually functioned in ways similar to what in other countries were called "engineers," underwent an educational program separate from that of the gymnasium, with the gymnasium degree or *Abitur* being the only path into the university.

Early attempts to enhance the cultural prestige of technical learning and work included creation of the Association for the Promotion of Technical Activity in Prussia (1821) by Prussian Finance Minister Christian Peter Beuth. Understanding *Bildung* and cognizant of negative effects of industrialization on English workers and landscapes, Beuth sought to promote a distinctively German industrialism that imbued technology with art and emphasized aesthetics as an evaluative criterion (Brose 1992). According to Beuth, industrialization would be acceptable in Germany as a site for the emancipation of *Geist* by means of a new form of *Bildung*. He thus stipulated, unsuccessfully, that art and aesthetics be included in the curricula of nascent technical schools serving the lower classes of society.

An educational movement that proved more immediately successful established *Technische Hochschulen*. These were technical post-secondary schools or institutes that included among their responsibilities fundamental research on *Technik*, a concept that included both technical products and the technological processes for their production (Manegold 1978). First established during the middle part of the century, the new institutes gained greater visibility and status after the 1870s, during the unification of Germany under the Prussian-led Second Reich. Advocates for the technical institutes also established a new form of quasi-academic secondary education in *Oberrealschulen*, whose "realism" included teaching modern rather than classical languages.

In 1885 a commission of the *VDI* (which had been founded in 1856) concluded a review of the structure of German education and its implications for engineers by demanding that the courses students followed into and through the technical institutes have the same legal standing as those through the *Gymnasium* to university. "The engineer in the eyes of many," according to the commission,

> was – and partly still is – an advanced artisan, neither requiring nor deserving the higher *Bildung* offered by the *Gymnasium*. We declare that German engineers have the same needs with respect to their general *Bildung* and wish to be subject to the same standards as the other higher professions. (Gispen 1990, p. 146)

William II approved this request in 1892 by giving *Oberrealschulen* graduates the right of admission to the engineering corps, in 1899 accepting them as eligible for employment in the civil service, and in 1900 granting them equal status to graduates of the classical *Gymnasium*.

In the early twentieth century, members of this new professional engineering community defended the thesis that the emancipation of the human spirit included not just classical culture but also *Technik*. In *Lebendige Kräfte* (1904), for instance, the German engineer Max von Eyth even argued contra Hegelian philosophers and Prussian lawyers that technology rather than reason should be seen as the vehicle for the unfolding of Geist or mind/spirit (von Eyth 1903). As historian Jeffrey Herf summarized Eyth's view,

> there was more Geist in a beautiful locomotive or electric motor than in the most elegant phrases of Cicero or Virgil. Technology, like poetry, dominates matter rather than serves it… . [T]echnology was actually more cultural than culture itself. (Herf 1986, p. 159)

Feeling empowered by an increasing national commitment to industry, engineers openly challenged the value of the universities and "praised their own achievements as 'national' ones and engineers as 'pioneers of German value and culture'" (Herf 1986, p. 156).

Elite German engineering intellectuals thus engaged in a kind of cultural politics that historian Karl-Heinz Ludwig (1974) has described as the "anticapitalism of technicians." This philosophy held that "technology emanated from the deepest impulses of German Kultur"; that contemporary crises in German society, especially after World War I, "were not due to the machine but to its misuse by private capitalist interests"; that "the welfare of the national community could be protected only by a strong state"; and that "engineers had a central role to play in providing the expertise necessary for Germany in an age of technological warfare" (Ludwig 1974). This engineering point of view found the development of National Socialism compatible with its goals, because the new political movement claimed to be oriented toward emancipating a German essence that promised to overcome the misdirections of a self-interested aristocracy and a disordered free-market capitalism by relying on a charismatic individual.

During the Third Reich, engineers tolerated and even supported antisemitism on the grounds that Jews were not essentially German and served as purveyors of free-market capitalism. Through a deliberate political neutrality oriented only to technical work, they stumbled into the role of collaborators who sanctioned through inaction, and sometimes obedience, a willful and active misuse of *Technik* to destroy humanity rather than develop it. When a reconstituted *VDI* was struggling to understand what had happened and how engineers should re-position themselves as positive contributors to society, they therefore had to extend their vision beyond any hypothetical German essence to include humanity as a whole. *The Engineer's Confessions* stipulated that "The engineer should not bow down to those who disregard human rights and misuse the essence of technology; he should be a loyal co-worker for human morality and culture." Engineers now had to re-conceptualize *Technik* to acknowledge that technology could have serious negative consequences that would not constitute societal advancement of any kind.

In the 1970s this new sense of social responsibility was expressed in efforts by German engineers to influence the emerging discipline of technology assessment. During this period German engineers sought to embody their broad ethical responsibilities in assessing technologies according to eight metrics of value in three categories, including functionality, economy, and material standard of living; safety, health, and environmental quality; and development of individual personality and quality of social life. The very use of the term *Technikbewertung* [Technology evaluation] as a translation of "technology assessment" tended to stress going beyond the kind of limited cost-benefit analysis that became the norm in the United States. Moreover, individual engineers were not left alone to evaluate technologies on the basis of personal conscience but were presented with guidelines that had been authorized by the engineering community as a whole (Huning and Mitcham 1993).

Why then a commitment to updating and simplifying these guidelines in 2002? Like the Japanese and the French, Germans were working to adapt to a world increasingly dominated by images of economic competitiveness, with an emphasis on low-cost production for mass use. On the one hand, German engineers were struggling to construct new practices in which technology evaluation was not only an ideal but also reduced costs (Legg 1990). On the other, a reaffirmation of a responsibility to engage in technology assessment offered evidence that *Technik* was still about emancipating *Geist*. Simplifying and reaffirming universal ethical principles was a way to achieve both ends.

Conclusion: How Engineering Ethics Follows Different Trajectories

As these comparative cases suggest, the progressive concern for engineering ethics in different countries may well be one manifestation among engineers of what is today called "globalization." Because of their situation in the largest economy in the world, within which competition on the basis of low-cost production for mass use has a long history, leadership in engineering ethics development in the United States undoubtedly influenced advocates for engineers and engineering in other countries. But border crossing also produces transformations. The fact that engineering ethics has been pursued in the United States to promote professional unity and autonomy does not mean that others would pursue it in similar ways in other countries.

In Japan, the early twenty-first century interest in engineering ethics among professional societies and the promotion of ethics education by a new Japanese engineering accreditation organization offers a case of consciously-imported influence, in part to achieve international recognition of domestic engineering programs. But engineering ethics in Japan can also be interpreted in terms of its relationships to the uniquely Japanese social institution of the *ie* and efforts to develop the engineering profession as a household center of belonging alongside existing corporate households. The professional engineer in Japan appears to be emerging as someone with a new, untarnished pathway to fulfilling obligations to the national household.

In France, formal education in engineering ethics has attracted little interest. Explicit courses in engineering ethics are easily seen as unnecessary if not insulting to those elite engineers whose dedicated study led to a higher education committed to civil service in pursuit of rationalist national progress. Indeed, in such a context, for non-elite schools to adopt education in engineering ethics might even be interpreted as an open admission and acceptance of subordinate status – although embraces of global competitive pressures, as well as new pan-European efforts could well lead in this direction.

In Germany, a post-World War II reassessment of the relation between engineering and the traditional ideals of humanistic *Bildung* has led to a new commitment of engineers to the good of humanity as a whole. A longtime commitment to social responsibility through the production of high quality technology further led to the adoption of technology assessment as a major feature of engineering ethics. For German engineers, engineering ethics and technology assessment constitute a spiritual contribution to globalization.

Recognition of how engineering ethics follows diverse local trajectories with distinctive implications across particular countries has implications for how to think about engineering ethics within any country. Who openly advocates instruction in engineering ethics? Who passively ignores such initiatives? Who openly resists? Asking questions such as these may serve to indicate something about both the positioning of ethics in engineering identities and the complexities of struggles among those who are content with their current identities and those who might be seeking change. In this sense, following debates over engineering ethics can provide a means of mapping and understanding some of the contemporary flows of globalization as engineers interpret and engage them.

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