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Avoiding Inferiority:
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Seemingly in parallel with colleagues throughout the world, many engineering educators across Japan are asking what must be done to prepare students for a globalized world. In 2008, for example, The *Journal of the JSEE* [Japanese Society for Engineering Education] published two theme issues on the topic. The journal translates the title of the first as "Breeding Future Engineer [sic] Compatible with Globalizing Society." Its editors, Harada Shoji and colleagues ask, "How can engineers cope flexibly with the changing world, with what kinds of knowledge and effort?" (Harada et al. 2008).[1]

Reform activities in engineering education taking place in different parts of the world frequently appear quite similar to one another. Upon closer inspection, however, their meaning and significance for engineering knowledge, engineering identities, and engineering practices tend to differ dramatically from country to country.

In the case of reform activities across Japan, one key indicator of their significance has been great reliance on the image of "internationalization." It has become a given that the preparation of engineers across Japan must include internationalization. What is at issue, however, is exactly what types of practices count acceptably as internationalization include.

Significant to the current struggle is the fact that since the mid-nineteenth century the image of internationalizing practices across Japan has carried the implication of intrusion and moral denigration. The linkage first scaled up to become true when unequal treaties formally granted extra-territorial rights to other countries. After Commodore Perry first arrived in 1853 with warships in Edo Bay and then pointed his guns inland, the *Bakufu* government found itself forced to accept treaties that gave other countries identities and rights across its territory. Between 1854 and 1867, first the *shogun*, the *Tokugawa* leader, and then the Emperor accepted unequal treaties with the United States, Netherlands, Russia, Great Britain, France, Portugal, Prussia, Switzerland, Belgium, Italy, and Denmark (Wada 2008:5).

What the leaders of the 1867 revolt called the Meiji Restoration in 1868 was a pathway to overcoming moral inferiority. As a popular government slogan put it at the time, it was about establishing a rich country with a strong army (*fukoku kyohei*). It was about rectifying an obvious moral subordination by achieving civilization and enlightenment (*bunmei kaika*), as another government slogan put it.

To engineering educators today, what is at stake in internationalizing curricula to serve a powerful Japan that is grappling with planetary acceptance of an image of economic competitiveness includes a significant continuity. That service can contribute to advancement, and ultimate harmony in the world, only by preventing localized moral inferiority. The world cannot be harmonious if Japan stands in a subordinate position. And once again, the key site for assessing status and progress is private industry, in this case

[1] Following local practice, we put surnames first for Japanese authors and other figures.

private consumer industry, preventing moral inferiority, in this case via the subordination of Japanese industry.

The analysis below accounts for what is at stake in recent efforts to internationalize engineering education across Japan by briefly describing some key episodes in the emergence of engineering formation since the late nineteenth century. As a contribution to the ethnography of "dominant images" (Downey 1998:1-31), it shows that the practices of engineering education that scaled up to dominance were congruent with evolving metrics of progress that also scaled up across the territory. These were events of "normative holism" in the making of engineers across Japan.

The development of practices to internationalize engineering education across Japan dates back to the late 1990s. The framing of the issues at stake has a much longer life. The makers of Japanese engineers are once again responding to feared intrusions that threaten to put the country in a state of moral inferiority.

Normative holism among engineering educators[2]

Engineers across the planet have long portrayed the formation of engineers as contributing directly to human progress. They have tended to see an equivalence between the technical contents of engineering practices and material advancements across the world for human benefit.

Official reports and vision statements for engineering formation around the world regularly invoke such connections as "benefit to humankind" (National Academy of Engineering 2004:1), "human development" (International Federation of Engineering Education Societies 2010), "development of society" (Japan Accreditation Board for Engineering Education 2010), "economic and social development," (Engineering for the Americas 2010), "match the social, economic, social, technological needs of the today society" (European Society for Engineering Education (SEFI) 2005), "service of mankind and the advancement of general welfare" (Indian Society for Technical Education 2010), "collective well-being [*bien-être collectif*]" (Comité d'études sur les formations d'ingénieurs (CEFI) 2010), safety and reliability of modern society (Ohashi 2004:3), and "complex and interdependent global challenges" (Anderl, Gong et al. 2006:1).

These stances are remarkable for their holism. Engineers contribute to human progress as a whole. Seeking optimal gain (Alder 1997:60) both as individuals and as a collectivity, they encounter and engage flows of experience as endless sources of technical problems to solve. They tend to judge distinct fields such as civil, mechanical, electrical, and chemical engineering as functional technical differences that complement one another (cf. Gilbert 2009). In quantitative material practices ranging from design to manufacturing to sales, engineers see in their work optimal material gains that help everyone (everyone, that is, in principle).

Normative holism in engineering formation maps a kind of knowledge in service. It portrays engineering work as contributing to something bigger than engineers. In embracing humanity as a whole, engineering typically assign themselves humble status.

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[2] Some material in the following two sections draws from (Downey 2011).

They serve. They serve powerfully, for identity building in learning engineering includes accepting iterations of submission and control and building a portfolio of control practices (Downey 1998:134-158). Yet the image of control should not be misread. Engineers still categorize control practices as elements of holistic service.[3]

Engineers' images of service to humanity are laudable, worthy of study and, frequently, emulation. Yet normative holism also carries a key limitation: it tends to produce tunnel vision on both sides of the equivalence between engineering work and material advancement. It tends to hide the very commitments to service that official vision statements claim to be definitive.

On the side of advancement, drawing an equivalence between engineering work and human progress in general means that educators and trainers of engineers need not assign themselves responsibility to teach students how to sort out and assess the diverse effects for different populations of engineering work in particular. Such analysis falls outside the boundaries of engineering practice.

On the side of engineers, the image of service to human progress as a whole inhibits engineers from paying attention to and examining a myriad of differences that distinguish themselves from one another. In particular, they typically have no analysis of how or why what it has meant to be an engineer and what budding engineers have come to value as their knowledge have varied so greatly across territory and time.

Academic researchers with Euro-American approaches to normativities in engineering have long examined and critiqued normative holism in engineering formation and practice, both directly and indirectly. Most work has called attention to its limitations by demonstrating inconsistencies with actual features of engineering formation and practice. When one diligently pursues hard the twin core questions of engineering studies--What is engineering for? and What are engineers for? (Downey 2009)--a commitment to normative holism can appear at best delusional, at worst conspiratorial.

One set of challenges has been to the implicit claim that holistic service presupposes professional autonomy. Engineers have tended to work, after all, as employees in large organizations. Anglo-American scholars have struggled with the engineers' acceptance of private industry as an appropriate venue for their work. David Noble put the issue most starkly by characterizing the normative holism of engineering service through private industry as essentially false consciousness. Engineers are a "domesticated breed," he claimed. "However firmly [they] convinced themselves that they served the interests of society as a whole, they in reality served only the dominant class in society." (1977:322,324)

On the Continent, Peter Lundgreen's (1990) comparative study of engineering education in Europe and the United States had two important effects. One was to call greater attention to the paramount role played by governments in engineering and other technical education, especially on the Continent. The other came from shifting attention away from

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[3] This is a key reason why engineers do not easily accept arguments that their learning and practices could be gendered, racialized, and bear the marks of class hierarchy.

job market demands in the private sector. It ignited expanded interest in the actual practices of supply through both training and formal education.

A second set of challenges has interrogated the contents of the engineering sciences and engineering design. Social philosophers have long mapped engineers as technological intelligentsia whose success depends upon a wide range of social, ethical, and epistemological criteria (Goldman 1984; Lenk 1984; Davis 1996). Micro-ethicists have made visible contrasts between formal codes and actual practices (Baum and Flores 1982; Martin and Schinzinger 1983). More recently, macro-ethicists make visible a range of broader material projects that engineering formation and engineering work could serve or, in some cases, does serve (Herkert 2009; Mitcham 2010).

Among design researchers, Walter Vincenti (1990) laid down a challenge by seeking to identify context-free categories of design knowledge. Yet others show that engineering designers work in different "object worlds" (Bucciarelli 1994), undertake complex practices that diversely organize people and objects at the same time (Vinck and Blanco 2003), and find ambiguity in design problems to call attention to the ethical dimensions of design judgments (van de Poel and van Gorp 2006).

An industry of work accounts for territorial differences in engineering formation as the product of capitalist relations of production modified by historical contingencies (Meiksins and Smith 1996:253), "distinct social and institutional factors" (Kranakis 1997:304), contrasting "styles" (Hård and Knie 1999:42), "host cultures" (Brown 2000:199), variable "codes of meaning" (Downey and Lucena 2004), and variable practices of appropriation, circulation, and transnationality (de Matos, Diogo et al. 2009).

A third set of academic challenges makes visible other material normativities in engineering formation and practice. Extending Sally Hacker's early work on the masculinzation of technologists (Hacker 1989; Hacker, Smith et al. 1990), researchers have shows how producing practitioner identities in engineering emerged as a "thoroughly male and middle-class endeavor" (Oldenziel 1999:168), tends not to recognize women as belonging (Tonso 2007), is frequently incongruent with the dominant gender identities of women (Faulkner 2009), supports racial selectivity (Slaton 2010) and heteronormativities (Cech and Waidzunas 2011), and depends upon multiple masculinities (Paulitz 2010). And far from advancing humanity as a whole, a robust and growing body of work documents how actual practices of engineering formation and work, especially in development contexts, exacerbate social injustices (Baillie 2006; Catalano 2006; Riley 2008; Lucena, Schneider et al. 2010; Nieusma and Riley 2010).

Despite this valuable work, normative holism continues to thrive in practices of engineering formation, including the pronouncements leading engineering educators make about it.

Rather than beginning by identifying the limitations or shortcomings of normative holism in engineering, in this paper we seek to map how it operates as a dominant image of engineering practice that students must be taught. In particular, we are interested in how it operates as a *localized* image of engineering practice.

Our approach is to explore connections between the emergence of dominant practices of engineering formation across Japan and evolving dominant images of what constitutes

advancement (or avoidance of loss). We focus on four episodes. We draw evidence for the contemporary period from ethnographic research, including interviews, document collection, and participant observation. We draw evidence for past episodes from both relevant documents and the findings of historians, who gain a kind of "ethnographic presence" from prolonged research about a particular period.

The plausibility of our analysis depends upon successfully making the case that what we call dominant images of progress were indeed accepted as given or true at that historical moment as well as that the educational practices we describe did scale up to dominance.

Engineering education to achieve enlightenment

The *Meiji* government's most famous move into engineering education was establishment of the School of Engineering (*Kogakuryo*), which recruited its first students in 1873.[4] During the early 1870s, nearly one-third of the government's budget was allocated to hire foreigners (*oyatoi gaikokujin*) to share their expertise . . . and then leave. The Scottish engineer Henry Dyer was brought in to serve as principal of *Kogakuryo*. Notably, he held control only of the curriculum, not of the school's active management, which was held by Yamao Yozo. It is also notable that students were tightly linked to work in the big mines, mills, railroads, and other projects organized by the Ministry of Industry (*Kobu-sho*).[5] It is notable, finally, that the Emperor visited and formally launched the school only when its new buildings were complete, in 1878. Only then, one might say, did the school become a recognized "household" in the Empire.[6]

The image of an inferior Japan been gaining acceptance across the collection of more than 250 domains, or *han*, that had long competed with one another across islands just off the coast of the Korean peninsula (Morris-Suzuki 1994:27). The competition was non-

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[4] An earlier move in response to the unequal treaties was to establish a school devoted to lighthouse construction. This school was founded by the Japanese government in 1870 and led by the British engineer Richard Brunton. It was later incorporated into the *Kogakuryo.*

[5] It is instructive that the most literal translation for *kobu-sho* is Ministry of Industry (Wada 2008) but, following Dyer, it has often been called the Ministry of Public Works. The distinction has a difference on both sides. For Dyer, the image of public works granted elevated status in relation to industry, which was really struggling for legitimacy across Britain by the 1870s. This image generates considerable confusion when one realizes there was also a Ministry of the Interior, and the fact that *kobu-sho* was responsible for railroads and the other has responsibility for roads. For the Japanese leaders, building public works would produce progress only if the work advanced industry and the consequential accumulation of wealth and strengthening of the army. Morris-Suzuki (Morris-Suzuki 1994:73) reports it has also been translated as Ministry of Engineering or Ministry of Construction. It was clearly a ministry *for* industry.

[6] We use the term "household" to label a key organizational form that refers to both people and property. The most localized household was the family household, or *ie*. Family members moved through identities *within* a family household rather than potentially gaining ownership *over* the household. Below we draw on an extensive literature characterizing the organization of *Tokugawa* domains or clans as kinds of households. Our implication here is that the Emperor was mobilizing the given image of *ie* in identifying the now Imperial College of Engineering as a completed Imperial institution in 1878. A good entry point into the extensive literature on *ie* and household organization from the family to the territory as a whole is Murakami (1984).

military in content since the *Tokugawa* household gained decisive military control in 1603. For 260 years, the *bakufu* government had kept other *han* subordinate by such measures as banning firearms, limiting contact with foreign ships, banning Christianity, and requiring leaders to spend alternative years living in *Edo*. Not a single revolt took place.

All this changed during the nineteenth century with the increased appearance of foreign ships and the expansion of imperialism by Western countries. The 1840-1842 Anglo-Chinese War (first Opium War) and resulting unequal treaty granting Britain extra-territorial rights made it clear China was no longer the most powerful outsider to Japan in the region. The image of inferiority quickly scaled up to dominance in 1853 when the American Commodore Perry appeared with warships at the entrance of Edo Bay and pointed his guns inland.

Between 1854 and 1867, first the *shogun*, the *Tokugawa* leader, and then the Emperor accepted unequal treaties with the United States, Netherlands, Russia, Great Britain, France, Portugal, Prussia, Switzerland, Belgium, Italy, and Denmark (Wada 2008). Granting these countries extraterritorial rights meant that the collection of clan households led by the *Tokugawa* household and *bakufu* government were at risk of becoming colonies of "blue-eyed" countries.

The *bakufu* responded to the new fact of inferiority and associated experiences of humiliation by initiating steps to grow stronger. Some of these included establishing a naval training center in Nagasaki (*Nagasaki-kaigun-denshujo*) and in Edo the Institute for the Study of Barbarian Books (*Bansho-shirabesho*), and Warships Training Center (*Gunkan-sorenjo*) (Uchida 1986:168-170; Numata 1989:187-194).

The *han* were ranked according to their social distance from the *Tokugawa* household. The indicator was the relative loyalty and military performance of ancestors in sixteenth and seventeenth-century warfare. After Perry's second arrival in 1854, several *han*, in particular the low-ranking *Choshu* and *Satsuma* households of the far south, sent young *samurai* administrators to Europe, especially the United Kingdom. Their assignment was to acquire knowledge their *daimyo* (a term referring both to a clan leader and the clan as a whole) could use to protect their territories from invasion.

In 1867 armies from these two *han* defeated a *bakufu* army. With his household no longer the strongest, the *shogun* resigned. Young *samurai* leaders moved the Emperor from Kyoto to Edo (Tokyo) and announced the establishment of an Empire with the Emperor *Meiji* (enlightenment) as its benevolent leader. They called it a restoration.

What is crucial to us here is that the image of inferiority that became dominant in the 1850s attributed this status to Japan as a whole. All members of all *han* were equally inferior to the enlightened civilizations of EuroAmerican countries. This justified attempting to unify them as subjects of the Emperor. No *bakufu* government, even one led by inventing a *Choshu-Satsuma* alliance, could likely have achieved acceptance as linking and defending the households across the territory as some sort of integrated whole (Murakami 1984:323). Its normative content was incongruent with the facts of the present.

The *Meiji* government went to work mobilizing people to end the subordination. The stories are legion and legendary. The new government used its new-found strength to break up the *han*, terminate the *daimyo*, and eliminate the *shi-no-ko-sho* categories that

ranked warriors *(samurai*), farmers, artisans, and merchants. Breaking up the *han* ended stipends for *samurai* leaders.

The diagnosis of inferiority was crucial. It depended on the obvious absence of industry and the wealth that comes from it. What Japan needed to do to end its subordination was build industry. Importantly, the image of enlightenment in the slogan *bunmei kaika* did not refer to a philosophical move distinguishing humans from nature and vesting humans with agency in relation to both nature and God. Enlightenment meant gaining industrial power (Swale 1998:18). Only through developing industrial power could Japan become a rich country with a strong army. The themes were wealth and military strength across a territory whose government defined all as subjects of the Emperor, for economic wealth and military strength were indicators of moral strength.

In 1885, the Ministry of Industry was dissolved. The Ministry had spent huge amounts of funds on developing demonstration projects that failed to generate enough income to cover their costs. The government sold these projects off to private industrialists at great discount and shifted its efforts to supporting industry through laws, regulations, grants, and educational institutions to supply personnel.

In 1886, the Imperial College of Engineering was reinvigorated to serve Japanese industry, yet as one category of supplier among many sources of such supply, including law and commerce. The government incorporated it into the Imperial University (Tokyo) as a College of Engineering.[7]

Multiplying technical schools to expand industry

It took time for the government's image of subjects serving an emperor to gain broad acceptance, especially in rural areas. The Imperial Rescript of 1890 continued the practice of positioning education for moral development.[8] "Know ye, Our subjects," it began, using the new term *shinmin* to denote both loyal-officials-directly-subordinated-to-the-emperor and people-who-obediently-comply-with-their-commands" (Bix 2001:30). Importantly, it subordinated the Confucian emphasis on filial piety within the family to loyalty to the Emperor (Ueno 1996:214). It defined the Emperor as a benevolent ruler (Dore 1965) who stood in direct relation to his subjects across the territory.

The work of government, those loyal-officials-directly-subordinated-to-the-emperor, in building civilization across Japan by overcoming inferiority justified the 1894-1895 war with China. In this image, China was not a country but simply a designation marking a demonstrably inferior territory (Gordon 2009:198). Being forced by the Russian, Germans, and French to return Liaodong peninsula after the war demonstrated the importance of further increasing military strength and ultimately justified the 1904-1905 war with Russia. A popular riot in 1905 included among its demands governmental action to achieve hegemony in Asia and the respect of the West (Gordon 2009:131).

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[7] The Imperial College of Engineering was transferred to the Ministry of Education in 1885, bringing it alongside the University of Tokyo. Graduates of the engineering school had been receiving salaries of 30 yen a month, while graduates of the University of Tokyo had been receiving 50 yen (Nakamura 2002:107).

[8] A rescript is a document released by some authority in response to an action or request.

The Rescript on Education defined a hierarchy of educational institutions that would last until the Pacific War. At the top were the Imperial Universities, expanding by 1910 to include universities at Kyoto (1897), Tohoku (1907), Kyushu (1911) and Hokkaido (1918). Both Tohoku and Kyushu drew upon substantial resources contributed by large family-owned industrial conglomerates called *zaibatsu,* marking a substantial connection between education at the highest levels and the expectation of industrial advancement (Hara 1966). *Zaibatsu* also played a substantial role in establishing leading private universities, e.g. Keio and Waseda (Morikawa 1992). Finally, prefectures established technical colleges to produce middle-level technicians who would also work in private firms. The regulations of the Minister of Education, Inoue Kowashi, brought together in relation to one another the technical schools, agricultural schools, commercial schools, mercantile marine schools, industrial continuation schools for those who did not complete middle school, and apprentice schools for workers who had previously learned trades on the job (Yaguchi 1959:173).

The government actively promoted private industry as providing vehicles of civilization and enlightenment. As Morris-Suzuki (1994:127) explains, "financial profit would become the servant of science and technology, rather than vice versa." While fewer than 4% of technology graduates worked in private industry in 1883, that number increased to nearly 43% by 1900. Industrial companies focused on production, and management was management of imported technologies (Iwata 1977; Yonekawa 1985). Graduate engineers tended to work as internal consultants since they frequently did not hold ownership stakes (Hunter 1991). With networks of large, small, and tiny enterprises growing with the support not only of laws and regulations but also local trade associations, industrial initiatives blurred the boundaries between the public and private sectors, intertwining them tightly (Morris-Suzuki 1994:94).

External threats did not subside after World War I, and the image of the Emperor standing to his people as a father to his children scaled up to clear dominance (Gordon 2009:142). Japan joined the Versailles peace conference as one of the victorious allies. But Woodrow Wilson and other leaders refused to accept Japan's proposal that racial equality be made a founding covenant of the League of Nations (Bix 2001:148). In addition, the U.S. Immigration Act of 1924 prohibiting Japanese immigration entirely was widely seen as "singl[ing] Japan out as a nation and stigmatizing them as unworthy and undesirable in the eyes of the American people" (Daniels 1967:101). Defenses limited to Japanese territory would not be enough. Agreement was widespread, including both socialists and intellectuals, that the territory of the Empire must expand to provide resources and markets.

By the 1920s, a clear hierarchy of technical schools served a hierarchy of employment. Formally it drew ideas and plans from the Prussians who were building a hierarchy of technical schools. But while the Prussians were expanding the population of those who could emancipate German spirit via *Techniks* (Downey and Lucena 2004), the Japanese were expanding the population of those who would increase strength through exports and military hardware.

The elites completed six years of elementary school, four years of middle school, three years of high school, and three years of Imperial university. The competition for admission

was fierce. Those lower down went to private universities, and those still lower to technical secondary schools.

On the job, there was a sharp distinction between white-collar and blue-collar positions. To retain employees, companies began remaking themselves into households to which workers would transfer their practices of loyalty and duty. They developed systems of training specific to their organizations and practices. They explicitly followed a "German path" rather than an "American path." That is, they developed practices for maximizing the use of raw materials and formulating alternatives rather than seeking to minimize labor costs regardless of the implications for resources.

The makers of engineers, the technical workers at the top, adapted their practices to keep them congruent. In anticipation of graduates gaining additional on the job, for example, they focused formal engineering education on its fundamental, most general forms formal education in engineering (Hara 1966).

Enrollments in engineering education skyrocketed during the Pacific War, as the military sought to extend the Empire to what the government called an Asia-Pacific Co-Prosperity Sphere. Between 1940 and 1945, 100,000 engineers graduated from universities, roughly 23% of the total. Seeking an engineering degree made one exempt from conscription.

Mass engineering education for mass consumer production

Losing the war was an indicator of moral weakness. It made the image of overcoming inferiority by military expansion of an empire a lesson in what to avoid in the future. The American victory was, likewise, an indicator of moral strength. The occupation terminated the empire, reducing the Emperor to an icon for what was now a country. Occupying authorities also disbanded the military, broke up the *zaibatsu*, ended research on aeronautics and production for military purposes (Hasegawa 1966), and instituted "reforms in the constitution and political institutions, land [ownership], business and organizations, industrial relations, and education" (McCormick 2000:26).

Industry remained a prime focus of attention, but not to produce a rich country with a strong army—only a rich country. The new metric of industrial strength that scaled up was strength in consumer industries and the export of consumer products. Prohibited from competing militarily with the Great Powers, Japan could compete economically.

Thirty years before the image of economic competitiveness scaled up across the United States to become an indicator of a country's planetary standing, the Japanese accepted export consumer industries and a growing balance of payments as a metric for overcoming inferiority and seeking equity alongside countries superior in military power.

Reminiscent of the Iwakura mission of the 1870s, in 1955 alone no fewer than fifteen missions with nearly 175 members visited the United States in order to study its consumer industries, e.g., automobile, and those industries that supported them, e.g., steel-making. Divisions of the former *zaibatsu* re-grouped into loosely organize, industry-specific business groups (*kigyo shudan*), which made clever use of technology licensing, reverse engineering, and continuous product and process engineering (Hull, Hage et al. 1984) to build new product lines.

The U.S. occupation authorities actually jump-started the whole process by allowing small and medium-sized enterprises to trade in their existing machinery for equipment that had been seized in the reparations program. This continued after independence in 1952 with prefectural governments and cooperative organizations playing the key role of matching the needs of local firms with available machinery. Prefectures also supported small local laboratories for improving production practices in industries of local interest (Morris-Suzuki 1994).

There was no master plan. Rather a multitude of overlapping ministries competed with one another to formulate and enact places in support of new consumer industries. What is important for us here is the accepted focus on consumer industries as the key vehicle for Japanese advancement.

The perceived connection between consumer exports and territorial strength was most prominent in the policies of the Ministry of International Trade and Industry (MITI). MIT was less interested in domestic originality than in fostering rapid dissemination of knowledge and technology among rival firms and preventing what it revealingly characterized as “excess competition” (Morris-Suzuki 1994). Internal competition to drive down prices was not congruent with the image of new economic households fulfilling their responsibility to serve the whole by means of production for export.

The key metric that had scaled up lay in the moral implications of achieving highly competitive consumer production. It demonstrated acceleration upward into the mix of advanced countries. It amounted to a claim of equity and parity as well as, and perhaps most importantly, a demand for respect. Across the territory of Japan, it meant the Japanese were on the right track.

The makers of engineers worked hard to maintain congruence with this evolving holistic vision. The old hierarchy of educational sites and practices was now a limitation. Status was no longer measured from proximity to the Emperor outward, nor within private industry between white collar and blue-collar positions.

The makers of engineers of engineers responding to the scaling up of mass consumer production through a dramatic expansion of available seats in engineering at universities and colleges. Between 1950 and 1980, the number of higher education institutions increased from fewer than 200 to nearly 450. Imperial Universities became national universities, whose ranks swelled to nearly 70 universities distributed across all prefectures (Hasegawa 1966:361). Municipalities funded other public universities, and private universities expanded as well. Finally, both public and private two-years schools formed to help meet the rapidly expanding demand for technical workers.

The primary purpose of engineering education came to be getting students ready for industrial employment. Curricular focused on general skills in engineering analysis, knowing that graduates would be facing years of training on the job. For their part, companies came to see universities as primarily suppliers of manpower, not, say, of research results. Among the largest companies, lifetime employment and rank based on seniority was becoming routine. Taking the long view with personnel, companies looked for evidence of potential for future development rather than immediately applicable skills.

One effect of this focus on preparation for employment was that the most prestigious companies recruited their employees from the most prestigious universities, with lower-status companies recruiting from lower-status institutions. Indeed, companies sent invitations directly to professors who then allocated their students to specific companies with letters of introduction. Another effect was to place even higher pressure on high school students to score high enough on difficult entrance examinations to make their ways into the desired pipeline.[9]

On the job, the identities they gained were not as engineers but according to the industrial household they joined. They became Hitachi men or Toshiba men, not engineers employed at Hitachi or Toshiba nor even university graduates employed in engineering positions. Engineering education was most congruent with the new metric of progress when it effectively de-emphasized the identities of graduates *qua* engineers.

Global engineering education to provide protective competencies

The neatness of this relationship between experiences in engineering education and lifetime employment within a corporate household began to erode with increased multi-national flow of major Western corporations. The image of economic competitiveness was not itself felt as news across Japan. What was news was the scale and scope that the expansion of multi-national companies would achieve.

Japanese companies had long maintained international supply chains and distribution networks, and even assembly operations in other countries. The great success of the Japanese economic strategy has extended corporate households beyond the boundaries of the nation, confronting them with new pressures and granting them new, multinational identities. But ever since the unequal treaties of the 1850s and 1860s and the exceptional period of the Occupation, internationalization typically did not mean granting extra-territorial rights to people and companies with non-Japanese identities. The technology licensing arrangements that proved so productive from the 1950s to the 1970s had the effect of preserving the autonomy of Japanese firms. Even when divisions of Western-based corporations appeared across Japanese territory, their management remained relatively autonomous.

In this context, the prospect of heterogeneous globalization of multi-national firms can appear as a new threat to the territorial integrity of Japan and, hence, its loss of distinctive identity. The Japanese, according to Trevor (1983) are "reluctant multi-nationals." And yet globalization cannot be ignored. In 2010, a senior official in engineering education was asked why globalization poses a problem for the Japanese. "Because we have to participate in joint ventures," he replied. "Japanese companies are not big enough to go it alone."[10]

Sometimes the concern about extra-territoriality has been about the insidious intrusion into Japanese business practices of Western practices of maximization. One way the

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[9] Given the hard work that was required in high school and the dedication expected on the job, it was often said during this period that attendance at university was the only vacation that future "salarymen" would ever have in their careers.

[10] Interview with lead author in Tokyo, Japan, August 30, 2010.

successful extension of the Japanese corporate household beyond Japan may be generating a significant popular reaction at home may be in the experience of "loss of public trust" for Japanese corporations. When viewed through the household image, Japanese companies that function successfully in multinational environments may, on the one hand, be successfully extending Japanese identities to others outside Japan. But on the other hand, they may also be putting those identities at risk. Multinational Japanese companies may appear to Japanese people as losing their Japanese-ness. To the extent the latter may be occurring, the most likely scenario of emergence is that they are accommodating themselves to a Western corporate model built around "enlightened self-interest." That is, they may be behaving as corporate individuals charged with benefiting society by serving themselves first and maximizing self-interest. Yet, given the household image, traveling down such a path risks "disregarding the duties toward the household," failing to demonstrate "moral virtue," and even "selfish immaturity" (Kondo 1990).

A key response to this concern among engineering educators has been new-found activism by professional societies. As Luegenbiehl (2004:9) explains, "Japan does not have a tradition of professions." But a movement to build engineers as professionals has been thriving since the late 1990s, in part in response to the perceived ethical failures of corporations.

For example, at the 2004 World Conference on Continuing Engineering Education in Tokyo, four presenters of new initiatives by professional engineering societies found justification for their efforts in ethical failures by Japanese corporations (Kawashima, Ikeda et al. 2004; Owa, Ohashi et al. 2004; Seto and Honami 2004). As one leader of the movement of engineering associations, Hideo Ohashi, put it in 2000, "An unbelievable critical accident that happened at JCO's Tokai facility . . . left severe damages to the public confidence on technology and subsequently on engineers. . . . In recent years a number of incidents have resulted from the lack of ethics of the corporate executives or the engineers, drawing public criticism"(Ohashi 2000). Researchers in business ethics have reported similar phenomena. Wokutch and Shepard (1999:535) maintain, for example, that high-profile accidents, disclosure of concealed trading losses, and publicized neglect of sexual harassment have had the effect of eroding public trust in corporations.

To Ohashi (2000) and other engineering activists, the implications of a loss of public trust are self-evident: "This clearly indicates the importance for the engineers not to merely obey blindly the directions given by the organization, but to be able to judge what they should do or not to do according to the engineers' ethics."

In a way, the success of efforts to define a Japanese engineering "professional" depends upon an interruption in the flow of responsibility from workers through the corporate household to the national household. The movement does not include, for example, a call for supporting whistleblowers, people who risk job and career in the name of individual honesty and autonomous judgment, for whistleblowers still "are perceived as untrustworthy and would not be accepted by Japanese society" (Iino 2001). Rather, as Ohashi says, the new engineering professionals are "judg[ing] what they should do or not to do according to the engineers' ethics"(Ohashi 2000). The difference is subtle but significant. Rather than educating autonomous individuals, professional engineering

societies are offering themselves as new centers of belonging responsible for defining "engineers' ethics" in order to help them struggle with change.

In 1999, the newly-formed Japanese Accreditation Board for Engineering Education defined the obligations that promote its identity as a household. Its first criterion, or primary obligation, for engineers from accredited programs contrasted sharply with the focus on mathematics, science, and engineering found in the criteria issues by the American Accreditation Board for Engineering and Technology in 2000. The first criterion in Japan was to demonstrate the "ability and intellectual foundation for considering issues from a global and multilateral viewpoint" (Japan Accreditation Board for Engineering Education 2004). The provision responds to a fear. One can successfully consider issues from a global and multilateral viewpoint only if one is able to rise above self-interest, overcome selfish immaturity, and locate one's concerns and interests in relation to those of others engaged in the general pursuit of advancement.

Also in 1999, the Japanese Society of Civil Engineers amended its "Beliefs and Principles of Practice for Civil Engineers," replacing it with the "Code of Ethics for Civil Engineers." It is instructive that the Beliefs and Principles had not been updated since 1938 and had been of relatively little consequence during the interim period. The new Code does not mention responsibility to one's employer until the eighth of fifteen provisions. Rather, the Code first reminds civil engineers that they should "adhere to the ethical principles of self-disciplined moral obligation when applying advanced technology" and then repeatedly articulates their responsibilities to society at large. Thus, for example, the first provision 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." Note the explicit inclusion of women through the grammatical choice of "his/her." For Japanese civil engineers, to follow the provisions of the Code and fulfill obligations to society as a whole is also to accept the Japanese Society for Civil Engineers as a household through which obligations to the whole can legitimately be formulated and fulfilled.

In 2000, the Japanese Diet underwrote the legitimacy of this movement to professionalize engineers by transforming the "Consulting Engineers Law" into the "Professional Engineers Law." Its main provision emphasized the link between the individual engineer and a national household while also charging engineers with the obligation to help insure that Japanese corporations remain Japanese. The provision stipulates that "Engineers should not only posses the capability to take charge of their duties, but they should also have ethics that places the responsibility toward society and public benefits as the premise for the activities by corporations and other entities."

In parallel with the movement to professionalize engineers *qua* individual engineers, many engineering educators have worked to build attention to new competencies in engineering curricula that they themselves consider to be global competencies. In 2000, the Japan Council of Professional Engineers (2000) argued, "It is extremely important to develop strategies for appropriately evaluating the abilities of engineers from our country to participate in international society and not be put at a disadvantage." Similar to efforts to globalize engineering curricula across other countries, major emphases have included

"intercultural communication" (Danno 2001), enhanced liberal arts education (Nohara, Kawamoto et al. 2008), and fluency with English (Maruyama 2000; Furuya, Bright et al. 2008).

But to become like global engineers from other countries is more like licensing their technologies than is it like adapting and accommodating themselves to fit into new heterogeneous environments. With the risk of losing Japanese identities ever-present, and with that the engineering commitment to advancement of humanity as a whole, the new competences are as much about preventing loss as they are about achieving gains.

Across Japan, global competencies for engineers are also competencies for moral protection.

Conclusion: global engineering education is local

Building a college of engineering as the apex of early efforts to produce people for industry quickly established congruence between practices of engineering education and the dominant image of advancement as overcoming the fact of inferiority. The government built a multitude of pathways for people to help Japan achieve parity and respect through enlightenment. The Ministry of Industry also built commercial schools, mercantile marine schools, and continuation schools all to help support the development of industry. The makers of engineers in both imperial and private universities had little trouble manifesting a commitment to normative holism. Both by leading industrial departments of the administration and serving as internal consultant in the emergent *zaibatsu*, the makers of engineers could claim direct connection to the work of building a rich country with a strong army.

When the Empire changed direction, when the territory became a country, and when the country changed direction, engineering educators adapted their educational institutions and curricula to keep the contents of engineering education congruent with whatever metrics of progress scaled up to dominance. When the Emperor really was to the people what a father was to his children, engineering educators offered learning in a hierarchy of forms according to their distance from the Emperor. When military expansion was replaced by the mass production of consumer products, engineering education grew proportionally and took care to provide general knowledge and skills on which graduates could draw after they took lifetime positions in companies. For the makers of engineers, perhaps the only thing more feared that an inability to facilitate, if not lead, advancement is to become irrelevant to the process.

With the country struggling once again with images of external intrusion and moral subordination, both through the transformation of Japanese enterprises and the erosion of Japanese identities for its employees, the makers of engineers are now working to add new identities. They seek to product professionals who are not exactly individuals, individuals who are defined by their duties, and competent, self-directed, ethically-aware communicators in English who treat their new competencies as opportunities once again to help advance humanity by making sure the Japanese are not inferior members.

It is clear that, across Japan, global engineering education is very much localized engineering education.[11]

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