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The Difference Between Engineering Education at Public and Private Institutions:
University of Michigan, Dearborn and Milwaukee School of Engineering

Jeffrey K. Lee
Amanda Dion

Duke University
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Abstract

This paper serves as a preliminary research study into the question of whether a difference exists between the response strategies of public and private engineering colleges to the emerging threat of global labor supply competition, particularly in India and China. Selecting the Milwaukee School of Engineering (MSOE) and the University of Michigan-Dearborn College of Engineering and Computer Science (UMDCECS) as our private and public institutions for comparison, respectively, we find that MSOE is committed to innovation-based learning and the development of “uncertainty” and “open-ended” problem solving skills, whereas UMDCECS is focused on using local industry and real-world/hands-on experiences to train its students in engineering competencies. Both schools show an emphasis on “soft skills” and business acumen in their curricular reform, as well as a general attempt to increase awareness of globalization issues at their respective campuses.
Introduction

In recent years, Americans have seen the emergence of an increasingly inter-connected world, as technology has soared at dizzying rates. The growth of the Internet has broken down the time-space barrier between people in different countries and continents, and one of the consequences of this new inter-connectivity is the ability of companies and organizations to employ a global labor force. For some workers abroad, this occurrence has meant new job opportunities and increased wages; for others, particularly domestic workers, the new global outsourcing places a significant threat on their job security. U.S. companies have employed offshore outsourcing for decades, but the latest debates, in congress and in magazines such as BusinessWeek, have been on a recent and worrisome phenomenon – the outsourcing of high skilled, white-collar labor. As countries such as India and China continue to produce overwhelming numbers of capable engineers, U.S. companies are flocking abroad and substituting their domestic engineering labor force for Indian and Chinese engineers, who can be hired at a fraction of the cost.

The fact that competent, highly skilled engineers are now emerging from all corners of the globe spells new, serious competition for the American engineer and raises critical questions regarding the certainty of his or her career. One way to protect the US engineering labor force from global competition is by altering the engineering curriculum at colleges and universities, to produce an engineer whose skills are greater, less substitutable, and thereby less vulnerable to the threat of offshore outsourcing. While it does not address issues with the susceptibility of the current US engineering labor force, this solution does address the future of U.S. engineering, and merits significant research and discussion. No doubt, improving engineering education in the United States is a promising way to deal with international competition in the field. The
question, however, is not a matter of whether to improve engineering curriculum; rather, an interesting question that has developed in the debate is how engineering schools across the country should go about implementing academic reform in engineering.

In this paper, we have chosen to compare the recent reform strategies of two known leaders in mechanical, electrical, and industrial engineering: the Milwaukee School of Engineering and the University of Michigan-Dearborn’s College of Engineering and Computer Science. Both institutions are comparable in size (number of students), location (northern Midwest U.S.), and quality of education. Particularly, both are generally considered among the finest in the country in several engineering sub-fields. Table 1 outlines the summary characteristics of each school:

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<th>Table 1</th>
<th>Size and Discipline Expertise of Each School</th>
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<tr>
<td></td>
<td>Milwaukee School of Engineering</td>
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<tr>
<td>Undergraduate Students</td>
<td>2,092</td>
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<tr>
<td>Graduate Students</td>
<td>223</td>
</tr>
<tr>
<td>Total Students</td>
<td>2,315</td>
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<tr>
<td><strong>US News &amp; World Report Rankings</strong></td>
<td></td>
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<tr>
<td>Computer</td>
<td>5</td>
</tr>
<tr>
<td>Electrical/electronic</td>
<td>8</td>
</tr>
<tr>
<td>Industrial/Manufacturing</td>
<td>4</td>
</tr>
<tr>
<td>Mechanical</td>
<td>9</td>
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Our motivation for selecting the Milwaukee School of Engineering and University of Michigan-Dearborn’s College of Engineering and Computer Sciences (UMDCECS) lies in their overall similarity, yet primary difference as a private and public institution of learning, respectively. We are interested in the question of whether public and private engineering schools approach and respond to the issue of global engineering competition in different ways. One possibility is that a private school would, by nature of being dissociated from major external (ex. state government) pressures, have the ability to devise and implement more creative solutions,
and push through greater reform in a shorter period of time. However, one could also hypothesize that a public institution would be more sensitive to state issues of unemployment and labor supply issues, and would thereby respond more readily and with greater urgency to the issue of offshore engineering. Dearborn’s engineering school, in particular, is only an hour’s drive from Detroit, home of the “Big Three” car companies and a city whose locals have been heavily affected by outsourcing. The issue of India and China’s engineering must be highly salient to people in the local region and state, and one might conclude that this would affect the decision-making of the engineering school at the University of Michigan.

To state that the only difference between the Milwaukee School of Engineering and Dearborn’s engineering school is their public-private affiliation would be an oversimplification. In other words, we are not truly able to control for school size, regional differences, and most notably, educational quality, and one should not conclude that the differences between the strategies of these two schools are solely due to their status as a public or private school. Nevertheless, we feel that their similarity in all of the traditional dimensions such as size, region and overall quality provides for an interesting and relevant comparison of public and private school reform strategy. This research study serves as a preliminary analysis on whether public and private engineering schools differ in their response to the challenge of a global engineering supply, and combined with further analyses of other public and private institutions, may reveal a striking and interesting difference between the public and the private engineering school in the discussion of engineering reform.
The Milwaukee School of Engineering (MSOE) has been particularly outspoken in the education reform discussion, sending several school representatives each year to the American Society for Engineering Education (ASEE) annual conference to present their perspective on what major changes need to be made in engineering education, particularly in response to the new competition from abroad. Part of the reason for its active participation in the debates is fear and awareness among some of its faculty towards the competitive engineering threat in China and India. In an interview with Dr. Owe Petersen, chair of the electrical engineering and computer science department at MSOE, Petersen says that he first became aware of the change in the engineering field when he spoke several years ago with the vice president of a Silicon Valley startup company who was no longer impressed with the abilities of engineering graduates, especially their understanding of problems in a non-technical context. He describes this problem as a global, regional, and local one, noting that China has been a competitor with the United States for decades and suggests we may be so slow to realize the impacts of the globalization phenomenon because we are the current dominant power. “But that won’t last,” he warns.

In a document prepared for the upcoming 2006 ASEE annual conference in Chicago, the members of the Electrical Engineering department write:

“Preparing the next generation of engineers to enter this world with a competitive advantage requires inventive, resourceful, and continuously evolving methods to instill parallel intercultural communication, global resource management, and interpersonal professional training alongside the requisite and non-negotiable technically related subjects of the discipline.” (Mossbrucker et al, 2006)

How then has MSOE specifically responded to the rising competition from abroad? Four members of the Electrical Engineering department at MSOE (including Dr. Petersen) recently wrote a paper entitled, “Preparing for Uncertainty – Addressing Globalization in an Engineering Curriculum,” which they presented at the 2005 ASEE conference. In this paper, they specifically
addressed the issue of globalization’s impact on the industry, comparing the expansion of engineering design abroad to the spread of manufacturing from Western to global markets, citing it as a “disruptive event.” Given the gravity of the changes occurring in the engineering labor market, the authors propose several ways to better prepare students for success in the engineering field. According to the authors, extrapolating from past teaching methods will not be satisfactory in the current dynamic environment. Rather, they recommend a new set of objectives for education, which are summarized below in Table 2.

<table>
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<td><strong>Summary of Recommendations by MSOE faculty at 2005 ASEE conference</strong></td>
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<td>1. Approach training for the entire time the student is enrolled.</td>
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<td>(Unstructured problem solving must be taught early and consistently.)</td>
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<td>2. Adding enough courses is simply not possible; integrate concepts.</td>
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<td>3. Go beyond numerical and specific focus to think in global terms.</td>
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<td>4. Develop the concept of having a customer focus.</td>
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<td>5. Teach problem solving beyond the confines of technical engineering.</td>
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<td>6. Include regional geographic effects.</td>
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<td>7. Comprehend the fluid nature of knowledge.</td>
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<tr>
<td>8. Develop the right skills (communication, teamwork).</td>
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<tr>
<td>9. Teaching about the worldwide workplace.</td>
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<tr>
<td>10. Have students ask questions of themselves.</td>
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<tr>
<td>11. Covey the difficult message that in the end, it's all business.</td>
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Source: Mossbrucker et al., 2005.

Of particular interest is the first recommendation. Instead of trying to adjust the program by offering new courses that may practice a different skill set or educate students about the needs of the work environment, the authors feel that the transformation needs to be made in a *way of thinking*, something that must be absorbed and engrained through repeated exposure. This new way of thinking, which the authors emphasized in the paper, allows engineering students to go beyond technical specialty and solve “unstructured” problems with “open-ended” solutions, two concepts with which most engineering students may find not only unfamiliar, but also uncomfortable. The authors claim that, “engineering programs, in general, do a very good job of teaching structured problem solving, (e.g. ‘design a system with the following specifications’)”
but later note that “globalization has introduced a level of competition whereby survival, at every level, depends on the ability to address unstructured problems.” The overall message in the first point is bold and clear: a change in the philosophy of engineering is needed in order to survive globalization, and because it is a philosophical (as opposed to curricular) change, it must be reinforced throughout the duration of the student’s education at MSOE.

The fourth, eighth and eleventh points addressed are also interesting. Beyond developing a broader range of problem solving skills and technical abilities, the authors also feel that it is essential for the MSOE engineer to develop business acumen. The fourth point addresses the need to ensure that solutions are practical and customer-oriented, whereas the eleventh point stresses the need for engineers to understand economics and the ultra-competitive nature of business. Perhaps most interestingly, the eighth point emphasizes social skills. While traditionally, these characteristics may be seen as essential only for the top engineers in the field, the authors describe them as, “a minimum requirement for success.” The point of this recommendation is to provide one additional safeguard from the threat of offshore outsourcing. By acquiring the ability to interact well with others and properly articulate plans, engineers coming from the United States may be able to perform a variety of tasks that are impossible for those who only have a deep understanding of scientific and mathematical processes. Much like the first point, these additional points shift away from traditional engineering competencies and stress the importance of developing “soft skills” and other non-technical abilities.

Following these recommendations, the authors describe (in their paper) some of the changes that have been made in the Electrical Engineering program at MSOE. These changes include (1) redesigned courses during the freshmen year to expand their perception of the world and current issues in electrical engineering, (2) a required junior-level courses that confronts
students with globalization issues and how it affects their career in the electrical engineering profession, (3) introduction an “unstructured problems” approach to the year-long senior design experience, (4) career planning assistance that emphasizes the development of non-technical skills, and (5) the incorporation of courses from the humanities, social sciences, business and technical communications into the electrical engineering track at MSOE. Most of the current changes primarily reflect the department’s objective of developing global awareness in engineers at MSOE, in addition to the department’s emphasis on strong professional skills (teamwork, communication) as well as the need to incorporate “unstructured” problem solving into the curriculum.

The fact that the authors have taken these recommendations and applied them to the Electrical Engineering curriculum shows an active attempt to reform the structure and quality of education in the face of globalization. However, according to Dr. Petersen, this department is unfortunately the only one in the engineering school to forthrightly address the issue of globalization and engineering competitiveness. While he mentions that the larger administration favors the principle of reform, it faces difficulty in implementation. Additionally, he believes that many engineering faculty members may not understand the urgency of the matter, an issue that is difficult to solve since mentioning their lack of knowledge may cause unwanted conflict. Throughout the process, the most spirited and helpful collaboration has come from some particularly talented liberal arts faculty, but Dr. Petersen is unsure how much impact they can have beyond their department.

Petersen anticipates that the students, despite the potential frustration that comes with altering a manner of learning, would be very receptive to the change as long as everything were properly explained to them. Yet a change in the learning process, experience and essentially, the
culture of engineering must come from the faculty, according to Petersen. Dr. Petersen articulates the magnitude of this challenge: “Key to addressing the issue is that it requires many people, people in a position to influence curriculum and they must be able to ultimately change the thinking climate of the campus. If a critical mass of like-minded thinking isn’t reached, nothing will happen. Academics are very resistant to change.” He adds, “We are only now reaching out to other universities to collaborate. I am not sure that much will happen jointly.”

**Analysis of University of Michigan-Dearborn College of Engineering**

Given that the College of Engineering and Computer Science at the Dearborn campus of the University of Michigan shares the school’s motto as the “leaders and best,” this engineering school has attempted to be at the forefront of engineering curriculum change and preparing tomorrow’s leading engineers in the face of globalization. Indeed, UMDCECS’s engineering school has a history of making innovative changes to its engineering curriculum – particularly in the learning environment at the college – that extends to the present. However, the changes that have been made at Dearborn’s school of engineering appear to be minimally related to the threat of globalization.

In a sense, one can infer that the strategy behind UMDCECS’s changes has been to emphasize core engineering competencies. The philosophy appears to be that the school’s responsibility is to produce the highest quality engineer, and that the technical training opportunities at Dearborn should provide a safeguard from job security threats, whether the source of competition is domestic or global. For example, one of the major changes made at UMDCECS over the past two decades has been the development of its relationship with the local engineering industry, which it uses to help train its own engineers. In the early 1990s, the school
established the Center for Engineering Education & Practice (Sengupta, 2004). While the center does not directly address the issue of globalization, it does seek to improve the certainty of the engineering students’ careers by giving them exposure to practical problems. The school believes that, “education of engineers in universities, when isolated from the practice of engineering, becomes sterile, irrelevant, and obsolete.” Through the center, Dearborn’s engineering school is able to exploit a local niche, expanding the abilities of their students through projects in design and innovative courses featuring interaction with local industries. By providing them with useful real-world experiences and exposing them early to how industry actually operates, the center hopes to develop engineering skills in their engineers and thereby create more job-security for them.

Some noteworthy changes to the engineering curriculum have been made directly in response to globalization. Believing that globalization has increased the demand for versatile engineers, the University of Michigan-Dearborn has introduced a business themed course this semester, mandatory for all engineering majors except mechanical engineering majors (Keshav Varde, personal communication, March 7, 2006). The course is “team-taught” by faculty and two “technical/managerial” individuals from local industries. Again, the university appears to be using the abundant and rich local resources to better train its students. Additionally, a new undergraduate course focuses on current trends in engineering, and the college routinely sponsors workshops and seminars for both students and faculty on the latest topics of discussion in engineering and computer science. Unlike MSOE, however, the recent changes made at Dearborn are not in response to seeing American jobs move offshore; rather, they are responses to the emerging global aspects of engineering, according to Dean Keshav Varde, chair of the curriculum committee at Dearborn.
Like MSOE, Dearborn’s school of engineering has also made its forays into creativity-based learning and the development of soft skills for its engineers (Jeanne Girard, personal communication, March 7, 2006). One interesting addition to the University of Michigan-Dearborn’s graduate-level curriculum occurred ten years ago: a course based on Peter Senge’s *The Fifth Discipline*. The course focuses on organizational learning, and features a classroom (often called the “Enginuity Lab”) that has replaced desks with executive style chairs, toys, and music to inspire creative learning techniques. Additionally, the engineering school has a program called Engineering Professional Development (EPD), whose mission – according to its director, Jeanne Girard – is to provide soft-skill learning opportunities for students as well as technical professionals. In addition, like MSOE, UMDCECS has also attempted to develop awareness of global issues and their relation to the engineering field. In fact, the Dean at the College of Engineering and Computer Science in Dearborn has required all faculty members to read Thomas Friedman’s *The World Is Flat*.

Nevertheless, despite some similarities with MSOE, including an increase in business courses in the curriculum, the encouragement of soft skill development, and some attempts at increased awareness of globalization, the strategy of UMDCECS towards globalization is altogether different. To reiterate, Dearborn’s school of engineering has not specifically addressed the development of competition from abroad; rather, their reaction to globalization has been to better prepare their students for work in the global economy by exposing them to global business and engineering issues. The emphasis on exposing students to “uncertainty” and “open-ended” problem solving – a key component of the MSOE strategy – is nonexistent in the UMDCECS agenda. When given a description of the “dynamic engineer” and recent innovation-based attempts at increasing the competitiveness of US engineers (see MSOE or Duke
University), and asked whether Dearborn had made similar strides, Dean Varde responded, “Not in that fashion.” He then pointed out that there is the opportunity to practice innovation in some of the design courses, but clearly the emphasis on novel problem solving skills is not stressed. Reflecting Dearborn’s focus on engineering core competencies, Varde added, “We prepare students for engineering; we are not preparing them for management jobs.”

Conclusion and Discussion

The Milwaukee School of Engineering and the University of Michigan-Dearborn College of Engineering and Computer Sciences, though reasonably similar in background and composition, have interesting differences in their approaches. One preaches open-minded thinking to solve problems with a range of solutions while another emphasizes practical, hands-on training and fundamental, applicable engineering. One prepares students to perform above the level of international peers by supplementing technical excellence with non-technical skills, while the other seeks to create a global engineer by increasing interaction with those outside the school, working with them and learning what is demanded from a successful engineer. Both strive to increase the soft skills common to businesspeople – communication, articulation, and teamwork. Further convergence occurs in the fact that neither school appears willing to sacrifice the technical aspects of their students’ education to attain this greater engineer. Neither does it seem that either school finds this task insurmountable.

The primary difference between the two schools – an emphasis on innovation and “unstructured” problem solving to reduce the threat of global competition (MSOE) versus an emphasis on real-world experience and engineering fundamentals for success in the global labor market (Dearborn) – could be attributable to a general difference between private and public
MSOE appears to have gone far beyond Dearborn in reform, suggesting that public institutions may be less inclined towards dramatic, fast-paced changes, perhaps due to the extra friction imposed by the government and other stakeholders. A private school, such as MSOE, may be able to make more education changes under the radar, or may have a culture that is more conducive to change. Granted, as Dr. Petersen of MSOE aptly pointed out, academics can be resistant to change, and both schools appear to have some difficulty conveying the urgency of globalization and the need for reform to everyone within the institution. Yet the friction towards educational reform could be greater at public institutions in general; this possibility merits further research. If indeed, public schools are more hesitant to large philosophical changes in education, and these changes are necessary for US engineers to survive the emerging engineering labor force in foreign countries, then this finding needs to be publicized, and an extra effort needs to be placed towards public engineering schools in order to allow full reform to occur in those schools.

The authors of this research paper strongly caution against making quick judgments regarding the validity of the approaches taken by MSOE and UMDCECS, respectively. While it seems that Dearborn is slightly more resistant to reform than MSOE, it is quite possible that this hesitance towards innovation-based learning and a new philosophy of engineering may be justified. Some might argue that innovation and dynamism simply cannot be trained in the classroom, and that the efforts of educators such as Dr. Petersen of MSOE are valiant but nevertheless fruitless. It would then be most logical, in this situation, to maintain an educational focus on real-world engineering, while providing a small, healthy dose of non-technical skills, as UMDCECS appears to have done. On the other hand, some might argue that the collegiate experience is crucial in developing the philosophy taken by US engineers, and that innovation-
based learning would spur more creativity, more entrepreneurship, and ultimately more job-
security. Proponents of this viewpoint might argue that in the end, most engineering skills will
be outsourced offshore, and that the only safeguard against the threat of globalization is the
ability to innovate. Here, it would be most logical to devote a greater percentage of the
engineering curriculum to “uncertainty” problem solving, and encourage larger reforms aimed at
changing the broader philosophy of engineering education. No viewpoint has emerged as the
definitively correct viewpoint, and the contrast between MSOE and UMDCECS raises an
interesting question of how best to go about reforming the engineering education in America.

Yet as we explore ways to improve engineering education in America, a prerequisite
question that we must answer is whether there is only one correct viewpoint and strategy for all
engineering schools in the US. Perhaps different schools, based of the typical job market
placements of their graduates, have different educational needs to fulfill, and therefore require
different strategies. For example, Dearborn might expect most of its engineers to get engineering
jobs upon graduation, and foreseeing an increase in global engineering interaction in the future, it
may believe that the best way to train its graduates for the future is to teach them how to practice
engineering in a global setting. By contrast, MSOE might expect many of its engineers to enter
management in engineering, or to be placed in positions at US firms where the need for dynamic
skills is much greater. From this perspective, training engineering students to think “outside the
box” is far more valuable than training them from a Dearborn engineering approach. Seen in the
context of employer needs (both local and global) and expected skills needed after graduation for
their respective populations, are different strategies and approaches to engineering education
valid at these different schools? In other words, should engineering reform strategy be
contextual? Or do all engineering schools need to implement innovation and “dynamic
“engineering” into their curriculum, regardless of the job market placements of their graduates? One additional question that must be raised is whether a school can effectively implement multiple reform strategies. For example, is it possible (and sensible) for a school to train its students both to innovate and to work in a global engineering environment? Could a pioneering school combine the strategies of MSOE and UMDCECS, as well as other top engineering institutions, to produce stronger engineering graduates for the future? These issues are very important to consider, and should be kept at the forefront of the debate on engineering educational reform.

A few final points merit consideration. Though we have emphasized the differences between the two schools, both have numerous similarities, including the recent emphasis on professional development and softer-skilled, such as teamwork, communication and general social skills. Independent of the innovation versus core-competency debate, we strongly believe that the recent move towards developing these non-technical skills is highly positive and worthy of continued support. From a pure, neo-classical economic standpoint, non-technical skills should be irrelevant – the skill of a worker should determine his employment and success. Yet from a psychological, sociological, and “real-world” perspective, certain intangibles such as emotional intelligence and teamwork skills do matter in employer decision-making and the lifelong success of the engineer, and should be factored into any engineering school curriculum reform.

Second, both schools, to a varying degree, made efforts to spread awareness of globalization and the issues that arise from it. MSOE appears committed to ensuring that undergraduate engineers understand the global environment that they will be working in, and the competitive threats that they may face; UMDCECS also does this (to a lesser extent), but has
additionally called for all faculty members to read Thomas Friedman’s latest book on globalization, *The World is Flat*. This response towards globalization – the encouragement of internal discussions about globalization, and attempts to raise awareness about world events that will likely play a role in the engineering student’s future – was lacking in our preliminary review of other engineering institutions. While many other colleges and universities seemed to focus on curricular/program changes, they neglected to explain to current students and faculty why reform is necessary. We feel that this is almost a prerequisite for engineering reform at any college/university; engineering students need to know not only how their education is different from previous generations of engineers, but also *why* their education is different, and why the changes are necessary. Increasing the salience of global engineering issues, which will no doubt have an effect on the engineers in school today, is a move that we applaud for both the Milwaukee School of Engineering and the Dearborn College of Engineering and Computer Science, and encourage for other institutions of higher learning. While educational institutions face incredible barriers to reform (from administrative issues to general resistance to change), the rapidity of globalization and the emergence of a global labor supply demands attention from engineering schools across the country. Discussion and scholarship on globalization and what it means for American engineering is a first and necessary step towards a brighter future for engineering schools and professionals, and at a broader level, the U.S.
References


Interviews

Dion, A. (Speaker). (2006, March 2). Interview with Dr. Owe Petersen.


The co-authors also exchanged personal communications with Jeanne Girard at the University of Michigan-Dearborn, who is the Director for Professional Engineering Development.