Some Ethical Dimensions of Additional Education for the 21st Century

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Abstract: In October of 1998, the ASCE Board of Direction adopted Policy Statement 465 supporting the concept of the master's degree or equivalent as a prerequisite for licensure and practice of civil engineering at the professional level. Citing globalization, an intricate and complex infrastructure, and new engineering and information technologies, in October of 2001, the board unanimously voted to move forward with a revised Policy Statement 465, entitled ''Academic Prerequisites for Licensure and Professional Practice.'' This paper examines the ethical dimensions surrounding the call for additional education. To this end, the ASCE Code of Ethics will be discussed as a living document that governs the practice of safe, effective, and professional civil engineering, and will be brought to bear on the issues surrounding the implementation of ASCE Policy Statement 465.

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Introduction: Time for Change

Maintaining the engineered environment in the 21st Century will require a new mindset from project participants (Allenby 2001). There is a growing consensus within the civil engineering community that current practice differs significantly from that of even the recent past. Increases in human population, a growing reliance on information technology, the onset of a truly global economy, shrinking project timescales, and a complex and degrading infrastructure will continue to challenge civil engineers and their education system (Little 1999; Grigg 2000; Bordogna 2001). To account for the myriad challenges and complexities confronting the profession, many within ASCE have begun to seriously and, most important, formally reevaluate the length and content of civil engineering education (Russell et al. 1996; ASCE 1998; Wulf 1998; Liggett and Ettema 2001; Sparrow 2001; Yao and Roesset 2001). While current education may be adequate, there is an opportunity for civil engineers to emerge as ''master integrators'' of the 21st Century (Bordogna 1998). Rather than simply meeting the minimum requirements, the writers would like to witness a revitalization of the profession through a reengineering of the entire education-experience-licensure paradigm. To accomplish this, civil engineers will require more, and better structured, formal education.

To be sure, formal education is not the only variable determining the level of professional preparation; experience and continuing education are also important elements in this equation. Nevertheless, formal education is the critical link in providing the fundamental background and understanding for the challenges, problems, and joys of practice. Formal education is also where the majority of practitioners develop their basis for understanding and adhering to the ethical standards of a profession.

Throughout the 20th Century, many professions recognized the need for additional education to provide graduates with the skills, knowledge, and ethical base necessary for professional practice. In the 1910s and 1920s, medicine and law significantly restructured their education systems, while more recently accounting, architecture, occupational therapy, and pharmacy have restructured theirs (Thorne 1973a,b; Haber 1991; Hitchens 1997; American 1999; Cumming and Rankin 1999). Currently, the minimum education requirement for civil engineering—a 4 year bachelor of science in civil engineering (BSCE)—falls well short of the requirements for accounting (5 years), architecture (5 years), occupational therapy (5 years), pharmacy (6 years), law (7 years), and medicine (8 years) (Task 2001). Considering the incredible advances in science and technology and the increasing complexities of civil engineering practice over the last 100 years, this disparity is conspicuous and a little bit troubling.

Until recently, little effort was taken to systematically address the root causes of how and why civil engineering has slipped behind other professions regarding formal education. Fortunately, this has changed, with education at the forefront of the professional agenda. However, the ethical ramifications of the current level of education have yet to be addressed in any organized fashion. For a profession dedicated to upholding public safety, health, and welfare, as stipulated by Canon 1 of the ASCE Code of Ethics, ethical issues should be central (ASCE 2002). This paper argues that the current education system is already taxed to provide the necessary technical education, much less a foundation in areas such as teamwork, leadership, and management that have become recognized as essential skills for professional practice. Furthermore, if educational changes are not enacted soon, the ethical and professional standards of the profession will be significantly challenged.

The purpose of this paper is to address the ethical implications of requiring or not requiring additional formal education. This

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Fundamental Principles
Engineers uphold and advance the integrity, honor and dignity of the engineering profession by:

1. Using their knowledge and skills for the enhancement of human welfare and the environment;
2. Being honest and impartial and serving with fidelity the public, their employers and clients;
3. Striving to increase the competence and prestige of the engineering profession; and
4. Supporting the professional and technical societies of their disciplines.

Fundamental Canons

1. Engineers shall hold paramount the safety, health, and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties.
2. Engineers shall perform services only in areas of their competence.
3. Engineers shall issue public statements only in an objective and truthful manner.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest.
5. Engineers shall build their professional reputation on the merit of their service and shall not compete unfairly with others.
6. Engineers shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession.
7. Engineers shall continue their professional development throughout their careers, and shall provide opportunities for the professional development of those engineers under their supervision.

Fig. 1. ASCE Code of Ethics (ASCE 2002)

paper is organized around the ASCE Canon of Ethics and will concentrate on two themes at the heart of the code—public safety, health, and welfare (Principle 1 and Canon 1) and enhancement of the profession (Principle 3 and Canon 6). Specialization, professional skills, project failure, the trend of nonengineers managing civil engineers, and leadership development will also factor into this analysis. This paper concludes with an exploration of the ethical obligation contained in Canon 7, which charges all civil engineers to ''provide opportunities for the professional development of those engineers under their supervision'' (ASCE 2002). The writers make no claims regarding the definitive nature of the arguments presented herein. Rather, they hope these ethical considerations will encourage the ongoing discussions surrounding Policy Statement 465 and the need for additional education to meet the mounting challenges of the 21st Century.

ASCE Code of Ethics

The ASCE Code of Ethics, originally adopted in 1914, is a set of four principles and seven canons intended to regulate the ethical conduct of ASCE members. It covers all areas of practice, from project safety to honesty in business transactions. The fundamental principles and canons are presented in Fig. 1, while the complete code, including the detailed Guidelines to Practice, is published in ASCE's annual Official Register (ASCE 2002). The original Code of Ethics consisted of six canons—what are now Canons 2–7—without the four principles. While a commitment to public safety, health, and welfare has long been a part of the ethos of ASCE, the original code stressed principled and honest interaction between clients and other engineers. Public safety was not an explicit ethical goal or objective until the mid-1970s.

Beginning in the 1950s, civil engineers collectively faced increasing liabilities as the interpretation of negligence and failure laws allowed persons injured on or in a facility to sue the engineers and architects who designed or otherwise supervised the construction of that facility, even long after the facility was built. During the same period, civil engineers came under fire from social critics concerned with the harmful effects of technology and the professions responsible for developing and promoting the technological transformation of postwar society.

In response to new liability and increasing criticism, many ASCE members wanted to openly assert their commitment to society at large, a proposition not without controversy. A contingent within the civil engineering and design community thought an explicit alignment with public welfare and safety would open design professionals to further litigation and obligation, possibly with negative financial and professional consequences. After debate within ASCE, the board chose to align the society firmly with public safety and adopted a new Code of Ethics on September 26, 1976 (Pfatteicher 1996). Included in this revamped code was a new canon proclaiming that member engineers ''shall hold paramount the safety, health and welfare of the public,'' as well as the four principles, the first of which states that civil engineers shall use ''their knowledge and skill for the enhancement of human welfare and the environment'' (ASCE 2002).

For the last 26 years, ASCE members have been obligated to uphold public safety, health, and welfare, but can this pledge continue to be upheld in the 21st Century without additional education? Given the general trend toward complexity, the education-experience-licensure system as currently conceived may not adequately prepare individuals to practice—ethically, technically, or professionally—in the year 2030 and beyond, and this is a concern.

Upholding Public Safety, Health, and Welfare: Principle 1 and Canon 1

Not only does its very name evoke the public that it serves, but of all the major engineering disciplines, civil engineering has the highest percentage of practitioners employed by public agencies (Ellis 1998; Kupferman 2000; Russell et al. 2001). Over 80% of civil engineers work for some form of government or in consulting, ''which contracts heavily with government'' (Grigg 2000). While civil engineers have long been the designers and maintainers of the nation's multitrillion dollar infrastructure, ensuring the welfare and safety of the population in the 21st Century will challenge their professional and ethical mettle. By looking at the specialization confronting both education and practice, and by addressing the notion of failure and litigation on civil engineering projects, the ethical ramifications surrounding additional education become clearer.

Specialization

The fragmentation of civil engineering over the course of the 20th Century into fields such as structural and geotechnical engineering mirrored the original diversification of engineering into civil and military branches, followed by the specialties generally recognized today—civil, chemical, electrical, mechanical, military, and nuclear. Specialization has unquestionably become an attribute of the modern world and will continue to affect civil engineering throughout the 21st Century—so much so that some individuals and organizations have become concerned that engineering as a whole may be ''losing what is central to any profession ... a shared body of knowledge'' (Schwartz 2001).

To provide students with the skills and understanding they need to gain employment, many universities have implicitly embraced specialization as the organizing principle of their programs. Whereas once civil engineering students took a unified technical core, today's students take fewer common civil engineering courses, and concentrate on a particular aspect of practice for a greater percentage of their academic careers (Pauschke and Ingraffea 1996; Russell et al. 2000). By their third academic year, many students have already made a decision to specialize in construction, environmental, or perhaps structural engineering. While all students take some common courses, many elect, or are encouraged, to take advanced courses in their chosen specialities. What this means is that structural engineering students may take next to no project management, and environmental engineering students may take only a single structural analysis course.

In an attempt to prepare students for specialized practice, a general understanding of the civil engineering enterprise may be the opportunity cost, a factor contributing to the widespread reputation of civil engineers being overly specialized technicians (Little 1999). It is difficult to say whether the level of specialization in education has gone too far. Regardless, if overspecialization were the only concern with current undergraduate programs (and civil engineering practice), more general technical courses could conceivably be added, although few educators would agree that there is any room left in the jam-packed, and shrinking, 4 year box (Task 2001). The problem is more extensive than fewer total credits or too much specialization. Not only has the core technical curriculum been spread thin to cover a complex, specialized world, but the current curriculum fails to adequately prepare students for many aspects of professional practice. Many undergraduate ''programs are weak ... in providing engineers with an integrative and deep knowledge of the areas encompassed by civil engineering'' practice, and unless this problem is proactively addressed, many signs point to its continuation (Liggett and Ettema 2001). This lack of holistic understanding of how to safely and effectively participate in and manage the project process may be impacting public health, welfare, and safety even more so than any technical deficits in education. One possible measure of the preparedness of civil engineers to practice safely and effectively involves project failure and the resultant litigation.

Failure Analysis

Failures on a project or with a facility generally cost owners and the public time and money, and can contribute to injury or loss of life. It has been proposed that a quantitative exploration of the rate of change of engineering failures over time could determine whether the decrease in the common technical education has affected the safety of civil engineering practice (Nixon 2001). In addition, such a failure analysis would conceivably gauge the relative alignment of the current education-experience-licensure system with the demands of professional practice, whether measured against technical or nontechnical criteria. After all, failure on a project points to either (1) an error in judgment and/or a lack of understanding, which are technical in nature; or (2) inadequate leadership and/or management of a process, which are nontechnical in nature.

According to Feld and Carper (1997), there are generally few structural collapses, making comparisons over time of catastrophic failures statistically insignificant. If, however, one takes the definition of failure used by the ASCE Technical Council on Forensic Engineering, which is ''an unacceptable difference between expected and observed performance,'' then clearly the raw number of failures would increase by several orders of magnitude (Leonards 1982). In addition to structural collapse, failure under this definition would include any functional, process, or systems malfunction whereby facilities do not operate as intended within temporal or financial parameters. While it would be difficult to reliably account for variation over time in the quantity and severity of all failures, examining recent data suggests that failure itself may correlate with the inadequate preparation of civil engineers to communicate, manage, and work on a team.

Insurance Errors and Omissions Claims

For DPIC Companies, one of the leading underwriters of designer errors and omissions (E/O) insurance, a striking seven out of 10 claims are nontechnical in nature. DPIC classifies E/O failure claims as primarily technical or nontechnical. Technical failures are errors, omissions, and/or deviations from any accepted design practice that result in a loss prevention file or claim. Technical E/O claims stem from scenarios such as the misdistribution of a load or the specification of a heating system with insufficient capacity. According to DPIC, nontechnical errors are essentially a ''breakdown in project or practice management processes which contributes to a loss prevention file or claim being made.'' The four most severe nontechnical claims, in order of importance, stem from (1) communication; (2) project team capabilities; (3) client selection; and (4) negotiation of contracts. By far the most common cause for nontechnical errors is inadequate communication, accounting for 27% of total E/O claims. These claims can include such problems as the lack of procedures to identify or address conflicts, project staff being unaware of responsibilities, lack of documentation regarding changes in scope (i.e., change orders), potential disputes not handled promptly, and scope of services not clearly explained to the client. For DPIC and the firms they insure, inadequate communication accounts for nearly one-quarter (22%) of the loss of revenue dollars related to claims.

Litigation

The overwhelming majority of E/O claims attributable to nontechnical factors (70% of DPIC claims) emphasize the importance of communication and effective management of project processes to avoid or mitigate failure. Regardless of whether a claim is technical or nontechnical in nature, however, resolving that claim almost always entails negotiation and communication. If this process is not amicably resolved by the project participants, claim resolution can fall to legal counsel, with increased project costs. In a series of interviews with design/construction (D/C) practitioners, a special *Engineering-News Record* report has highlighted the difficulties posed by increased litigation on D/C projects (Post 2001). Failure and litigation may simply be consequences of the modern D/C project, but, regardless, current education does not appear to adequately prepare civil engineering graduates to deal effectively with litigation, much less provide strategies to minimize the use of legal counsel (Day 1992).

Need for New Skill Set

Business, communications, leadership, management, and a basic understanding of the legal process have become indispensable to the civil engineer. Together, these professional skills comprise a significant portion of the new skill set needed to safely and effectively practice civil engineering in the 21st Century (Little 1999; Bernhardt and McNeil 2001; Yao and Roesset 2001). While such skills are becoming critical and necessary to ensure a safe and effective project process, they are seldom given the same emphasis as technical subjects in the undergraduate curriculum. Accordingly, the Accreditation Board for Engineering and Technology (ABET), the body that accredits the nation's engineering programs, has recently reformed its criteria and declared that all engineering students should be able to demonstrate an awareness and understanding of professional skills (ABET 2001). ABET defines professional skills as leadership, management, teamwork, communication, and knowledge of contemporary issues. While these subjects are typically covered as components of civil engineering courses, very few institutions offer courses devoted to these important topics.

The writers recently conducted a statistical analysis of the nation's accredited civil engineering programs based on uniform data compiled from recent ABET accreditation visits. In total, 90 of the nation's 218 accredited programs (41%) participated in this analysis, including the majority (81%) of the top undergraduate programs at schools that have a corresponding graduate program, and 50% of the top undergraduate programs without a graduate program, as identified by *U.S. News and World Report* (''Best'' 2002). Measured by the number of graduates, this analysis accounts for nearly 50% of the nation's student body, as in 2001 the participating schools graduated 4,035 of the 8,219 total civil engineering graduates (Engineering 2001). On average, civil engineering students are required to take less than one semester course in their academic career devoted to professional skills, not including basic oral and written communication. While 34 programs (38%) require project management, only three schools require a course in either leadership or team building. Two of these programs are U.S. military, while the other offers a one-credit course. Seventeen programs (19%) require a course in engineering ethics, while nine schools require a course in contract law or specifications. Only one school requires both an ethics and a leadership course.

Professional skills are sprinkled throughout the undergraduate experience, but few programs dedicate space in the curriculum to imparting the fundamentals. The questions must be asked: Is the current education system providing the average student with optimal or even adequate levels of professional skills, and if not, what are the consequences to the profession?

If essential educational outcomes are to include both technical understanding and a professional skill foundation, as ABET, many educators, and a growing voice within industry champion, then without requiring additional formal education beyond the baccalaureate level, integrating professional skills may come at the cost of technical education. This raises an interesting question: Should the hallmark of the civil engineer in the 21st Century continue to be the technical understanding of some important but particular facet of a project, or should civil engineers strive to understand, manage, and direct the engineered environment? To be certain, the two options are far from irreconcilable, but the current system privileges specialization to the detriment of a general understanding. Of course not every civil engineer aspires to oversee a project or organization, but every civil engineer can benefit from a better understanding of communication, time management, team work, and the sociopolitical factors affecting the planning, design, construction, maintenance, and operation of engineered facilities. A formal study of the fundamentals of professional skills would allow future civil engineers to contribute more successfully to problem resolution and avoidance, and in general add more value to the project team. What's more, a lack of grounding in these critical subjects may even increase the likelihood of failure, and thus decrease public welfare and safety.

That project process breakdowns, whether technical or nontechnical, lead to failure, claims, and sometimes litigation is a given. While formal education is not and should not be the only medium to address process breakdowns and failures, the college classroom is the ideal forum to teach the fundamentals of the profession. Additional formal education will not guarantee that less failure and/or litigation will be experienced on engineering projects, but increased contact time in the classroom will allow students to engage both technical and professional skills more thoroughly and completely. While civil engineering students will not learn all the subtleties of effectively communicating with contractors, owners, and architects, a rigorous education in the fundamentals of technical and professional skills will provide a foundation for them to build on throughout their careers. Perhaps more important, students will also be impressed with the importance of developing communication, management, and leadership skills and the notion that the civil engineer must work to become a deft communicator, able to explain project options to other team members who do not possess the same technical proficiency. Additional technical and professional skill education will in turn increase future civil engineers' knowledge about the systems they are designing, the communities they are designing them for, and the most efficient and safe ways to design, construct, and maintain the built environment. In this way, an enhanced curriculum will eventually translate into safer design practices and augment public health, welfare, and safety.

Enhancing the Profession: Principle 3 and Canon 6

Principle 3 states that civil engineers should strive to ''increase the competence and prestige of the engineering profession,'' while Canon 6 states that civil engineers ''shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession'' (ASCE 2002). These precepts do not suggest that civil engineers should compete for the same salaries as doctors or lawyers, or strive for the same celebrity status enjoyed by leading architects, but they do encourage civil engineers to dedicate themselves, at least in part, to the responsible promotion of the profession.

Without fully qualified graduates who possess both technical and professional skills, it will be difficult for civil engineering to proactively enhance the prestige and competency of the profession. Disturbingly, if civil engineers do not take the lead in responding to the challenges of 21st-Century engineering, nonengineers, more adept at managing and communicating, may increasingly dictate the future of the profession. There is a trend toward individuals with a master of business administration, master of public administration, or law degree managing civil engineers, especially in the public sector (Bordogna 1998; Adamski 1999; Beder 1999; Bonasso 2001). The primary reasons cited for this trend are the perceived inability of civil engineers to communicate effectively, manage responsibly, and lead a business or organization. The primary concern for the profession (and public welfare and safety) is that these individuals do not often possess a technical understanding of the infrastructure systems they are overseeing and, consequently, may not always select the optimal, or safest, courses of action.

The profession must make an intentional, proactive effort to enhance its prestige and competency, as there is little incentive for nonengineers to impart the necessary leadership and management skills to civil engineers. The argument could be made that there is a *disincentive* for other professions or employers of civil engineers to encourage their improvement and development. With increased value-adding skills, civil engineers would likely command higher remuneration and compete more successfully with other professions for technical management and leadership positions. But unless civil engineers acquire ''more of the right communication and business skills,'' Myron Calkins, P.E., former Kansas City director of public works, warns that the ''writing is on the wall'' for a gloomy and marginalized future (Davis 2000).

Leadership Training

One means of preparing future civil engineers to successfully navigate through a complex future is leadership training. Leadership is a complicated notion that includes the art and science of providing direction and vision to an organization, communicating that direction, and motivating others to buy in and contribute to the realization of that vision. Leadership can be based on, but is not the same thing as, technical expertise. Civil engineers are unquestionably leaders in the technical aspects of designing buildings, public-works facilities, and highways. But few engineers in general, and fewer civil engineers in particular, occupy leadership positions outside of their technical specialties. As such, civil engineers are not commonly perceived as leaders.

A recent poll commissioned by the American Council of Engineering Companies (ACEC), an association representing consulting engineering firms, confirms that civil engineers are not perceived as leaders outside of their technical areas of expertise. ACEC queried business leaders; federal, state, and local legislators and authorities; utilities and Department of Transportation officials; media representatives; and engineering students. Only 14% of these wide-ranging respondents viewed consulting engineers as community leaders, while 45% viewed them primarily as technical consultants (''Fuzzy'' 1998). As further evidence, consider the recent special issue of *Time Magazine* that named the most influential ''Builders and Titans of the 20th Century'' (''Builders'' 1998). Among such varied luminaries as Henry Ford and Walt Disney, only Stephen Bechtel represented the ranks of civil engineers. Whereas star architects such as I. M. Pei, Frank Gehry, and Ceasar Pelli are commonly celebrated in the media as visionaries, and their projects given front-page representation, civil engineers are rarely even mentioned by name, and their projects hardly touted (Weingardt 2000).

Intentionality

The way leaders are developed in civil engineering is not always intentional. The current process of identifying and cultivating future leaders is self-selective at best, haphazard at worst. To be sure, not every civil engineer can or should aspire to lead organizations or communities. It has been estimated that only 15% of the profession is involved in upper management (Matteson 2001). However, leadership can and does take countless forms, from standing up for disadvantaged coworkers to reporting unethical behavior to the proper authority. Even in the most technical of positions, civil engineers must be aware of such issues as cost accounting, taxation, liability, safety, quality control, marketing, and client relations—concerns central to good project management and leadership. Consistently, however, the value of leadership is not explicitly communicated to civil engineers as a priority of their education. The engineer and popular writer Samuel Florman has observed that most engineers do not gain an appreciation for leadership—or literature, philosophy, and history—until they are deep into their careers (Florman 1987). This is hardly surprising: A marginal, almost negligible, percentage of the civil engineering curriculum is focused on leadership training. Without fundamental education, it is little wonder that so few civil engineers become leaders within greater society. This is unfortunate, because the insight and understanding that civil engineers possess could immeasurably enhance the public dialogue on crucial issues facing the 21st Century, such as sustainability, vulnerability, and environmental protection.

The fundamentals of leadership can and should be taught to all civil engineering students (Bowman and Farr 2000; Bergeron 2001). The same can be said for other professional skills such as communication, teamwork, and management. Yet with fewer credit hours in the BSCE, there is less time in the 4-year curriculum to acquire an up-to-date technical understanding of civil engineering fundamentals, much less gain a wider appreciation of leadership, professional skills, and the liberal arts such as history, economics, and political science (Russell et al. 2000). Doubting the importance of leadership training, professional skill fundamentals, and a foundation in the liberal arts is to underestimate just how much the design and construction industry is changing (Robar 1998; Bowman and Farr 2000; Bonasso 2001).

While additional leadership, professional skills, and liberal arts education will not instantly elevate civil engineers to a new level of prominence with enhanced control over professional concerns, more of the right kind of education will certainly give the next generation of civil engineers an advantage. More depth and breadth of technical and professional skills will provide tomorrow's graduates with the tools to enhance their careers and serve society more effectively. With value-adding knowledge and skills, the next generation will compete more successfully for middle- and then upper-management positions, as well as vie for leadership positions in companies, and appointed and elected positions within government. Over time, as individual civil engineers take on more responsibility and leadership positions, the profession will gain more influence, and gradually a culture shift will occur. By 2030, the professional civil engineer could be known for his or her ability to make sense of a wide variety of social concerns relating to the built and natural environments, as well as his or her ability to communicate this understanding to a broad audience. But how can this exciting future of enhanced prestige, competency, and integrity be engineered without more, and more broadly based, fundamental education?

Conclusion: Canon 7

Every practicing civil engineer has an obligation to improve the engineering profession. Specifically, Canon 7 of the Code of Ethics states that civil engineers ''shall provide opportunities for the professional development of those engineers under their supervision'' (ASCE 2002). In a very real sense, the next generation of civil engineers is under the supervision of today's practicing professionals. It is up to those currently practicing to shape the future of the profession by preparing the next generation of talented, holistically educated civil engineers to safely design the buildings and infrastructure that support our economy and civilization. Additional technical and professional skill education will help enable future civil engineers to manage and solve complex technical problems. Experience and mandatory continuing education will be central to any successful effort to improve the caliber of the profession, but neither continuing education nor experience alone is the best means to help young civil engineers develop fundamental communication, leadership, and technical skills and understanding at the outset of their careers.

Without additional education, the challenges to the profession will continue to mount as the resources and opportunities for change become increasingly scarce. Civil engineering must act now to pave the way for a bright, safe future for the practitioners of this noble endeavor and for the public at large. While there is much to be learned about the best means of restructuring the education-experience-licensure configuration of civil engineering, enhanced technical and professional education will enable the next generation of practitioners to ''advance the integrity, honor and dignity of the engineering profession'' (ASCE 2002).

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