ENGINEERING THE FUTURE OF CIVIL ENGINEERING

REPORT

Of The

TASK COMMITTEE
On The
FIRST PROFESSIONAL DEGREE

To The

EXECUTIVE COMMITTEE
BOARD OF DIRECTION
AMERICAN SOCIETY OF CIVIL ENGINEERS

D R A F T
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ABBREVIATIONS

AAEE	American Academy of Environmental Engineers
AAES	American Association of Engineering Societies
ABET	Accreditation Board for Engineering and Technology
ACFE	American College of Forensic Examiners
ACPE	American Council on Pharmaceutical Education
AICPA	American Institute of Certified Public Accountants
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASEE	American Society for Engineering Education
ASME	American Society of Mechanical Engineers
BIC	Board of Investigation and Coordination
BSCE	Bachelor of Science in Civil Engineering
BSEE	Bachelor of Science in Electrical Engineering
CAD	computer-aided drafting
CASE	Council of American Structural Engineers
CE	civil engineering
CERF	Civil Engineering Research Foundation (of ASCE)
CPA	Certified Public Accountant
CPD	continuing professional development
CPP	Committee on Professional Practice (of ASCE)
DE	Doctor of Engineering
EAC	Engineering Accreditation Commission (of ABET)
EC-2000	Engineering Accreditation 2000 (of ABET)

EdAC	Education Activities Committee (of ASCE)
EMC	Engineering Manpower Commission
EWC	Engineering Workforce Commission
FEANI	Federation of National Engineering Societies
FE	Fundamentals of Engineering (as in FE examination)
FPD	First Professional Degree
GS	General Schedule (in the federal government's GS grades)
INTAC	International Activities Committee (of ABET)
MA	Master of Arts
MBA	Master of Business Administration
MD	Medical Doctor
MEngr	Master of Engineering
MEnvE	Master of Environmental Engineering
MOE	masters or equivalent
MPA	Master of Public Administration
MRA	mutual recognition agreement
MS	Master of Science
MSCE	Master of Science in Civil Engineering
NAAB	National Architectural Accreditation Board
NAE	National Academy of Engineering
NASBA	National Association of State Boards of Accountancy
NCABB	National Council of Architectural Registration Boards
NCEES	National Council of Examiners of Engineering and Surveying
NCSEA	National Council of Structural Engineers Associations

NSF	National Science Foundation
NSPE	National Society of Professional Engineers
NTU	National Technological University
OECD	Organization for Economic Cooperation and Development
OPM	Office of Personnel Management (of U.S. government)
Pharm.D.	Doctor of Pharmacy
SAME	Society of American Military Engineers
TC	Task Committee
TCCEEI	Task Committee on Civil Engineering Education Initiatives
WFEO	World Federation of Engineering Organizations

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EXECUTIVE SUMMARY

ASCE Policy Statement 465 supports the concept of the master's degree as a prerequisite for the practice of civil engineering at the professional level.

Policy Statement 465 and Charge to and Approach of the Task Committee

The ASCE Board of Direction, in October 1998, adopted Policy Statement 465, which begins as follows: "The ASCE supports the concept of the masters degree as the First Professional Degree (FPD) for the practice of civil engineering (CE) at the professional level." This policy is explicitly supported in *Building ASCE's Future – Strategic Plan* adopted in 2000 by the Society. The ASCE Board formed the Task Committee (TC) for the FPD in October 1999 and charged it with "developing a vision of full realization of ASCE Policy Statement 465 …and a strategy for achieving this vision."

The TC encouraged and achieved open, creative and broad ranging discussions within the group and solicited and considered stakeholder input. Internal tasks carried out by the TC included researching the education, experience, licensing and certification requirements of other professions; studying the history and forms of CE education in the U.S. and elsewhere; and reviewing current and future challenges to and opportunities for CE. Ways in which the TC interacted with ASCE members and other stakeholders included examining supportive and opposing resolutions and other communications, conducting interactive sessions with many groups, and presenting progress reports.

The Task Committee believes that the four-year bachelor's degree is inadequate formal education for the practice of civil engineering at the professional level in the 21st century.

The Issue

The question is not, in the TC's view, what should be the first professional degree but instead what should be the educational prerequisite for the practice of CE at the professional level. The TC believes that the fundamental issue addressed by Policy Statement 465 is: ***The current four-year bachelor's degree is inadequate formal academic preparation for the practice of CE at the professional level in the 21st Century***. This fundamental issue facing the CE profession has many facets and related concerns which are summarized as follows:

- Narrow formal education of civil engineers providing inadequate preparation for a rapidly changing work environment, changing production and delivery systems, and for leadership roles.

- Gradual historic reduction in credit hours required for the BSCE degree and "slippage" in the civil engineering education-experience-licensing-certification-continuing professional development process relative to other professions.

- Low compensation received by civil engineers relative to other engineering disciplines and other professions.

- Declining appeal of CE to highly motivated young people.

Vision of Full Realization of Policy Statement 465

The Task Committee believes that admission to the practice of civil engineering at the professional level occurs at licensure and requires a body of specialized knowledge as reflected by a combination of a baccalaureate degree and a masters degree or equivalent, appropriate experience, and a commitment to life long learning.

Policy Statement 465, as currently written, focuses on the designation of a masters as the first professional degree for the practice of CE. The TC believes that the focus should be on establishing the prerequisite educational requirements for licensure and practice at the professional level and recommends that the Policy Statement 465 be retitled as *Academic Prerequisites for Licensure and Professional Practice* and the policy be revised to read: "The American Society of Civil Engineers (ASCE) supports the concept of the Master's Degree or Equivalent (MOE) as a prerequisite for licensure and the practice of civil engineering at the professional level."

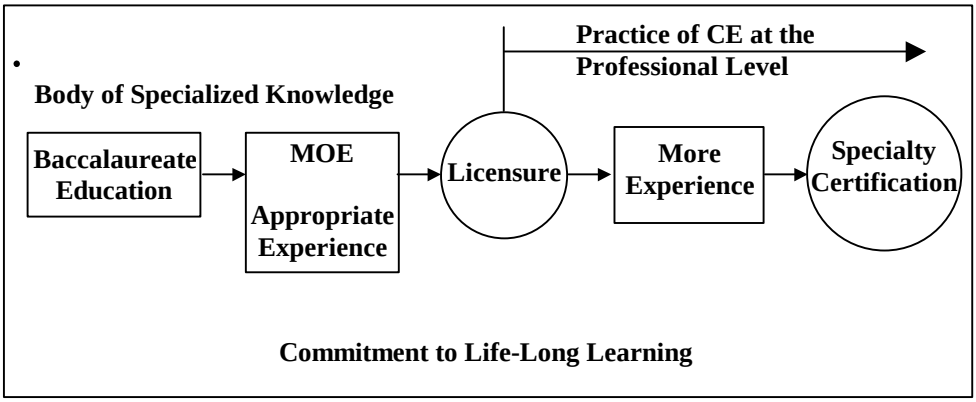
The practice of CE at the professional level means practice as a licensed professional engineer. Admission to the practice of CE at the professional level occurs at licensure which requires:

- A body of specialized knowledge as reflected by a combination of a baccalaureate degree and a master's or equivalent (MOE)

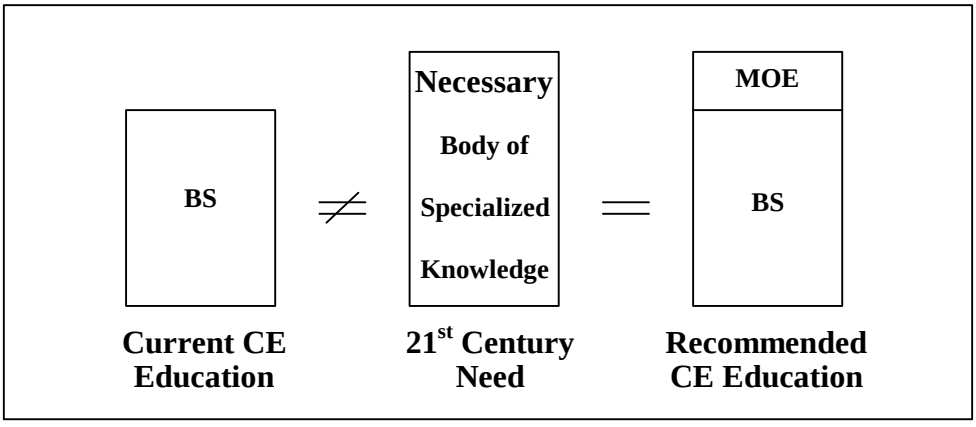
- Appropriate experience

- Commitment to life long learning

The essence of this vision for CE, which incorporates current baccalaureate education and the current experience requirement, may be illustrated as follows:



The body of specialized knowledge includes four components. They are 1) a technical core, 2) a non-technical core, 3) technical electives, and 4) technical and non-technical courses to support an individual's career objectives. As illustrated in the following figure, and as previously noted, the body of specialized knowledge needed to practice CE at the professional level in the 21st Century can no longer be accommodated within a four year bachelor's degree. However, and as also illustrated in the following figure, the necessary body of specialized knowledge can be provided by the combination of a baccalaureate degree and a MOE.



ASCE recognizes attainment of the body of specialized knowledge as a prerequisite for licensure and entry into the practice of CE at a professional level. The MOE may be a traditional masters degree or an appropriate combination of courses whose content and quality are equivalent to or exceed a traditional masters degree. Besides civil engineers that currently practice at the professional level, that is, are licensed, the CE community includes CE technicians and technologists and non-licensed civil engineers. Some of the last category are in the process of seeking licensure and others have elected not to do so.

Strategies

The Task Committee identified strategies which were subsequently used to develop the recommended implementation plan.

Many strategies were identified by the TC to use as the basis for addressing the issue and achieving the vision. The TC subsequently used these strategies to construct the recommended implementation plan. The categorized strategies are:

Leadership Strategies

- Lead, don't wait.
- Identify and proactively work with stakeholders.
- Protect the current status of members of the CE profession.
- Coordinate with ASCE's sesquicentennial.
- Develop specialty certification.

CE Education Strategies

- Define masters or equivalent (MOE).
- Learn from engineering education practices in other countries.
- Utilize distance learning.
- Address concerns of and opportunities for exclusively or primarily undergraduate CE programs.
- Address concerns of and opportunities for masters degree programs.

Strategies Involving Joint Efforts with Other Professional Organizations

- Learn from non-engineering professions that recently raised education standards.
- Recognize the supportive goals and policies of the Accreditation Board for Engineering and Technology (ABET).
- Build on the supportive aspects of the National Society of Professional Engineers' (NSPE's) new licensure model.
- Recognize the potential support of the National Council of Examiners of Engineering and Surveying (NCEES).
- Support the Fundamentals of Engineering Examination.

Implementation Plan

The implementation plan identifies principal participants, defines four key action items and 31 supporting tasks, and establishes a schedule.

While strategies are essential, an implementation plan with principal participants, action items, specific tasks, and definitive milestones is needed if concrete actions are to occur. Accordingly, a detailed implementation plan was developed as a way to proactively achieve full realization of ASCE Policy Statement 465. Three groups of principal participants in the plan are: 1) ASCE, its Institutes, the general membership and employers of members of the CE profession; 2) the NCEES and state licensing boards; and 3) the ABET, universities, other educational providers, and other professional societies serving civil engineers.

ASCE, working in partnership with NCEES and state licensing boards; ABET, universities and other educational providers; and other professional societies serving civil engineers should be able to substantially implement this report's recommendations within 20 years.

Four major action items, each with supporting tasks, should be completed over the next 20 years. ***All four action items should begin at the outset and proceed in parallel with appropriate inter-task communication and coordination.*** These action items are supported by a total of 31 specific tasks each of which is 1) assigned to one or more principal participants, 2) is given a scheduled duration, and 3) includes defined outputs. The four action items and the 31 supporting tasks are:

- Action Item A: ASCE leads through continuous interaction with other stakeholders.

    1. Approve refined Policy Statement 465
    2. Form Implementation Committee

3. Accept and endorse report

4. Distribute report to leaders of NCEES, ABET, Founder Societies and others as appropriate

5. Interact with stakeholders

6. Ask the ASCE Committees on Professional Practice and Educational Activities and the ASCE Institutes to support the report's recommendations

7. Ask professional societies and organizations to support the BS-MOE as a prerequisite for the practice of CE at the professional level

8. Revisit ASCE membership grade requirements

- Action Item B: Licensing jurisdictions adopt the BS-MOE as a requirement for the practice of CE at the professional level.

    1. Review the change processes used by other professions

    2. Prioritize licensing jurisdictions

    3. Prepare fact sheets and guidelines

    4. Convince state legislators and regulators

    5. Refine the Model Licensure Law

    6. Pass legislation and/or adopt rules

    7. Encourage employees to obtain licensure

    8. Encourage users of CE services to more rigorously require licensed civil engineers to be responsible for CE projects

- Action Item C: ABET, universities and others revise CE curricula, programs and culture.

    1. Obtain input from individual practitioners and employers

2. Emphasize role of employers in partnering with employees on MOE and continuing education

3. Select BS-MOE model(s) and design curricula

4. Develop BS-MOE certification criteria

5. Provide faculty development

6. Develop accreditation criteria including dual level accreditation

7. Obtain accreditation

8. Explore the professional school model

- Action Item D: ASCE Institutes lead the development of specialty certification

    1. Identify interested Institutes

    2. Explore relationships with other professional societies

    3. Prepare common criteria

    4. Pilot the specialty certification program with one institute

    5. Expand the specialty certification program with other institutes

    6. Encourage practitioners to obtain specialty certification

    7. Encourage users of specialized CE services to require participation by specialty certified civil engineers

Closing Thoughts

While a "no action" option is possible, it would lead to a declining role for the civil engineering profession and its members. More importantly, society would gradually lose the benefit of the civil engineering profession's long and caring tradition of placing the highest priority on protecting public safety, health and welfare.

The TC offers a challenge in the form of respectful queries to those who oppose ASCE Policy 465 and the TC's recommendations presented in this report. Given the dynamic changes within and around CE, if you do not support the BS-MOE as a prerequisite for licensure and practice at the professional level now, when will you support it? If you do not support the BS-MOE, regardless of when it would be implemented, what do you advocate so that CE can thrive, or at least survive, in the rapidly changing environment? How would you have our profession lead, or at least keep up, within the infrastructure and environmental arena and relative to other professions?

In the opinion of the TC, a "no action" option is possible, but not prudent; feasible but not future focused. "No action" would lead to a diminished role for the civil engineering profession and its members. Paralleling this declining role, society would gradually lose the benefit of the profession's infrastructure and environmental competence and long and caring tradition of placing the highest priority on protecting public safety, health and welfare.

The Task Committee urges the ASCE Board of Direction to quickly adopt and assertively implement the recommendations presented in this report.

The TC thanks the ASCE Board of Direction for the opportunity to serve and offers this closing thought and its recommendation. Civil works will always be in demand—that is unquestionable. To be decided, however, is who will lead the planning, design, construction and operation of civil works in the U.S.; civil engineers or others? Our environment will increasingly need protection. Civil engineers could lead this effort, but will they? The CE profession can engineer its future or others will engineer it for us. The TC strongly endorses the former. ***With pride in the history and traditions of CE and confidence in the profession's future, the TC urges the ASCE Board to quickly adopt and assertively implement the recommendations presented in this report.***

INTRODUCTION

As of 1998, ASCE policy supports the concept of the master's degree as a prerequisite for the practice of civil engineering at the professional level.

The ASCE Board of Direction, in October 1998, adopted Policy Statement 465 which "supports the concept of the masters degree as the First Professional Degree for the practice of civil engineering at the professional level." A task committee (TC) was formed and charged with "developing a vision of the full realization" of the policy. This report is the result of the TC's work.

The report first provides background information including the policy statement, a description of the TC's approach and a synopsis of the history of civil engineering education. Next, the basic issue addressed by Policy Statement 465 is described along with the issues' many facets. Then the vision of full realization of the policy is presented followed by the implementation strategy and a 20 year implementation plan. Report appendices include supporting documentation and other materials. Notes and a Bibliography conclude the report.

BACKGROUND

Policy Statement 465

Policy Statement 465 begins as follows. "The American Society of Civil Engineers (ASCE) supports the concept of the master's degree as the First Professional Degree for the practice of civil engineering at a professional level." The entire policy, an issue discussion, and a rationale explanation are included as APPENDIX A to this report. The statement was approved by ASCE's Educational Activities Committee on September 9, 1998 and by the ASCE Committee on Policy Review on October 2, 1998 and adopted by the ASCE Board of Direction on October 17, 1998.

The policy is reflected in ASCE's strategic plan.

Policy Statement 465 is reflected in *Building ASCE's Future – Strategic Plan*. Adopted in 2000, the plan "prescribes the direction that the American Society of Civil Engineers plans to take during the next five years." Goal 3, "Advocate lifelong learning to aid our members' continued growth throughout their careers," includes this objective: "Redefine the educational requirements for civil engineers and technologists." The objective calls for developing "a plan to implement the FPD policy statement and persuade those opposed to the concept to see the value of such a program." The specified end product is "A recommendation from the TC on the FPD detailing the plan, budget and timeline to implement the vision of Policy 465."

The Board of Direction charged the Task Committee with developing a vision for full realization of Policy Statement 465 and a strategy for achieving it.

Charge to the Task Committee

"The Task Committee for the First Professional Degree is charged with developing a ***vision*** of the full realization of ASCE Policy Statement 465: The First Professional Degree, and a ***strategy*** for achieving this vision. The Task Committee will solicit input from Society membership and consider the needs of the engineering profession during this process." Appointments to the TC on the First Professional Degree (FPD) were completed in October, 1999. Members of the TC are presented in APPENDIX B. The Task Committee (TC) was asked to deliver its final report to the Executive Committee of the ASCE Board of Direction by October 2001.

The Task Committee engaged in open, creative and broad-ranging discussions and interacted in various ways with ASCE members and other stakeholders.

Task Committee's Approach

The TC's organizational meeting was held in October 1999. Subsequent in-person and conference call TC meetings were convened in January, June, August, and December 2000 and in February, March and April 2001. From the outset, the TC focused on its charge. Open, creative, and broad ranging discussion of topics among members was encouraged and achieved. Identification of and responsiveness to issues raised by ASCE members and other stakeholders were established as guiding principles.

Specific tasks carried out by the TC include:

- Researched and summarized the education, experience, licensing, certification, and continuing professional development requirements of other professions. Refer to APPENDICES C and D, respectively, for tabular and graphical summaries.
- Reviewed the history of civil engineering (CE) education and practice in the U.S.
- Studied potential education models in both the U.S. and other countries.
- Prepared this report. (Number superscripts in the text refer to the Notes section appearing after report appendices. The Bibliography follows the Notes.)

Communication efforts of the TC include:

- Reviewed resolutions and other communications supporting ASCE Policy Statement 465 (APPENDIX E lists these items) and letters and other communications opposing the policy (APPENDIX F lists these items).

- Met with and made interactive presentations to various groups of CE practitioners, faculty and students. See APPENDIX G for a tabular summary of over 50 representative presentations by TC members, ASCE staff members and members of the ASCE Board of Direction.

- Met with John E. Durant, Executive Director, ASCE Institutes and leaders of ASCE Institutes.

- Established, in March, 2001, a portion of the ASCE website featuring free form threaded discussions of topics related to Policy Statement 465.

- Provided direct access to the TC's draft report via the ASCE website in May 2001.

During the course of its work, the TC presented information reports to the Board of Direction. These reports were submitted in April and October 2000 and April 2001. The TC led a half-day, in-depth Board workshop on its preliminary findings and recommendations in April 2001. The TC's final report (the final version of this document) was submitted to the Board of Direction in October 2001.

History of Civil Engineering Education and Related Matters

Civil engineering's four-year education paradigm goes back 200 years. Is it still appropriate?

The Four-Year paradigm. Why does a basic CE education last four years? The answer is found in the history of post-high school education in the U.S.[1] Go back to the late 18th century and consider the status of higher education and engineering practice in the U.S. "Engineering" was an art learned by doing—there were no engineering colleges in the U.S. The absolute or very limited access to formal engineering education 200 years ago in the U.S. is emphasized by the observation that the 350 mile long Erie Canal, which was constructed from 1816 to 1825, was called "America's First School of Engineering."[2]

By the beginning of the 19th century, the time had arrived to begin formalizing engineering education in the U.S. How would this be accomplished? One possibility would be to integrate engineering into the existing U.S. colleges. But this option was not to be. The U.S. colleges of the early 19th century highly valued the humanistic, liberal arts tradition inherited from England and as exemplified by Cambridge and Oxford. Adherents to that tradition strongly preferred teaching a common core of knowledge so that graduates would be "properly educated." Learning for its own sake was highly valued. Integrating engineering, with its strong practical purpose, would threaten the prevailing liberal education model.

Having been rejected by the then existing colleges, the engineering community established the first engineering colleges as essentially new institutions. West Point was founded in 1802 to educate military engineers and Rennselaer Polytechnic Institute, which graduated its first civil engineers in 1835, was formed to prepare civilian engineers. A four-year duration was selected probably because that was part of the college paradigm. Therefore, engineering education was established in the U.S. ***parallel*** to liberal arts education.[3,4] The die was cast. Engineering was a four-year undergraduate program. As illustrated in APPENDIX H, formal engineering study in the U.S. was born as and continues to be in ***parallel*** with liberal arts education.

Civil engineering study in the U.S. was born as and continues to be parallel to liberal arts education. In contrast, most other professions use a longer, more comprehensive serial model.

In sharp contrast, most other professions position their formal education in ***series*** with a liberal arts, or at least a more general, education. For example, legal and medical education were structured in ***series*** with liberal arts education. These schools were first established by practitioners and later became part of universities as professional schools. Completion of a liberal education was assumed at the onset of one's medical or legal education. Given this linkage, liberal arts graduates naturally flowed into the medical and legal professional schools. However, there would be, and still is, little motivation for liberal arts graduates to "go back" and enter a four-year undergraduate engineering program.[3]

As stated by Kerr,[4] "Students interested in becoming engineers generally studied engineering ***instead of*** the liberal arts, not ***in addition to*** the liberal arts." They still do. But must this always be the model? Might integration of liberal arts, engineering, and business into a longer program be a more appropriate paradigm for the future? Policy Statement 465 can be interpreted as encouraging the beginning of a movement away from the parallel model and towards a modified series model.

The TC reviewed the history of civil engineering and other professions. One goal was to learn from other professions. Another was to determine how CE fared relative to them.

Historic Overview: Civil Engineering and Other Professions. In keeping with the spirit of Harry S. Truman's comment that "the only thing new in the world is the history you don't know," the TC reviewed the education and related history of CE and a few other professions. Learning from the experiences of other professions was one goal. Another goal was to see how CE fared relative to other professions in historically elevating educational and other standards.

Timelines presented as APPENDICES I-1, I-2 and I-3 summarize the history of CE, legal and medical education and related matters from 1700 to the present. APPENDICES J and K present snapshots of, respectively, legal and medical education at various points between 1890 and the present.

Based primarily on the referenced appendices, the following observations pertinent to the TC's charge are offered:

1. Engineering, more specifically CE, formalized professional education before law, medicine, and other professions. As already noted, the origin of this was the creation of four-year professional education programs at West Point and Rennselaer Polytechnic Institute in the early 1800's.

2. By the early 1900's, medicine and law formalized professional education as a post-baccalaureate program of at least two years. In the meantime, engineering's professional education remained as a four-year undergraduate program.

3. By about 1920, legal and medical professional education were, respectively, three and four-year graduate programs. In contrast, engineering professional education continued to be a four-year undergraduate program; no post-baccalaureate study was required.

4. The first recommendations for graduate education for engineers was the 1929 Board of Investigation and Coordination (BIC) report. It recommended that engineering students who were above average in general ability should extend their studies and obtain a graduate degree. One result of this vague recommendation was to confirm the practice of the four-year bachelor of science degree for civil engineers.[5]

5. Beginning in 1960, a series of six ASCE education conferences was initiated and occurred at roughly five year intervals. Each of the six conferences considered the extension of the basic CE education to include a year of graduate study or similar. The last conference, which was held in 1995,[6] resulted in the formation of the Task Committee on Civil Engineering Education Initiatives (TCCEEI) reporting directly to the ASCE Board of Direction.

6. Formation of the TCCEEI was a first in that it resulted in a TC reporting directly to the Board. Recommendations in the TC's April 1998 report to the Board led to the Board's October 1998 adoption of Policy Statement 465.

7. In October 1999, the Board formed the TC which prepared this report and submitted it to the Board in 2001. As a point of reference, and as documented later in this report, at the time of this TC's formation, most other professions had gradually raised educational and other standards for entry into their respective profession so that they exceeded those of engineering, or more specifically, CE.

The issue of civil engineering education beyond the baccalaureate level has been repeatedly studied for more than 40 years with the same result: The practice of CE at the professional level requires more formal education. Now is the time to stop studying and start implementing.

The preceding historic review led the TC to three conclusions:

1. CE started as a professional education leader in the U.S., but CE and other engineering disciplines gradually fell behind other professions who opted for the series, as opposed to, the parallel model and other more demanding and rewarding post-education requirements and opportunities.

2. Six CE conferences studied the formal education question for civil engineers and all considered formal education beyond the baccalaureate degree. This issue has been repeatedly studied in depth since 1960 with the same conclusion: the practice of CE at the professional level requires more formal education.

3. Now is the time to stop studying (the need for graduate education for civil engineers) and to start implementing (post-baccalaureate education).

THE ISSUE

The current four-year bachelor's degree is no longer adequate formal academic preparation for the practice of civil engineering at the professional level in the 21st Century.

Issue Statement

While the implementation of ASCE Policy Statement 465 may result in many beneficial outcomes for the CE profession, it is imperative to identify the fundamental issue that the Policy addresses. Specifically, the proponents of the Policy assert that –

> ***The current four-year bachelor's degree is inadequate formal academic preparation for the practice of CE at the professional level in the 21st Century.***

Focusing on this fundamental issue was critical to the TC's logical discussion of the Policy. Ultimately, the TC's vision of and plan for full realization of Policy Statement 465 was based on addressing this fundamental issue.

The issue of inadequate formal education for civil engineers has many facets, that is, aspects and implications. Nine were identified and examined by the Task Committee.

Issue Facets

The issue faced by the CE profession has many facets. ASCE Policy Statement 465 (See APPENDIX A) cited some significant, rapid and revolutionary changes impacting the profession. These are: globalization, information technology, societal diversification, new engineering and construction technologies, enhanced public awareness and increased stakeholder involvement, and the need to maintain infrastructure. The TC explored these and other changes and identified facets of the issue of inadequate formal academic education preparation for the practice of CE at the professional level.

As the Society and its members contemplate the inadequate education issue and ways of addressing it, many concerns arise. Nine major facets of the issue are summarized here. Included are references to articles, papers, books, websites, and other sources. Specific ways to address the issue and related concerns are presented in the later "Implementation of the Vision" section of this report.

1. Narrow Formal Education of Civil Engineers

A consulting firm's or government agency's vitality and resiliency require three different but inextricably related functions, namely leadership, management and production. Today's thriving, as opposed to surviving or dying,

organizations expect and enable everyone to perform all three functions.[7]

Unfortunately, the message implicit in most CE education programs is that civil engineers are only doers—and the student is being prepared to be a doer. A de facto mission of many CE education programs is to train graduates to work for the graduates of the business and law programs, either as doer employees or as doers in the social/political/economic structure. As a result, and in accordance with expectations, too many civil engineers as students and as practitioners perform well as producers while failing to see and participate in leadership and management, opportunities.[8]

While maintaining the present civil engineering education model may meet the short-term needs of employers, its narrow focus does not serve the long-term interests of the public, employers and individual civil engineers.

In the short term, maintaining the present CE education model appears to be in the best interest of many private and public sector employers. The four-year, technically focused, and producer-oriented education paradigm assures an ample supply of immediately productive, technically capable employees.[9]

In the meantime, the principals of engineering firms and the senior managers of government entities will continue to complain about the inadequacies of entry level and experienced civil engineers.[10] These inadequacies include, but are not limited to:

- Poor communication skills
- Inability to manage projects profitably
- Lack of marketing interest and/or skill
- Getting bogged down in technical matters
- Failure to meet client expectations
- Lack of visibility in the community
- Inability to understand global context
- Having little business sense.

Deficiencies like these are typically resolved by training programs, lateral promotions, demotions, and firings. These

costs could be greater than the higher compensation that would be warranted by hiring better-prepared graduates of longer, more comprehensive CE programs.[11]

In the long term, functional narrowness, technical focus, limited vision, and large numbers of graduates will lead to more commodization of services and more intense price-based competition between consulting firms. Continuation of today's CE education paradigm will also steer more of the "best and brightest" away from civil engineering or cause them to leave the profession early.[12]

Civil engineering students will respond favorably if more is expected of them.

In an optimistic vein, Russell et al.[13] note that:

> *…..students respond to what is required as well as the atmosphere within which it is required…..if CE education included a directing and deciding message, that is, a management and leadership theme—most CE students would respond favorably. They clearly have the ability to fulfill broader expectations.*

ABET's Engineering Criteria 2000 place added emphasis on non-technical outcomes.

A positive sign with regard to broadening the formal education of civil engineers is full implementation by the Accreditation Board for Engineering and Technology (ABET), beginning in 2001, of new criteria for accrediting U.S. engineering programs.[14] *Engineering Criteria 2000* (EC-2000) places much more emphasis on establishing institution-specific educational objectives in both technical and non-technical areas, followed by on-going evaluation and improvement. Eleven outcomes are specified more than half of which are non-technical. Achieving these desirable outcomes within the traditional four year program will be a challenge.

ASCE's constituency includes all of the civil engineering programs in the United States. ASCE's goals should be explicitly reflected in the goals of all civil engineering programs. ASCE's goals, as articulated in the current strategic plan, imply a strengthening of the general education experience for all future graduates. Accomplishment of many of the Society's goals will depend on more broadly educated civil engineers rather than on civil engineers with greater technical knowledge.

Achieving ASCE's leadership goal requires a partnership between ASCE and educators leading to design of a broader education for civil engineers.

Consider ASCE's "Develop Leadership"[15] goal, for example. Civil engineers will not effectively participate as leaders in society unless they are more broadly attuned to the role of technology in society – which is to say more broadly educated. To successfully "champion infrastructure, environmental and socioeconomic programs and projects" and "promote sustainable development" will require a different kind of civil engineer. The ASCE policy on the Role of the Engineer in Sustainable Development states as part of the strategy that engineers should cultivate a broader understanding of political, economic and social issues and processes rated to sustainable development. This requires an appropriate general education for all future civil engineers.[16]

ASCE, in its role as lead society for ABET-accredited civil engineering programs, should analyze its objectives and goals and work with the universities and industry to develop program curricula that better reflect the overall vision of the civil engineer of the future. This is an opportunity to meld the Society's vision, on a long-term basis, with the education of the civil engineers that will practice over the next one hundred years.

2. Gradual Historic Reduction in Credit Hours Required for the BSCE Degree

Becoming a civil engineer appears to be getting easier as a result of the continued movement to reduce course credit graduation requirements. Perhaps the rigor is higher thus offsetting some of the credit reductions.

Elliott[17] surveyed U.S. CE programs in 1997 to learn more about what he called the "course reduction movement." Based on 51 responses, he found a range of 120.0 to 147.5 credit hours (non-military maximum) with a mean, median, and mode of, respectively, 132.9, 133.3, and 136.0 hours. Elliot expressed this concern with the course reduction movement:

> *Whereas physicians, attorneys and architects have progressed to requiring education beyond the bachelor's degree, engineering remains mired at the bachelor's level… We [engineering]*

> *have actually moved backward, from about 150 semester hours in the 1950's to an average of 133 today, and moving towards 120 hours in the future. All of this during a time of unprecedented explosion of technology… In addition to the technology explosion, we are also being told that we need to add other items to the curriculum – communications skills, leadership, teamwork, management, finance, contemporary issues, and more.*

Not only has the number of credits required for a BSCE degree significantly decreased in recent decades but the total credit hours of engineering content has also markedly diminished.

Russell et al.[18] examined BSCE degree requirements over the past 75 years for 11 leading CE programs dispersed around the U.S. Some of the decrease in total required credits is explained by factors such as reductions in or elimination of physical education requirements and Reserve Officer's Training Corps and by improved mathematics preparation of incoming first year students. Nevertheless, the paper concluded that "not only has the number of credits comprising a BSCE degree gradually but significantly decreased, but the total credit hours of engineering content has significantly decreased in many of the nation's leading CE programs." M. S. Barter,[19] President of the National Council of Structural Engineers Associations, stated that the four-year CE program no longer adequately prepares graduates to be structural engineering interns. M. L. Porter, President of ASCE's Structural Engineering Institute, expressed the opinion that employers of structural engineers prefer MS graduates over BSCE graduates because of the minimal preparation of the latter.[20]

Although the number of credit hours in civil engineering curricula may have dropped over the last 30 years, the knowledge needed has not. It has increased. As an indication, compare the volume and variety of ASCE Transactions for 1964 with the 1999 version.

Civil engineers are knowledge workers[21] and their ability to deal with the problems that seem insurmountable to many in the non-technical world[22] will depend increasingly on their ability to apply a mix of non-technical and technical skills and knowledge. The optimism for the future that prevails in the scientific and technological culture[23] must be

communicated to the rest of society. There is no question that technology has made major contributions to the quality of life over the last century but the role of technology in the future is less certain with some seeing technology as a cause rather than a cure for many environmental problems.

The need is certainly not for less technically prepared civil engineers but it is for more broadly trained engineers with an education that more closely parallels the liberal arts experience at the basic level and, coincidentally, more closely resembles the series educational model for the professions of law and medicine.

The knowledge explosion pushes for more specialization at all levels which makes communication among the different subcultures that make up society – policy makers, the general public and the technical community – even more difficult. The need is certainly not for less technically prepared civil engineers but it is for more broadly trained engineers with an education that more closely parallels the liberal arts experience at the basic level and, coincidentally, more closely resembles the series educational model for the professions of law and medicine. An education that would even go so far as to promote communications among the majors – technical and non-technical – would lead to civil engineers being better prepared to contribute to society. A basic first degree with a stronger general education experience appropriate to CE and an advanced degree – a master's – for more specialized knowledge is a model that is a first but a necessary step in this direction.

3. Inadequate Preparation of Civil Engineers for a Rapidly Changing Work Environment

Dramatic societal changes over recent decades profoundly affect all professions and jobs in the United States. Our nation has become far more communicative and mobile with the resulting tendency to increasingly relocate, be it to achieve education, employment or retirement objectives. At the same time, the U.S. work environment has changed from a product base (production) to an information base (technology transfer and communication). These and other evolutionary changes have greatly affected the working environment of all Americans, including civil engineers.

Profitability pressure, mobility, opportunity, instant information, early retirement, public concerns, litigation, educational opportunities, business consolidation, market forces and many other factors contribute to changes in the work environment. Employees of all types, including engineers, are changing jobs more frequently, either by choice or by employer action. The typical engineer can no longer expect to spend a career with a single employer,

either public or private. Typically, engineering careers vary from a few employers to over a dozen.

Changing jobs no longer has the stigma or negative effect of years ago. Employers and employees alike feel more free to change personnel or jobs as needs change. There will, of course, be many who stay with a single employer, but even this will be affected by the potential for change. The manner in which insurance, retirement plans, and training are administered all reflect this evolving environment.

Unfortunately, the education of civil engineers does not prepare them for the rapidly changing work environment. Many employers, aware of labor market dynamics, only reluctantly educate or train employees beyond the immediate job needs, unless that employee is specifically targeted for a future leadership role. Engineers must increasingly assume prime responsibility for educating and training themselves in order to ensure future marketability in the area of choice, be it technical or management.

Enhanced formal education is needed to enable civil engineers to address the demise of job security and other employer-employee changes and, more importantly, realize their potential in an increasingly complex society.

Enhanced education is needed to enable civil engineers to realize their potential in an increasingly complex society. And not only in technical areas but also in non-technical areas such as communication, humanities, social sciences, economics, management and leadership. This education can best be achieved by a combination of a broader, formal education base early in the engineer's career and an ongoing, regularly updated continuing education process throughout the career.

The civil engineer has a right to expect employer education and experience support for career goals and the engineer employer has an ethical obligation to provide this education. However, ultimately only the individual engineer can ensure achievement of the planned career.

4. Most Civil Engineers Do Not Receive Leadership Education

Civil engineers will achieve at least moderate success if they are enthusiastic and technically competent in their chosen specialties. However, even a cursory review of pay scales in most professions, including engineering, reveals that the best paid, and many times most personally

satisfying positions, are those with major leadership responsibilities.

A look at careers of successful civil engineers today typically indicates a conscious move earlier in a career from primarily technical work through project management and into management and leadership. Increased remuneration occurs during the process. The unaware civil engineer, failing to see and seize these leadership opportunities, may remain longer, perhaps forever, in less demanding and less challenging work with lower compensation and maybe lower job satisfaction.

Civil engineers are not being prepared to compete for leadership positions; their formal education is deficient in non-technical knowledge and skills.

With the competition for desired leadership positions coming from other engineering disciplines, as well as from non-engineers, it seems obvious that the best educated civil engineers in both technical and leadership areas will succeed the earliest. To help civil engineers compete for leadership positions, their formal education must include awareness, knowledge and skills in non-technical, social, marketing, political, economic, teamwork, and management areas. Many engineering faculty do not have these skills or the education needed to teach them—and, therefore, cannot pass them or their importance on to students, especially when under pressure to reduce credit hours required for graduation. Only by increasing the base education can the civil engineer compete effectively for these leadership positions.

Faculty composition must be changed. Successful leaders from engineering industry and government should be invited into academia at both the undergraduate and graduate levels to share practical knowledge and skills. Practicing professionals should not be viewed as competition or a threat to traditional faculty. These full-time and adjunct faculty members must be carefully selected for their practical experience and their educational, motivational, and communication skills.

5. Non-Engineers Increasingly Managing Engineers

Increased societal complexity coupled with vast education opportunities have created a "new" career opportunity: "Management." With a four year limit, there is little room in an undergraduate CE curriculum to introduce management perspectives, knowledge and skills.

At the same time, critical issues previously not considered "engineering" have been introduced into the engineering workplace. Examples are accounting, taxation, personnel practices, ethnic and minority relations, harassment, liability, safety, quality control, marketing, and client relations. Advancing professionally as an engineer today, even in a technical area, requires a general knowledge of issues like these which fall under management.

Most of today's practicing engineers (about half have a four-year undergraduate education) have only a limited knowledge of management issues. Both public and private employers have increasingly chosen to give greater attention and credence to non-technical issues, which they partially understand or at least understand well enough to appreciate the negative consequences of ignoring. Some employers probably know little or nothing of the technical issues involved in engineering and, therefore, have a tendency to discount its importance. After all "a graduate engineer or a licensed engineer must be able to do anything in engineering, therefore we need someone else to cope with non-engineering things."

Non-engineers are increasingly managing civil engineers with the principal reason being that the non-engineers possess stronger leadership, communication and business skills.

The result is that more and more top-level engineering assignments with titles such as Director of Public Works, Chief Engineer, City Engineer, District Director, Engineering Department Manager, Secretary of Transportation, Director of Environment, and Plant Manager are now being filled by non-engineers possessing skills which are perceived to be of greater value than those of a typical engineer.[24]

Professionals assuming these leadership roles include attorneys, accountants, and business majors with MBA's. Incidentally, as documented in APPENDICES C and D, these and many other professions have more stringent basic education and continuing professional development (CPD) requirements than engineering. Perhaps the overall mathematics and problem solving skills of some other professions have improved (e.g., in the information technology area) thus partly neutralizing engineering's traditional advantage in these areas. With the greatest part of the engineer's education being technically focused, the trend to non-engineers assuming leadership roles is understandable.

6. Production and Delivery Systems Changing and Non-Civil Engineers Entering the Infrastructure and Environmental Field

The last half of the twentieth century produced an ever-accelerating change in the tools and techniques by which the engineer, whether in public or private enterprise, delivered services. Consider the following:

a. Computers/Software: In four decades, computation has shifted from the slide rule of the sixties through the electronic calculator, large computers, integrated computer systems and ever-improving software, to powerful desktop and laptop computers of the early 21st century. The engineer today can quickly and accurately perform complex computations to develop alternate solutions and to make life-cycle costing, design-build, and numerous other engineering related assessments. Fewer civil engineers can now do more because of greatly increased computational abilities and practice.

b. Surveying: Though long a hallmark of the civil engineer, most surveyors today are skilled specialists who have learned the trade through technical school training and practice. Gone are the transit, level, and plane table, being replaced by sophisticated electronic instruments. Most engineering schools today include only a basic surveying or measurement course in the undergraduate curriculum. Most civil engineers no longer do surveying.

c. Drafting: Until the 1960's, most engineers were expected to do drafting as part of their training and practice. Slowly, full-time drafters were employed and drafting was eliminated from the curricula of engineering schools. The introduction of Computer Aided Drafting (CAD) further removed civil engineers from the creation of drawings and technicians and technologists skilled only in CAD rushed in to fill this gap. This need helps encourage technology schools to provide training for jobs that were nonexistent only decades earlier. Civil engineers do relatively little drafting.

d. Litigation: Trends in society for intolerance of error and the shift to a litigious society have forever changed the way all engineers work. Each civil engineer must be constantly vigilant and knowledgeable about quality control, safety, the American judicial system, and other liability issues.

e. Rapid Advancement: Whereas a half century ago it was common to expect years of experience before assuming management responsibilities, today's civil engineers advance professionally as fast as their people, management and leadership skills allow. Employers increasingly seek to advance the engineer as quickly as possible; the alternative being to relegate the engineer to a narrow technical role.

As a result of technology, non-engineers are performing tasks traditionally done by civil engineers. Civil engineers are not being prepared to take on different, higher value responsibilities.

The combination of these and other like similar trends have created a new generation of technical opportunities enabling non-engineers to do tasks or related assignments heretofore generally regarded as CE. While the civil engineer being educated today in the industrialized societies of the world could and does learn some of these largely new technical skills, application of them increasingly resides with that portion of our profession that does not require a "professional degree." In the non-industrialized societies of the world, CE is still being taught and practiced at a basic level commensurate with the needs of the local economy.

A recently released Civil Engineering Research Foundation (CERF) brochure[25] offers a thoughtful and comprehensive projection of significant advances in the design and construction sectors over the next 10 years. Implicit in the projections are broader and deeper demands on the knowledge and skills civil engineers will need to fully participate. Bottom line: As we move into the 21st Century, in the United States and other industrialized nations of the world, those civil engineers that seek to advance their careers will require a different kind of education, one that will go above and beyond the traditional baccalaureate degree.

7. "Slippage" in the Civil Engineering Education-Experience-Licensing-Certification-Continuing Professional Development Process Relative to Other Professions.

As explained in the earlier "History of Civil Engineering Education" section of this report, U.S. engineering education has a four year duration because it was established, almost 200 years ago, in ***parallel*** to liberal arts education. In contrast, and following the lead of law and medicine, most other professions positioned their formal education in ***series*** with a liberal arts, or at least a more general, education.

CE still retains the four-year, parallel constraint. Meanwhile, most other U.S. professions, building on the more open-ended serial model, have expanded their formal education requirements. They have also instituted increasingly stringent licensing, continuing professional development and specialty certification requirements. Meanwhile, as explained in this section, civil and other engineering disciplines have lagged behind.

Post-High School Education. Besides law and medicine, which require, respectively, 7 and 8 years of post-high school education, other professions as practiced in the U.S. now require more than four years of post-high school education. Other examples are accounting (5 years), architecture (5 years), dentistry (8 years), optometry (8 years), pharmacy (6 years), and veterinary medicine (8 years). Refer to APPENDICES C and D for, respectively, tabular and graphical summaries of college and post-college education requirements for various professions.

Civil engineering, by retaining the 200 year old four-year basic education model, has fallen behind accounting, architecture, dentistry, law, medicine, pharmacy and veterinary medicine.

Some of these professions recently increased basic education requirements (e.g., accounting, architecture, and pharmacy). Meanwhile, CE retains the 200 year old four-year basic education model and, based on formal education, has fallen behind accounting, architecture, dentistry, law, medicine, pharmacy and veterinary medicine. The veterinarian who neuters your dog must have twice the formal education as the civil engineer who designs your community water supply system.

The federal government has much lower formal education expectations for its engineer employees than for some other professions. According to the federal Office of Personnel Management (OPM), completion of 60 semester credits in an

engineering curriculum is sufficient to be titled an engineer within the federal government. Neither an engineering degree nor an engineering license are required. In contrast, use of the titles physician and attorney require licenses and, therefore, the corresponding formal education.[26]

The continuing professional development requirements of most other professions exceed those of civil engineering.

Continuing Professional Development. Continuing professional development (CPD) represents a profession's commitment to maintaining currency and its ability to adapt to change. While some professionals believe this commitment as a personal responsibility, others, as reflected in other professions' licensing board's requirements for licensure renewal, see it as a sine qua non. All 50 states require continuing education in as a condition of license renewal for the accounting, law, medicine, and optometry professions (APPENDICES C and D). More than 40 states require it for dentistry and pharmacy and half the states for veterinary medicine. In contrast, only 17 states have such a mandate for engineers.

High school and college students contemplating a CE career and young civil engineers anxious about their future evaluate their prospective and current profession on its relevance. They want to be part of a profession that uses contemporary and emerging management approaches, that adapts to new science and technology, and that accepts and exploits the many opportunities inherent in 21st century information technology. One measure of a profession's vitality is employers' commitments to education and training and licensing boards' explicit requirements that CPD is occurring. In an age where the rate of change grows exponentially and young people expect to keep up with change, civil engineers should not be surprised that their profession is not as attractive to top quality young people as those professions that promise, support and require CPD.

Civil engineering ranks below medicine, pharmacy, and veterinary medicine in availability of specialty certification.

Experience and Specialty Certification. Perhaps our profession's bottom ranking in basic education and continuing education is offset by more stringent standards in other areas such as experience and availability of specialty certification. However, as documented in APPENDICES C and D, CE ranks below medicine in experience required for licensure. Furthermore, CE's experience requirement is not as rigorously managed as the clinical experience in other professions. Furthermore, CE ranks below medicine, pharmacy and veterinary medicine in availability of specialty certification.

Civil engineering, as well as other U.S. based engineering professions, is behind all other major professions in the overall education-experience-licensing-certification-continuing professional development arena. Furthermore, civil engineering is slipping further behind.

Observation. CE, as well as all other U.S. based engineering professions, is behind all other major professions in the overall education-experience-licensing-certification-continuing professional development arena. Furthermore, given engineering's essentially static position in that arena, while other professions have progressed, engineering is slipping further behind. Perhaps one of the major reasons engineering is in this position is the splintering of the profession into the basic disciplines such as civil, mechanical, and electrical engineering. Engineering has long lacked a unified voice for the profession. NSPE and AAES have both tried to step into this breach to fill this role, but both have been largely unsuccessful. Most other professions have a very strong unified national presence which has assisted them in developing and maintaining their national presence and everything that flows from that recognition.

8. Low Compensation Received by Civil Engineers

To some extent, engineering's image concern is a euphemism for concern with low compensation. When engineers claim they "get no respect," it means, in part, that they are dissatisfied with the level of their compensation relative to two benchmarks:

- The critical nature of their environmental protection and infrastructure development efforts.
- Higher compensation received by members of other professions.

Does the perception of low compensation reflect reality? Are engineers, in general, and civil engineers, in particular, inadequately paid? What standard of comparison should be used? What are the compensation benchmarks? To provide some answers to these questions, consider the results of various salary surveys carried out over the past several decades.

Recent History of Civil Engineering Salaries. Alexander[27] provides a snapshot of salary trends several decades ago, from 1955 to 1988. APPENDIX L-1 shows that average starting salaries for civil engineers increased a total of only 7% (about 0.2% per year) during that 33 year period. In contrast, all employees' average salaries increased a total of 35% to 45% during that period while teachers' and physicians' salaries increased, respectively, by 56% and 64% during that period.

Although APPENDIX L-1 "compares apples to oranges" in that it mixes all salaries and starting salaries, it suggests that when measured by monetary compensation, civil engineers did poorly during the 1950's, 1960's, 1970's, and 1980's. As an interesting aside, and as documented by Alexander, various individuals and organizations (e.g., ASCE, Engineering Manpower Commission (EMC), and the U.S. Bureau of Labor) raised concern about shortages of engineers, including civil engineers, during that period.

Trends in engineering salaries for just over the past decade (1987 through 1999) are available[28] as a result of annual salary surveys conducted by the Engineering Workforce Commission (EWC) of the American Association of Engineering Societies (AAES). As an indication of the magnitude and possibly the representative nature of the survey, the 1999 study included 45,377 engineers in industry and government. Although the survey does not identify engineers by specialty, it does distinguish engineers by 18 employment sectors.

When adjusted for inflation, civil engineering salaries have been generally static for the last decade.

APPENDIX L-2 shows trends in median compensation, in actual and in constant 1999 dollars, for the 13 year period 1987 through 1999. Salary data are presented for engineers with 25 and 10 years of experience and less than one year of experience. The good news is that inflation adjusted salaries stopped an at least eight year decline in 1995 and have increased significantly since 1998. The bad news for engineering, as stated in the source report, is that "starting salaries have nearly returned to the …1987 levels." Essentially the same can be said for engineers with 10 and 25 years experience.

Maybe the very recent upturn in the buying power of all engineers is the start of a long term upward trend. Or perhaps it is just a temporary rise that will disappear with the next economic slow down. Time will tell.

Regardless of experience level, civil engineering salaries generally fall below those of other engineering professions.

Civil Engineering Salaries Relative to Other Engineering Disciplines. AAES salary survey data also provide an index to the compensation of civil engineers versus other engineers. Three of the 18 employment sectors identified in the annual salary survey are likely to include civil engineers. This conclusion is based on the list of survey participants arranged by industry sectors.[29] These categories are architectural/engineering services, other non-manufacturing

and public administration. APPENDIX L-3 presents 1999 median salary data for all engineers and for the three "civil engineering" sectors. The data strongly suggest that the 1999 salaries of civil engineers fell well below the salaries of all engineers. This applies to a wide range of experience levels, that is, from less than one year to 25 years.

There may be offsetting factors not evident in the data. For example, some civil engineers employed in consulting firms receive bonuses which are probably not reflected in the data used to prepare APPENDIX L-3.

A positive sign within the overall discouraging CE salary picture is the year 2000 compensation received by civil engineers who serve as project managers. A global survey conducted by the Project Management Institute[30] concluded that the mean compensation for civil engineer project managers was less than that for industrial and electrical project managers but greater than that of mechanical, electronics, other, and environmental project managers.

Starting salaries of civil engineers fall below those of most other engineering disciplines.

Farr[31] notes the unprecedented economic prosperity enjoyed by the U.S. over the past decade. However, as shown in APPENDIX L-4, when adjusted for inflation, today's starting salaries for civil engineers are only slightly above where they were 20 years ago. Somewhat discouragingly, but not surprisingly, Farr goes on to say the following about civil engineers:

> *At the entry-level position, they are still the lowest paid engineers and haven't really recognized any significant {starting} salary growth in the last 20 years.*

Civil engineering salaries are significantly lower than most professions.

Civil Engineering Salaries Relative to Other Professions. Based on median salaries published by the U.S. Bureau of Labor Statistics[32] and shown in APPENDIX L-5, CE salaries fall slightly below those of the other four largest engineering fields. More importantly, CE salaries are significantly lower than most professions. For example, the 1999 median salaries in medicine, law, optometry and pharmacy were, respectively, 110, 66, 44, and 24 percent greater than those for CE. Compared to CE, all of the more highly compensated non-engineering professions require more formal education as a condition of practice. Compensation correlates with formal education.

The federal government's perceived lower value of civil engineers is illustrated by comparing the General Schedule (GS) grades at which civil engineers and other profession start federal service and other professions. As shown in APPENDIX L-6, civil engineers enter at GS grades lower than occupational therapists, pharmacists, optometrists, attorneys, dentists and medical doctors. Unlike civil engineers, a graduate degree is required to enter all of the listed professions.

Historically civil engineering compensation has been static and falls below that of most other engineering disciplines and most other professions.

Summary of Compensation. Based on the cited surveys and studies:

- Inflation-adjusted salaries for entering and experienced engineers have remained essentially static for at least a decade.
- CE compensation falls below that of most other engineers.
- CE compensation falls below that of most other professions.

9. Declining Appeal of Civil Engineering to Highly Motivated Young People

Consider CE as bright ambitious high school or early college students seeking a profession might view it. Like many of us already in the profession, some young people might be excited about participating in infrastructure planning, design and construction and in environmental protection. The opportunity to positively impact society may be attractive to others. Some may be inclined toward teaching and research. Providing for many of society's basic physical needs is indeed a high calling and has appeal.

Bright, motivated young people are more likely to be attracted to professions other than civil engineering. Reasons: low compensation coupled with a lagging education-experience-licensing-certification-continuing professional development model.

Bright young people consider other factors. Based on education preparation and continuing education required to practice at the professional level, CE is not as attractive as most other professions. It lacks a solid specialty certification program to recognize expertise. CE appears too "easy" or "basic."

If compensation is used as a desirability indicator, not only does CE fare poorly relative to most other professions, it also is positioned near the bottom of the engineering profession. This

may at least partly explain recent drops in CE enrollment and graduates.[33]

Stated differently, CE's present education-experience-licensure-CPD model is not likely to appeal to many highly motivated young people who want to be in a dynamic, ever improving discipline. Recruitment of future members should not be the primary objective of a profession's structure. However, recruitment is an important secondary objective. The prospects for CE's future can be no better than the quality[34]—not quantity—of young people attracted to the profession.

VISION OF FULL REALIZATION OF POLICY STATEMENT 465

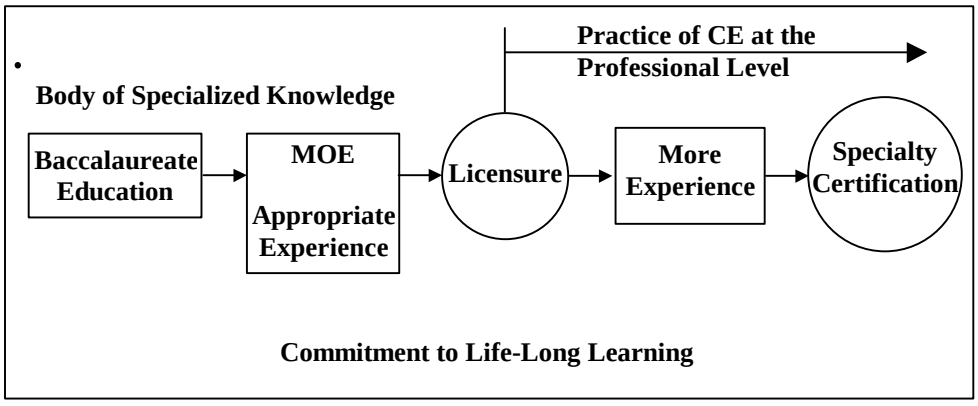
The Task Committee believes that admission to the practice of civil engineering at the professional level occurs at licensure and requires a body of specialized knowledge as reflected by a combination of a baccalaureate degree and a masters degree or equivalent, appropriate experience, and a commitment to life long learning.

Developing a vision of the full realization of ASCE Policy Statement 465 is the first part of the two-part charge to the TC (The other part is designing a strategy for achieving the vision.) The vision is as follows:

The practice of CE at the professional level means practice as a licensed professional engineer. Admission to the practice of civil engineering at the professional level occurs at licensure which requires:

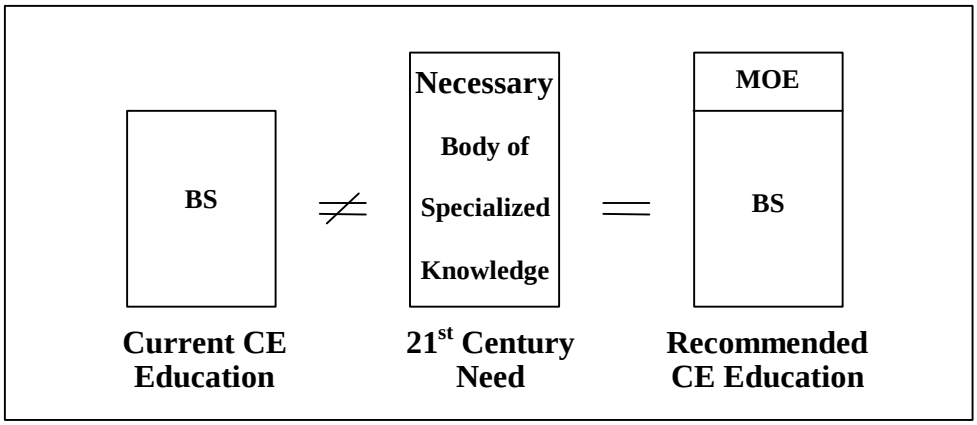
- ***A body of specialized knowledge as reflected by a combination of a baccalaureate degree and a master's or equivalent (MOE)***
- ***Appropriate experience***
- ***Commitment to life long learning***

The essence of this vision for CE, which incorporates the current baccalaureate education and the current experience requirement, may be illustrated as follows:



The body of specialized knowledge includes four components. They are 1) a technical core, 2) a non-technical core, 3) technical electives, and 4) technical and non-technical courses to support an individual's career objectives. As illustrated in the following figure, and as previously noted, the body of specialized knowledge needed to practice CE at the professional level in the 21st Century can no longer be accommodated within a four year bachelor's degree. However, and as also illustrated in the following figure, the necessary body of

specialized knowledge can be provided by the combination of a baccalaureate degree and a MOE.



ASCE recognizes attainment of the body of specialized knowledge as a prerequisite for licensure and entry into the practice of CE at a professional level. As described later, the MOE may be a traditional masters degree or an appropriate combination of courses whose content and quality are equivalent to or exceed a traditional masters degree. Besides civil engineers that practice at the professional level, that is, are licensed, the CE community includes CE technicians and technologists and non-licensed civil engineers. Some of the last category are in the process of seeking licensure and others have elected not to do so.

IMPLEMENTATION OF THE VISION

The Task Committee developed 17 strategies to use as the basis for developing an implementation plan.

Overall Approach

In response to its charge to develop a vision of full realization of ASCE Policy Statement 465, the TC identified and developed 17 strategies to use as the basis "for achieving this vision." The recommended strategies include key elements such as identifying and working with stakeholders, protecting the status of current members of the CE profession, learning from other professions and other nations, and encouraging innovation and variety in undergraduate and graduate engineering education. After developing the strategy, the TC developed an implementation plan, based on the strategies, to result in full realization of ASCE Policy 465. Descriptions of the strategies and implementation plan follow.

Strategies

Leadership Strategies

1. Lead, Don't Wait

ASCE is preparing to celebrate its sesquicentennial in 2002 with a plan of action to take CE into the twenty-first century. Included in that plan should be a bold advancement in formal education.

Just because ASCE is among the first to recognize the possibility of a diminishing role of engineers in the future and to proactively respond, does not mean that other fields will not face the same issue. Eventually, all branches of engineering will have to confront the changes CE is considering because all operate in the same integrated global economy.

ASCE should not "wait" on other engineering societies before implementing Policy Statement 465. In keeping with its historic role of being the first nationwide engineering society, ASCE's leadership in advancing formal education seems particularly fitting.

Meanwhile, ASCE should not "wait" on other engineering societies before implementing Policy Statement 465. In keeping with its historic role of being the first nationwide engineering society, ASCE's leadership in advancing formal education seems particularly fitting. ASCE should actively engage other engineering entities in discussions, particularly the American Association of Engineering Societies (AAES) and the American Society for Engineering

Education (ASEE), in addition to interacting with appropriate industrial and governmental units.

2. Identify and Proactively Work with Stakeholders

CE has many stakeholders because the practice of the profession has a profound effect on infrastructure and the environment and, therefore, on public health, safety and welfare. CE's stakeholders are those individuals and organizations who affect or are affected by the profession.

Identification of and partnering with stakeholders are essential to realizing a significant improvement in the civil engineering education and licensing process.

Identification of and partnering with stakeholders is a fundamental step in achieving a significant improvement in the process by which civil engineers are educated and licensed. Accordingly, the TC developed a working list of 26 CE stakeholders, which is shown in the first column of the matrix included as APPENDIX M. Given the large number of stakeholders, a thoughtful, systematic approach is needed for implementing the strategies. Such an approach is presented later in this report.

3. Protect the Status of Current Members of the Civil Engineering Profession

As previously indicated, today's CE family includes individuals with a variety of talents, experience and credentials. As the profession moves to a new paradigm for credentialing its members and establishing MOE-based licensing, it will be aware of the potential impacts of this action on its membership and the actions that such individuals can take to ensure their continuing viability within the profession.

Licensed civil engineers who do not possess an MOE would remain as licensed engineers: their status would not be diminished.

Licensed Engineers. Those licensed civil engineers who already possess a MOE have clearly met the standards for engaging in engineering work at the professional level of practice. Their obligation to the profession is to maintain currency through CPD. Licensed civil engineers who do not possess a MOE would remain as licensed engineers and would be expected, as a matter of professional pride, to use their participation in CPD as a means of reaching the MOE level and maintaining their currency. However, engineering firms and licensing boards would not

distinguish between those currently licensed civil engineers with the MOE and those without. The experience and professional status of already licensed civil engineers who do not possess a MOE would be in no way be diminished or denigrated.

Non-licensed Engineers. Engineers who earn a bachelors degree in CE choose to move into one of three categories. Some decide to work in other professions, using their learned fundamentals of engineering as background for the new fields. Some move directly to work in engineering and spend their career engaged at a journeyman level with no intention of obtaining a license or practicing at the professional level. Others take the Fundamentals of Engineering (FE) examination, seek positions of increasing professional responsibility and move toward attainment of their license. Some within the latter two groups participate in post-graduate engineering education. The three routes present each baccalaureate engineer with options that include providing valuable services to society, making use of their foundation engineering education and becoming members of the broad engineering community.

The establishment of the MOE as a requirement for licensing and practice at the professional level will not directly impact those who fall in the first two categories. By not entering the profession or by deciding not to seek a license, they have acknowledged that they do not intend to practice at the professional level.

Requiring the MOE and licensure for practice at the professional level may negatively impact some holders of civil engineering baccalaureate degrees who have no desire to become licensed. However, their MOE and licensure options remain open.

The new emphasis on defining practice at the professional level will, however, suggest that civil engineers who possess a bachelor's degree and are not moving toward licensure will not be practicing at the professional level. This may lead to eventual diminution of their status within the CE profession. This diminution in status may cause some of this group, especially those who have completed or are participating in post-graduate engineering education, to move toward licensing and completion of a MOE program and licensure.

Baccalaureate civil engineers who already are moving toward licensing will have to complete MOE work in order to obtain their licenses. While this will place an unexpected burden on some graduate engineers, most will have been doing MOE work either directly or as part of continuing professional development. Some reasonable grace period, during which the requirement for a MOE will be waived, will be needed to ensure that those who are currently close to obtaining their license are not set back by the MOE requirement. For example, civil engineers who have successfully taken the FE examination, could have five years following enactment of new procedures to obtain their license without an MOE. Moreover, the MOE requirement would not take effect in essentially all states until about 2020.

Engineering technicians and technologists, like baccalaureate civil engineers who are not licensed or moving in that direction, could, with additional education, become licensed and practice at the professional level.

Engineering technologists and technicians. The status of engineering technologists and technicians would remain unchanged under the BS-MOE concept. However, the distinction between civil engineers and technologists-technicians would be greater because of the elevated requirements for the former. Engineering technologists and technicians could move with additional education to become licensed.

The preceding discussion of licensed and non-licensed engineers and engineering technologists and technicians presumes that the CE profession will support an emphasis on the need for licensure to practice at the professional level. Since many industrial and government engineers and many members of some consulting firms do not need licenses to practice, it will be incumbent on senior managers to require and reward licensure of their practicing engineers. More demanding hiring and contracting processes could also encourage licensure.

4. Coordinate with ASCE's Sesquicentennial

ASCE's Sesquicentennial would be an opportune time to officially launch implementation of the BS-MOE as a prerequisite for the practice of civil engineering at the professional level.

ASCE should consider coordinating the official launch of implementation of Policy Statement 465 with ASCE's 2002 Sesquicentennial. However, ASCE should not wait until then to start but should link the implementation of Policy Statement 465 to the Sesquicentennial. That event approximates the 200th anniversary of the founding of West Point, the first

formal CE education program in the U.S. This would be the appropriate time to take another big step in elevating CE's formal education requirements.

5. Develop Specialty Certification

While the TC's principal goal was to address the practice of CE at the professional level as it relates to the MOE, the TC also examined the possibility and the desirability of some special recognition of expertise beyond the basic licensing of professional practice at the professional level. The TC was aware that several ASCE institutes also are examining this topic.

Although the specialty certification process is strongly recommended by the TC, the term "specialty certification" may present a semantics problem; it is used here in a generic sense. Specialty certification is descriptive but, because various types of certifications are becoming common (e.g., in the software and hardware areas), specialty certification may not be the best expression for use in the CE profession. Also, certifications are frequently issued for technologists capable of performing a certain sequence of laboratory tests or inspections and not likely to be engineers. An alternative is "diplomate," as now used by the American Academy of Environmental Engineers (AAEE) and the American College of Forensic Examiners (ACFE). "Diplomate" could be used as follows by a structural engineer being recognized by the ASCE Structural Engineering Institute: Mary Jones, PE, Dipl. SE.

The medical profession provides a useful example of recognition of expertise beyond the base level. At the base level, physicians are licensed for general practice. Should licensed physicians choose to seek additional education, training and or expertise in particular fields, they may be certified or identified as specialists in those fields, for example, a board certified ophthalmologist, with the certification coming from a peer group within that specialty. As indicated in APPENDIX C, diplomate status is granted by 24 specialty boards within the medical profession.

A specialty certification program, under the auspices of ASCE Institutes, would build on the MOE effort by officially recognizing expertise beyond that needed for licensure.

In the CE discipline, similar recognition would be possible. Those who seek recognition beyond licensing could seek to meet standards established by the specialty institutes and be certified by those institutes as having met those standards. This certification could be used to enhance the reputation of firms or, in the extreme, be established by clients, as a minimum level of qualification for those seeking to carry out work on a particular project emphasizing a specialty area. APPENDIX N uses a structure metaphor to illustrate the relationship between specialty certification and the MOE. The MOE as a licensure requirement strengthens the foundation of the career of all civil engineers who practice CE at the professional level while specialty certification is the expertise pinnacle for some.

Licensure and specialty certification are compared in APPENDIX O. They are seen to be different and complimentary. Licensure establishes the bar that must be crossed for all who desire to practice at the professional level. Just as a rising tide affects all vessels, so raising the bar affects all practicing professionals. Specialty certification is a catalyst that builds on that bar by encouraging and recognizing significant additional expertise. While protection of public health, safety and welfare are the primary purpose of licensure, the presence of a specialty certification system enhances that protection by expanding the cadre of experts.

The TC does not support the concept of establishing licensing by specialty within the CE profession. Civil engineers have long been known for their ability to deal with the breadth of the engineering practice, and in the opinion of the TC, should be recognized at the base (licensing level) for that characteristic. Certification within a specialty would follow attainment of that base level status.[35]

Civil Engineering Education Strategies

6. Define Masters or Equivalent

Crucial to implementation of ASCE Policy Statement 465 is the masters or equivalent (MOE), preceded by a baccalaureate degree, as one of the requirements for CE

licensure. (The other requirement is experience). This concept is implicit in Policy Statement 465 and is introduced, but not developed, in the section of this report titled "Vision of Full Realization of Policy Statement 465."

In general, the determination of whether or not an individual has an MOE as needed for CE licensure depends on two factors. The first is the specifics of bachelors degree earned by the person and the second is the details of the masters or other graduate degree held by the person. Discussion of the post-graduate educational experience is provided later in this strategy section.

Persons seeking CE licensure may hold many different types of bachelor's degrees. For example, they may be in CE or in other engineering fields, they may or may not be from ABET-accredited undergraduate engineering programs, and they may not even be in engineering.

Similarly, masters or other graduate degrees earned by individuals seeking CE licensure encompass a wide range of possibilities. For example, they may be in CE or in other engineering disciplines, they may be a Master of Science or a Master of Engineering, they may or may not be from ABET-accredited masters programs, and they may not even be in engineering. If the MOEs are not in engineering, then licensure candidates could be required to demonstrate how their non-engineering MOEs will protect the safety, health and welfare of the public in the performance of their professional duties.

The masters or equivalent (MOE) required for the practice of civil engineering at the professional level can take many forms. An underlying criterion is earning at least one degree from an ABET-accredited program and a civil engineering degree.

Therefore, a wide variety of bachelors and masters and other graduate degrees and resulting large numbers of combinations could constitute the BS-MOE. The Masters or Equivalent Matrix presented in APPENDIX P identifies up to 27 bachelors-masters (or other graduate degree) combinations that could be, in the opinion of the TC, acceptable BS-MOE sets. An underlying criterion (the "litmus test") is that a BS-MOE set requires an ABET-accredited or ABET Substantially Equivalent engineering degree and a CE degree. In a few cases, they may be one in the same.

Dual level accreditation is needed to provide a large number of BS-MOE options. The TC recommends that licensing boards utilize the Masters or Equivalent Matrix as a guide in determining if a candidate for licensure as a CE has met the formal educational requirement.

The most common candidate for licensure and entering the practice of civil engineering at the professional level will be the young person who decides to first earn a BSCE. APPENDIX Q shows career paths available to that person including options for obtaining the MOE while gaining experience.

While there are 27 potential bachelors-graduate degree combinations that constitute the BS-MOE as defined by the TC, the vast majority of combinations can be described as meeting one of four conditions. A candidate for CE licensure will be deemed to have met the BS-MOE requirement if he or she meets any one of the following four conditions:

- Earned a BSCE from an ABET-accredited (or substantially equivalent) program and a masters degree or beyond in civil engineering or some other relevant area. (11 options)

- Earned a non-CE baccalaureate degree in an ABET-accredited (or substantially equivalent) engineering program and a CE masters (not necessarily accredited) or higher CE degree. (3 options)

- Earned a BSCE from a non-accredited program and an ABET-accredited masters in engineering. (2 options)

- Earned a BSCE from an ABET-accredited (or substantially equivalent) program and completed at least 30 semester credits of acceptable graduate-level course work beyond that required for the baccalaureate degree.

The preceding four conditions constitute 17 of the previously mentioned 27 bachelors-graduate degree combinations that could constitute the BS-MOE as

detailed in APPENDIX P. To reiterate the common requirement is an ABET-accredited (or substantially equivalent) degree and a CE degree.

7. Learn From Engineering Education Practices in Other Countries

The European educational system requires formal education beyond a baccalaureate degree as a condition for entering engineering.

The concept of formal education beyond the basic baccalaureate program as a condition for entering engineering practice is well ingrained in many of the countries of the European educational system. In most of these countries, traditionally there has been no exit point, or intermediate degree, prior to the master's degree.[36] However, the rigid system that has characterized European engineering education may be changing.

In June 1999, 29 European countries became signatories to the "Bologna Declaration." This Declaration is a commitment by the 29 countries to strive for a system of higher education convergence at the European level. This is not a commitment to standardization or uniformization, but rather a recognition that the overall European higher education system must act in a coherent manner in order to be competitive in a world-wide economy. One of the key elements of the Declaration is the introduction of undergraduate and postgraduate levels in all countries, with first degrees no shorter than three years and relevant to the labor market.

The employers of European engineering graduates are conditioned to the master's degree being the first professional degree. Therefore, there is concern the three year degree may not be relevant in the workplace, because the master's degree will still be considered by employers to be the entry level degree for the professional practice of engineering.

The UK is moving toward formal education beyond the bachelor's degree as a licensing requirement.

Liang et al.[37] describe the recent elevation of engineering education requirements in the United Kingdom. Effective September 1, 1999, the first stage of becoming a chartered engineer (equivalent to a licensed engineer in the U.S.) can be satisfied by a four year MEng, or a BEng 2nd (Hons) plus one further year of learning. This is the required engineering base and

the MEng or the BEng plus one year are more stringent than the previous requirement. The UK requirements appear to be moving to a higher level than what has been considered the equivalent of the U.S. bachelor's degree in engineering.

In contrast, although not abandoning the Dipl. Ing., German schools appear to be moving toward the American or Anglo-Saxon model of a bachelor's and master's degree,[38] partly in response to the Bologna Declaration. There are many reasons for this including the time it takes students to complete the degree and enter the workforce. Grose[38] quotes industry sources as favoring the master's degree for specialization only after the graduate gains some professional experience. The sense is that too much specialization may be hurting the German economy particularly in the high-tech areas. The inflexibility of CE graduates is specifically mentioned.

Grunwald[39] discusses the importance of degree recognition in attracting foreign students to study in Germany. The need for international recognition brings with it the need for accreditation by recognized professional bodies. Detert[40] also discusses the move toward the Anglo-Saxon model as driven in part by the desire to attract students from abroad. Detert makes the point that the bachelor's degree must allow the graduate to enter the profession of engineering albeit at a basic rather than an advanced level.

A series of "country notes" sponsored by the Organization for Economic Cooperation and Development (OECD) in a study of tertiary education[41] include some useful information on the status of engineering education around the world. The perceived strong relationship between engineering education, particularly in the high-tech areas, and economic development is very evident as would be expected.

Engineering education is important in current discussions of trade in professional and educational services. Ascher[42] and Mallea[43] discuss the role of the mutual recognition agreement (MRA) such as the Washington Accord in resolving issues of professional equivalency.

8. Utilize Distance Learning

Although in a state of flux at this time, the role of distance learning in CE undergraduate, graduate and continuing education will become more prevalent and important in the coming years. This aspect of the educational process must be considered in the development of an implementation plan for Policy Statement 465.

Distance learning may be defined as "any learning that takes place with the instructor and student geographically remote from each other. Distance learning may occur by surface mail, video, interactive or cable TV, satellite broadcast, or any number of Internet technologies such as message boards, chat rooms, and desktop video or computer conferencing."[44] Besides the separation of instructor and student, this definition emphasizes the variety of available communication technologies. Moore and Kearsley[45] define distance education or learning as "planned learning that normally occurs in a different place from teaching and as a result requires special techniques of course design, special instructional techniques, special methods of communication by electronic and other technology, as well as special organizational and administrative arrangements."

The rapid growth of the Internet, and the almost universal access to computers by CE students and practitioners, will lead to a rapid assimilation of distance learning into the educational process. The types of distance learning that will occur will probably be as diverse as the number of institutions offering the service.

Already, a few undergraduate and graduate engineering programs are being offered that enable a student to obtain a legitimate degree without spending significant time on campus (e.g., Georgia Tech,[46] University of Wisconsin-Madison[47] and National Technological University[48]). There are certainly many pedagogic and logistical details to be worked out, such as how to conduct a soils lab over the Internet, or, how to develop effective mentoring of students by faculty via email. Yet despite all of the questions and concerns, distance

learning will become part of the educational process of civil engineers, and the Policy Statement 465 implementation plan should anticipate and leverage this eventuality.

The expected rapid growth of distance learning will provide more options for earning a MOE.

Policy Statement 465 is silent, as it should be, on distance learning. The wording in the 1998 Policy was intentionally vague because aspects of the educational process will change over the next few years. ASCE did not intend to limit the MOE to traditional, conventional delivery methods. Instead, the implementation of the policy will be flexible to permit traditional delivery methods as well as distance learning and perhaps other methods not now anticipated.

9. Incorporate Cooperative Education

Cooperative education (co-op) is not likely to play a major role in the implementation of Policy 465. Formal co-op programs are maintained by many U.S. engineering colleges and others have informal co-op and intern programs.

Some professional licensing jurisdictions permit engineering experience gained during co-op sessions (prior to the baccalaureate degree) to be applied towards the engineering experience required for licensure. Some of those jurisdictions that do permit this have relied on ABET accreditation of co-op program tracks to ensure that the experience gained during the co-op session is relevant and meaningful.

ABET recently modified its position on the accreditation of engineering co-op programs. ABET removed from their general criteria the criterion that permits co-op accreditation. Some programs may still elect to have their co-op programs evaluated as part of their overall EC-2000 evaluation, but ABET will not provide a separate accreditation recognition for the co-op component. Licensing jurisdictions that relied on ABET accreditation will now have to turn elsewhere for validation of the co-op experience at the respective educational institutions.

While cooperative education can provide a valuable growth experience, it is not likely to play a major role in implementation of the BS-MOE as a prerequisite for licensure and practice of civil engineering at the professional level.

This ABET action is expected to have a minor impact on the implementation of Policy Statement 465. The most pre-baccalaureate experience presently applicable to the experience requirement for licensure is 1.5 years. None of the findings or recommendations in this report are intended to affect that practice.

10. Address Concerns of and Opportunities for Primarily Undergraduate Civil Engineering Programs

About 20 percent of the approximately 225 CE programs accredited by the EAC of ABET are on campuses with no significant graduate programs in CE. They are exclusively or essentially undergraduate programs.[49] Eventual implementation of the BS-MOE, along with experience, as a prerequisite for licensure and entry into the practice of CE at the professional level may be viewed as an opportunity or as a cause for concern for these programs and their host colleges or universities. On the concern side, faculty and administrators may be anxious about:

- Perceived loss of legitimacy within the CE area if an appropriate masters degree, which completes the necessary formal education required for licensure, is not available on the campus.

- Cost and risk associated with adding a masters degree program.

Imminent implementation of enhanced formal education for civil engineers creates opportunities for progressive exclusively or primarily undergraduate civil engineering programs.

In contrast, imminent implementation of enhanced formal education requirements for civil engineers creates opportunities for progressive exclusive or primarily undergraduate CE programs. Examples of directions that could be pursued individually, or in various combinations, by a CE program are:

- Retain the undergraduate CE program and add an engineering masters program; perhaps using local practitioners to teach some courses. This approach may be a natural evolutionary step in some programs; it may be an element of the institution's strategic plan.

- "Sunset" the entire existing CE program and design a new program that retains while upgrading, refining and rearranging most of the existing science, technical, and engineering content. The new program would draw on other colleges/departments to create a broader, longer program. CE programs housed within universities often have vast resources to draw on including faculty and courses in business, communication, history, law, philosophy, political science, and psychology departments. The new program might be a BS-masters program or a masters program.

- Retain the existing four-year CE program and partner with another campus in a multi-campus system, another institution that already offers an appropriate masters degree program, or a distance learning provider.

- Retain the existing program as exclusively undergraduate. There is no reason to assume that the full realization of ASCE Policy Statement 465 will cause the demise of exclusively undergraduate engineering programs. As stated in Strategy 6 and presented in APPENDIX P, the concept of the BS-MOE places great emphasis on flexibility in allowing an individual to pursue post-undergraduate educational requirements. There is nothing in this report that emphasizes pursuit of the MOE immediately following, or at the same institution as, the undergraduate engineering experience. Full realization of ASCE Policy Statement 465, together with the provisions of EC-2000, will allow exclusively undergraduate programs more freedom to develop broad engineering programs that, coupled with the multiple methods of satisfying the BS-MOE, fulfill the formal educational requirement for licensure as a civil engineer. These exclusively undergraduate engineering programs will also attract other undergraduate students

who understand the great advantages of pursuing a liberal/engineering education—but who may not be committed to becoming practicing professional engineers.

Most of the preceding options and other possible opportunities available to what are now exclusively or essentially undergraduate CE programs would be more viable if such programs would continue to be accredited.

11. Address Concerns of and Opportunities for Masters Degree Programs

With implementation of the BS-MOE as the prerequisite for licensure and practice of CE at the professional level, a CE program will feel the need to accept most of its professional practice-oriented BS graduates into at least one of its masters degree program. To do otherwise for those BS graduates who plan to practice CE at the professional level (unless there is a two-tiered BS program), could have negative connotations such as:

- The institution is not offering full service, that is, through the master's degree for its BS graduates.

- The quality of the BS program appears questionable because some of its professional practice-oriented graduates are not prepared to continue their formal education.

The quality concern is exacerbated by the engineering graduate program tradition. One facet of that tradition is the principle that an engineering masters degree is intended only for the best students—"B" or better undergraduate averages—not the majority of graduates who have earned the BSCE. Furthermore, many engineering masters degree programs are research oriented, that is, they seek not only top BSCE graduates but such graduates who are also predisposed to do research rather than enter practice. Admitting non-research oriented BSCE graduates could frustrate the institution's research agenda.

Some CE departments may elect to offer multiple master degree programs so that they can provide the BS-MOE while continuing to foster research and other programs.

Multiple Masters Degree Programs. A solution to the concern with maintaining the quality of masters degree programs, in general, and the research focus of a subset of the programs is to do what many institutions already do, which is to offer multiple masters programs. Admittedly, this would add to an institution's costs (faculty, space, equipment, administration), but the associated costs could be offset by revenue generated through serving more students.

Russell et al.[50] notes that three primary types of master's programs are currently offered for professional practice in CE. The three types are technical practice/research, project management, and organizational management. Their essential features are shown in APPENDIX R.

Many content variations are possible on the preceding model. For example, the technical practice/research masters would have many common courses but could also have two sub-tracks; one emphasizing sophisticated technical practice and the other stressing research fundamentals. The former might not require a thesis while the latter probably would. ASCE's Institutes could have a major role in helping to design the masters programs, especially the technical practice/research masters.

Establishing a variety of master's degree options may stimulate cross-discipline movement. For example, a recent BSEE graduate may elect to obtain a technical practice/research masters in transportation signalization.

Multiple Means of Access. The preceding discussion may imply that the master's degree, regardless of its focus, would be earned by full-time, on-campus study immediately after completing the BSCE. This will not necessarily be the case as illustrated in APPENDIX Q. Many other options are available such as:

- Working professionally for a year or so and then returning for full-time, on-campus study.

- Taking traditional masters degree courses on campus on a part-time basis while working.

- Taking all or most courses via distance learning, most likely web-based distance learning.

- Taking courses part-time via the traditional and distance learning mechanisms and perhaps using the resources of two or more educational providers. The "OE" portion of the MOE is very realistic. This option could be similar to the accountant's "masters or 150 semester hours" requirement for taking the Certified Public Accountant (CPA) examination.

Professional School. Stimulated by ASCE's leadership in significantly strengthening the basic education of civil engineers, a few institutions may elect, over the next decade, to go even further and adopt the professional school model.[51] (Professional Schools are not recommended in this report.) Professional CE schools would generally be patterned after medical and law schools and require two to three years of post-undergraduate study and internships. Clearly, the graduate requirements for a CE professional school would exceed that of the BS-MOE model.

Strategies Involving Joint Efforts With Other Professional Organizations

ASCE can learn from the experiences of other professions that have or are raising educational and other standards.

12. Learn From Non-Engineering Professions That Recently Raised Education Standards

Other U.S. professions have recently raised educational and related standards or are in the process of doing so. Examples are architecture, pharmacy and accounting as related to CPA's. As ASCE develops and implements an implementation plan for Policy Statement 465, much can be learned from the experiences of other professions as they have raised the bar.

Certified Public Accountants. Consider the 330,000 member American Institute of Certified Public Accountants (AICPA).[52] In 1988, its membership

voted to require all new members after the year 2000 to have earned 150 semester hours of college education. Means of satisfying the 150 hour requirement include an appropriate masters degree or extra appropriate graduate level courses. This member requirement stipulation advances the AICPA's goal of requiring 150 semester hours as a prerequisite for taking the CPA examination; a goal that is close to reality. The AICPA's 150 semester hour requirement is intended to improve the quality of CPA work given "advancing technology, an increasingly complex business environment, and the continuing demand for accounting and assurance services."

Achieving the goal of 150 semester hours as the minimum to sit for the CPA examination requires changes in state laws, rules and regulations governing state accountancy boards. Accordingly, the AICPA and the National Association of State Boards of Accountancy (NASBA) published a guide which contains "model language for the law and the rules and regulations." As of early 2001, 39 jurisdictions had laws, rules and regulations in effect and another nine had laws, rules and regulations which would be effective at a prescribed future date for a total of 48 committed jurisdictions.

The AICPA expects the increased education requirement to result in higher starting salaries but the higher costs will not necessarily be passed on to clients. Reason: new entrants into the profession are "…expected to be more knowledgeable, efficient and work with less supervision."[52] Attraction of higher caliber students is another projected outcome of the elevated educational requirement. Reason: "The brightest and best high school students are increasingly opting for careers that require graduate training."[52]

Clearly, the AICPA made significant progress during the 13 years since the 1988 adoption of the elevated educational standards and AICPA expects a bright future. The TC believes that ASCE, working with the NCEES, could be equally successful.

Architects. According to the National Council of Architectural Registration Boards (NCARB), there are several types of professional degrees in architecture. Degrees include five-year Bachelor of Architecture programs, intended for students entering from high school or with no previous architecture training, two-year Master of Architecture programs for students with a pre-professional undergraduate degree in architecture or a related area, and three or four-year Master of Architecture programs for students with a degree in another discipline. Therefore, a variety of tracks are available to meet the educational requirements for the professional practice of architecture. The common feature is a five-year professional education.

The National Architectural Accreditation Board (NAAB) accredits professional architecture programs. The NAAB voted in October 2000 to stop accepting applications for candidacy and accreditation of new Bachelor of Architecture programs. The NAAB is also considering ceasing accreditation of Bachelor of Architecture programs after the year 2010. Reasons for these decisions include the recognition that "An overwhelming trend in most professions for a graduate level professional degree" and "An emerging trend of converting BArch programs to MArch programs…" The trend in Architecture is clearly to a graduate degree as a prerequisite for practicing architecture at the professional level.[53]

Pharmacists. Pharmacy programs are accredited by the American Council on Pharmaceutical Education (ACPE). The ACPE has stopped accrediting B.S. Pharmacy programs and schools are completing the transition to the Pharm.D. as the professional degree in pharmacy. The move toward graduate degrees in both architecture and pharmacy is occurring for many of the same reasons discussed in this report.

Impact of Elevated Education Standards on Compensation. APPENDIX L-7 presents 1990 and 2000 average starting salaries (not adjusted for inflation) in civil engineering, accounting, occupational therapy and pharmacy. During that decade, civil engineering average starting salaries increased 35% (an equivalent annual increase of 3%), compared to 39%,

70% and 76%, respectively, for accounting, occupational therapy and pharmacy. During the ten year period, the latter three professions were raising educational requirements which included required post-baccalaureate education. While several factors affect starting salaries, the preceding suggests that required formal education is one of them.

13. Recognize the Supportive Goals and Policies of the Accreditation Board for Education and Technology

The ABET general criteria prior to EC-2000 included the phrase "to prepare graduates for the practice of engineering at a professional level." The criteria then went on to define basic–level and advanced–level criteria. EC-2000 also includes general criteria for basic–level programs and advanced–level programs. The Engineering Accreditation Commission (EAC) is looking at ways to express advanced–level accreditation in terms of outcomes, rather than years. Dual-level accreditation is accreditation of undergraduate and graduate programs of the same name at the same institution. Dual–level accreditation, is currently not allowed by ABET policy for engineering programs. However, it is permitted by the other commissions of ABET for other than engineering programs. There is no reference in EC-2000 to "professional" level; it is now found only in the policy manual sections II.B.4.a and II.B. 9.[54] These are "bolded" indicating that they are policies of the ABET Board in contrast to procedures of a commission.

ABET's goal to encourage and accommodate new educational paradigms is very supportive of ASCE's efforts to expand the formal education of civil engineers.

As part of its vision and mission,[55] ABET adopted Goal 6, which is to "Encourage and Accommodate New Educational Paradigms." Objectives under this goal include: 1) examine feasibility of multi-level accreditation, 2) assist engineering disciplines in defining the first degree for professional practice, and 3) develop the capability to evaluate programs that use alternative educational delivery system. This ABET goal and the three listed supporting objectives are very supportive of exploring ways to greatly improve the CE education and beyond model.

14. Leverage the Relationship Between Accreditation Aspects of Policy 465 and Accreditation in Other Countries

ABET plays a major role in the definition of the first professional degree internationally in four ways. Strategic objectives of the ABET Board include a goal to "develop a broader program in international activities." The first role is manifested by the Washington Accord. It recognizes the substantial equivalency of accreditation systems with respect to the academic preparation of graduates to enter professional practice. Current members of the accord are accrediting agencies in Australia, Canada, Hong Kong, Ireland, New Zealand, South Africa, the United Kingdom, and the United States. Accredited programs of each of the countries are listed on the ABET web site. Each signatory is to make reasonable efforts to ensure that registering bodies accept the equivalent education programs in their registration process. This process is mainly directed at ensuring the quality of the accrediting processes.[56]

As its second international role, ABET has a program of substantially equivalent program evaluations. These evaluations are done through the International Activities Committee (INTAC), a standing committee of the ABET Board. Engineering programs at foreign universities are evaluated by ABET-trained program evaluators to determine if the programs are substantially equivalent to similar programs in the U.S. If so, they are granted substantial equivalency for a stated period.

The third international activity of ABET is the credentialing service performed by ABET. For a fee, ABET will review the academic credentials of engineers that have received their education outside of the U.S. to determine if their foreign education is substantially equivalent to a similar accredited engineering program in the U.S. The evaluation uses the ABET criteria in place in the year of graduation to determine if the educational experience is comparable to that of a graduate from an ABET-accredited program. This service is being utilized by individuals, universities, employers and licensing boards to

facilitate entry of foreign engineers into professional practice in the U.S.

A fourth international role is accreditation of engineering programs offered outside the U.S. Currently, the American University of Cairo is the only non-U.S. university which has ABET-accredited engineering programs. This institution meets the requirements for accreditation since it is licensed to confer degrees by the District of Columbia and is regionally accredited by the Middle States Association.

The current ABET strategy appears to be to expand MRAs, specifically the Washington Accord. Aberle et al. note that the Federation of National Engineering Societies[57] (FEANI) which represents engineers in 27 countries was, at least in 1996, considering joining the Washington Accord. Note that the Washington Accord deals only with recognition of the accreditation mechanisms (e.g., ABET) and not with licensure issues. The MRA process is much less advanced for professional recognition than for education. They are separate in the U.S. although not necessarily in other countries.

Also, as mentioned above, accreditation of advanced engineering or graduate degrees is apparently not covered under the Washington Accord[58] The web version of the agreement refers only to the "professional" degree.

Accreditation of advanced degrees is likely to become more important with the globalization of both engineering practice and engineering education. There will probably be a continuous move toward some international standard as is suggested in the papers by Grunwald[59] and Detert.[60]

The discussion of activities in other countries notes that the Washington Accord only covers degrees at the first professional or bachelor's degree level. The importance of being able to enter practice to gain professional experience is a theme common to the current U.S. model and the proposed German model. However, the importance of an advanced professional degree, typically a master's degree for some practitioners, is

also there. The need for an accreditation of advanced degrees appears evident.

15. Build on the Supportive Aspects of the National Society of Professional Engineers New Licensure Model

By explicitly recognizing an appropriate advanced degree, NSPE's new licensure model is supportive of ASCE Policy Statement 465.

In 2000, the NSPE Board of Directors approved a new licensure model.[61] As illustrated in APPENDIX S, included is a new, second path to licensure for those who hold an ABET-accredited bachelor's degree and an advanced degree. These license applicants would not need to take the FE examination and would receive experience credit for their graduate degree. By explicitly recognizing an appropriate advanced degree, the new model law is supportive of ASCE Policy Statement 465. Further refinements of this model could add support to implementation of the BS-MOE combination as a prerequisite for licensure and practice of CE at the professional level.

16. Recognize the Potential Support of the National Council of Examiners of Engineering and Surveying

NCEES may be supportive of ASCE in its efforts to strengthen formal education required for practice of civil engineering at the professional level.

NCEES seems poised to support ASCE's Policy Statement 465. According to a past president of NCEES, Steven T. Schenk,[62] increased formal education is an appropriate move for the profession. Considering that in 28 states one can still become a licensed engineer with only a high school education and that in 44 states one can become a licensed engineer with a non-ABET accredited degree,[63] Schenk warns the profession not to accept the lowest common denominator for professional practice.

17. Support the Fundamentals of Engineering Examination

The Fundamentals of Engineering Examination introduces civil engineering students to the need for licensing and to the licensing process.

The National Council of Examiners of Engineering and Surveying (NCEES) is advocating use of the new Fundamentals of Engineering (FE) examination for outcomes assessment. The NCEES's position is that the examination should be useful to schools in assessment and that encouraging students to take the FE examination would in itself promote licensure. For example, it introduces CE students to the need for

licensing, to the educational and experience process leading to licensure, and to the need (in a growing number of jurisdictions) for CPD as a condition of licensure renewal. A number of engineering programs are already using the FE examination as part of their outcomes assessment processes for ABET accreditation. Drnevich and Tener[64] are opposed to the mandatory use of this examination for assessment but recognize that it could be part of a program's overall assessment process.

The ASEE Engineering Deans Council in March, 2000 reaffirmed a 1994 policy that graduates of an ABET accredited program should be considered to have passed the FE examination. The resolution was intended to avoid teaching to the exam.

Implementation Plan

Building on and connecting the strategies, the recommended implementation plan identifies principal participants, defines action items and supporting tasks and establishes milestones.

Need for a Plan. Building on the preceding 17 strategies, the TC developed a specific implementation plan. While the underlying strategies are essential, an implementation plan that identifies principal participants, defines key action items and supporting tasks, and establishes milestones is needed if concrete actions are to occur. The plan energizes and connects the strategies and makes them operable. The purpose of the TC's implementation plan is to offer a coordinated, proactive way to achieve full realization of ASCE Policy Statement 465 by 2020.

Principal Participants. Listed in APPENDIX M are 26 groups and other entities having a stake in implementation of ASCE Policy Statement 465. While, by definition, all the listed stakeholders will be affected, the following three groupings of stakeholders were selected by the TC as principal participants in the partnership to implement the BS-MOE as a prerequisite for licensure and as entry into the practice of CE at the professional level:

1. ASCE, defined as the Board of Direction and implementation structure it may form, ASCE Institutes, and the general membership. Also, employers of members of the CE profession, that is, employers of licensed civil engineers, non-licensed civil engineers, and CE technologists and technicians.

2. NCEES and State Licensing Boards

3. ABET, other organizations and professional societies serving civil engineers, and universities including administrators, CE department heads, CE faculty, and CE students as well as other educational providers.

The essence of the preceding three groups of principal participants functioning as a partnership is illustrated in APPENDIX T.

Effective implementation of the BS-MOE as a prerequisite for licensure of civil engineers and their entry into the practice at the professional level will require thoughtful, proactive, coordinated actions by the preceding principal participants. They must, by their words and deeds, lead the effort (Strategies 1 and 2). If they do, most other stakeholders will support the transition to the BS-MOE.

Action Items. A total of four major actions, each with many specific supporting tasks, should be completed over the next 15 to 20 years. Each of these actions is outlined below and the appropriate principal participants are noted. APPENDIX U is a graphical implementation schedule showing when each action item should be started and completed. Note that many of the action items overlap, that is, they are not sequential. Therefore, ***all principal participants could immediately begin all action items.*** Some aspect of the launch of the implementation plan should be linked to the ASCE Sesquicentennial celebration (Strategy 4) but the implementation effort should not pause until then (Strategy 1). The TC recommends that conclusion of its work and the beginning of implementation be continuous. Full realization of ASCE Policy Statement 465 can be achieved by 2020.

Action Item A: ASCE leads through continuous interaction with other stakeholders

Principal Participant: ASCE

Task 1 – Approve refined Policy Statement 465: ASCE Policy Statement 465, which was adopted by the Board of Direction in October 1998, should be refined to reflect the TC's work and ideas and information developed since 1998. A suggested revised policy statement is included as APPENDIX V. The extent of the revisions are small in terms of text changes. However, the revisions are significant and should be approved by the Board because the recommended revised policy:

- Explicitly mentions master's degree or equivalent (MOE) (Strategy 6).

- States that the MOE and licensure are required for the practice of CE at the professional level.

- Stresses life-long learning.

- Omits the problematic expression "first professional degree" because the phrase has caused unnecessary confusion. Defining the educational and other requirements for licensure and practice of CE at the professional level are essential.

Task 2 – Form Implementation/Steering Committee: ASCE is the initiator of the BS-MOE as a prerequisite for licensure and the practice of CE at the professional level (Strategy 2) and is initiator of specialty certification (Strategy5). Under even the best of conditions, "full realization of ASCE Policy Statement 465" will require more than a decade and encounter many and varied obstacles. Therefore, ASCE as the initiator must provide continuous leadership until the vision is realized (Strategy 1). More specifically, besides its role as a principal participant in Action Items A, B, C and D, ASCE must listen to, respond to, inform and otherwise interact with non-principal stakeholders such as those listed in APPENDIX M (Strategy 2). The TC recommends that the ASCE Board of Direction immediately form a committee to steer implementation of the recommendations in this report.

Task 3 – Accept and endorse report: The TC urges the ASCE Board of Direction to accept and endorse this report.

ASCE, as initiator of the BS-MOE combination and specialty certification for civil engineers, must provide continuous leadership until the vision is realized.

Task 4 – Distribute this report to leaders of NCEES, ABET, the founder societies and others as appropriate: Two purposes will be served if ASCE transmits this report to leaders of NCEES, ABET, the founder societies and other organizations as may be appropriate. First, some of these, namely NCEES and ABET, are CE stakeholders whose active support is needed for implementation of the report's recommendations. Second, other engineering organizations may benefit from the data, information and ideas presented in the report. Interest in engineering education, licensure, and specialty certification clearly extends beyond ASCE.

Task 5 – Interact with stakeholders: Examples of ways the implementation/steering committee can inform and learn from stakeholders (Strategy 2) while guiding implementation are:

- Finalize implementation plan
- Publish progress reports and provide annual reports to the ASCE Board of Direction
- Respond to questions
- Consider suggestions
- Make presentations
- Conduct surveys
- Celebrate successes
- Deal with obstacles
- Acknowledge failures and learn from them
- Recognize individual and group (e.g., a state licensing board) leaders
- Provide funding and identify other funding sources

Task 6 – Ask the ASCE Committees on Professional Practice and Educational Activities and the Institutes to support the BS-MOE, licensing, and specialty certification recommendations: The charge to the Committee Professional Practice (CPP), a standing committee of the Board, includes providing vision, leadership and direction to ASCE and its members with regard to the professional aspects of CE. Several of the CPP's constituent committees are responsible for areas directly related to the TC's BS-MOE, licensing and specialty certification recommendations. These constituent committees include Continuing Education, Career Development, Licensure, Employment of Civil Engineers, and Practice Guidelines. Constituent committees are urged to study, refine and help to implement the TC's recommendations. The charge to the Educational Activities Committee (EdAC) includes enhancing CE education which is the intent of the TC's BS-MOE recommendation. EdAC is also urged to study, refine and help to implement the TC's recommendations. Finally, the Institutes, in the view of the TC, are clearly the logical leaders of specialty certification.

Task 7 – Ask professional organizations and societies to support the BS-MOE as a requirement for the practice of CE at the professional level: Many professional organizations and societies serve civil engineers, some almost exclusively and others as part of their overall membership. Similarly, many civil engineers actively support various CE related professional groups (Strategy 2). Examples of professional organizations and societies having a stake in CE are:

- Accreditation Board for Engineering and Technology (ABET)
- American Association for Engineering Societies (AAES)
- American Society for Engineering Education (ASEE)
- Council of American Structural Engineers (CASE)
- Federation of National Engineering Societies (FEANI)
- National Academy of Engineering (NAE)
- National Council of Examiners of Engineers and Surveyors (NCEES)
- National Council of Structural Engineers Associations (NCSEA)
- National Society of Professional Engineers (NSPE)
- Society of American Military Engineers (SAME)
- World Federation of Engineering Organizations (WFEO)

Task 8 – Revisit ASCE membership grades entrance requirements: Entrance requirements for various ASCE membership grades should be reevaluated to consider the effects of the BS-MOE, licensure and specialty certification recommendations. Appropriate more rigorous criteria should be gradually implemented. For example, while the Associate Member requirements might stay the same, Member might eventually require an MOE and Fellow an MOE and specialty certification or, as an alternative to specialty certification, a higher experience requirement.

Using a prioritized approach, ASCE should encourage the National Council of Examiners of Engineering and Surveying and licensing boards to adopt the BS-MOE for licensure and the practice of civil engineering at the professional level.

Action Item B: Licensing jurisdictions adopt the BS-MOE as a requirement for the practice of CE at the professional level.

Principal Participants: ASCE, Employers, NCEES, and Licensing Boards.

Task 1 – Review the change processes used by other professions: Accounting, architecture, and pharmacy changed education-experience-licensing processes in recent decades. ASCE can benefit from those experiences as it develops strategies and tactics for affecting change (Strategy 12).

Task 2 – Prioritize licensing jurisdictions: All 55 U.S. jurisdictions that license civil engineers (50 states plus the District of Columbia, Guam, Northern Mariana Islands, Puerto Rico, and the Virgin Islands) will need to adopt, through legislation or regulation, the requirement for the BS-MOE a prerequisite for licensure and entry into the practice of CE at the professional level. This process will require many years. Because starting the process will be a challenge, ASCE will rely on NCEES (Strategy 16) and Licensing Boards with assistance of NSPE (Strategy 15) to identify and prioritize those licensing jurisdictions most likely to be receptive to initiating the necessary revised legislation or rule making. The prioritization should concentrate on those 13 states and other jurisdictions that license engineers on a discipline specific basis.[65] These states and other jurisdictions are Arkansas, California, District of Columbia, Guam, Hawaii, Iowa, Louisiana, Massachusetts, Nebraska, Nevada, Northern Mariana Islands, Rhode Island, and Vermont.

Task 3 – Prepare fact sheets and guidelines: ASCE and NCEES and licensing boards should prepare and endorse fact sheets, frequently asked questions[66] and guidelines to use in communication with legislators and regulators.

Task 4 – Convince state legislators and regulators: Influential employers and influential individual members of the CE professional community should help to convince legislators and state regulators of the need for requiring the BS-MOE as a condition of licensure as a civil engineer.

Task 5 – Refine the Model Licensure Law: NCEES should refine its model licensure law to recognize the BS-MOE requirement for licensing civil engineers. One aspect of such recognition is to facilitate discipline specific licensing at least for civil engineers. As noted under Task 2, 13 states already have this provision which is consistent with the BS-MOE as a prerequisite for licensure and entry into the practice

of CE at the professional level. Licensing boards will be encouraged to adopt the ASCE-NCEES endorsed guidelines to promote uniformity and thus interstate mobility for licensed civil engineers.

Task 6 – Pass legislation and/or adopt rules: Language such as the following may be recommended for use in statutes or regulations:

> *After the expiration of the one-year period immediately following the effective date of this Act, the education requirement for licensing, which must be met before an applicant is eligible to apply for the examination, shall consist of the BS-MOE combination.*

The intent is to incorporate the MOE (Strategy 6). The recommended language would also include provisions to protect the status of current licensed and other members of the CE profession (Strategy 3) and provide a grace period for civil engineers who do not have a MOE but have passed the FE examination or are within a certain number of years past their baccalaureate degree. Statutes and regulations should also address cooperative education (Strategy 9), distance learning (Strategy 8), and the FE examination (Strategy 17). Finally, language recommended by ASCE-NCEES would state that the BS-MOE requirement for licensing would not affect, in any legal way, already licensed civil engineers (Strategy 3).

Task 7 – Encourage employees to obtain licensure: Employers in both the public and private sectors should provide added encouragement to their personnel, especially civil engineers, to obtain licensure (Strategies 3, 6, and 8). Obtaining licensure will take on added importance because it will now be a prerequisite for practicing CE at the professional level. Employers can support licensure in a variety of ways. Examples are recruiting education and training, advancement, compensation, and recognition policies and procedures. Special efforts should be made to assist unlicensed employees who hold a BSCE but do not have a MOE.

Task 8 – Encourage users of CE services to more rigorously require licensed civil engineers to be responsible for CE projects: Public safety, health and welfare are more likely to be protected if licensed civil engineers are responsible for even more CE planning, design, operation and other functions. Use of licensed civil engineers, as employees and consultants, can be required through adoption of more stringent policies, procedures, regulations and laws by federal through local government entities and other users, public and private, of CE services.[67]

Action Item C: ABET, universities and others revise CE curricula, programs and culture

Principal Participants: ASCE, Employers, NCEES, Licensing Boards, ABET, and Universities and other Educational Providers

Universities should seek input from practitioners, adapt or create BS-MOE models, provide faculty development, develop accreditation criteria and obtain accreditation.

Task 1 – Obtain input from individual practitioners and employers: The CE profession must define that body of specialized knowledge required to practice as the professional level (Strategy 2). This knowledge is that technical and management content gained in some combination of a four-year ABET accredited undergraduate CE program and the post graduate education that is needed to support practice of CE at the professional level. More specifically, the body of specialized knowledge includes four components. They are 1) a technical core, 2) a non-technical core, 3) technical electives, and 4) technical and non-technical courses to support an individual's career objectives. Employers of CE professionals and individual practicing civil engineers should be consulted to help define the knowledge and skills required by tomorrow's civil engineers.

Task 2 – Emphasize role of employers in partnering with employees in MOE and continuing education: Employers should consider their role in supporting their employee's participation in post-graduate and continuing education. Some employers may wish to offer enhanced educational experiences as a method of attracting and retaining quality individuals. Others may wish to develop formal shared-financing arrangements for their employees.

Task 3 – Select BS-MOE models and design curricula: Colleges and universities must review their role in baccalaureate and post-graduate education. Individual CE programs should evaluate their undergraduate and graduate curricula, program, and culture in light of how they want to participate in the movement to the BS-MOE as the prerequisite for licensure and practice at the professional level. As a starting point, universities should review the definition of MOE (Strategy 6). Many options are available to exclusively or primarily undergraduate CE programs (Strategy 10). Similarly, CE programs now offering graduate degrees have numerous options (Strategy 11). Employers, ASCE, and other organizations that offer continuing education should identify how they might help provide all or part of the MOE and should explore alternative source and delivery methods including non-traditional education providers and distance learning. All education providers should further develop a culture that values both attainment of the MOE and continuation of education beyond licensing.

Task 4 – Develop BS-MOE certification criteria: ASCE, NCEES and state licensing boards should take the lead in preparing criteria for certification of equivalent post-graduate educational experiences for CE licensure (Strategy 6). Universities may be able to serve as clearinghouses for such out-of-university education or it may be necessary to establish new certifying organizations, similar to International Association for Continuing Education and Training (IACET).

Task 5 – Provide faculty development: Universities, in general, and their CE programs, in particular, should prepare potential CE students, current CE students, CE faculty, and administrators for the gradual conversion to the BS-MOE as a condition for licensing of civil engineers. For example, administrators and faculty should work together to help faculty, as individuals and in total, more effectively model a broader set of professional attributes. Even more CE faculty should earn licensure partly to serve as models for their students. ABET's EC-2000 may serve as a catalyst for the preceding. The expected major retirement of post-Sputnik decade faculty by 2010 (one third to one half of the current faculty at some institutes[68]) provides an opportunity to markedly change faculty culture.

Task 6 – Revise accreditation criteria including providing dual level accreditation: ABET should work with ABET member societies (such as ASCE) to develop appropriate accreditation criteria and other ways to serve students. ABET is on record as being receptive to the MOE idea (Strategy 13). Revised accreditation criteria should include dual-level accreditation because such accreditation will increase the number and variety of BS-MOE (Strategy 6) options available to prospective licensed engineers. In creating or revising programs consistent with the BS-MOE as the requirement for licensure, universities should consider the role of cooperative education (Strategy 10) and distance learning (Strategy 11).

Task 7 – Obtain accreditation: Finally, universities should seek accreditation of their CE programs under the revised criteria.

Task 8 – Explore the professional school model: A few well-established, highly progressive universities should explore the possibility of creating professional schools of CE (Strategy 11). Assuming implementation of the TC's recommendation over the next decade or so, the next major improvement in the preparation of civil engineers is likely to be the creation of professional schools. Pioneering efforts undertaken early in this century could provide a wealth of experience.

ASCE Institutes, with help from the Implementation Committee, should lead the development of a civil engineering specialty certification program under the auspices of ASCE and other professional societies.

Action Item D: ASCE Institutes lead the development of specialty certification *(Strategy 5).* The TC recommends that the implementation/steering committee work with the ASCE Institutes that are considering specialty certification. The following suggested supporting tasks are not considered to be a complete listing of all tasks required for implementation of specialty certification by the various institutes, but rather a listing of those tasks that would be germane to and compatible with implementation of ASCE Policy Statement 465.

Principal Participants: ASCE (primarily the Institutes and the implementation/steering committee) and, preferably, other professional societies.

Task 1 – Identify interested Institute(s): The IC will work with ASCE staff and the staff and volunteers of the various institutes, to identify an institute (or institutes) that would be amenable to common development of the criteria required for specialty certification. Four Institutes are functioning (Geo, Structural Engineering, Architectural Engineering, and Environmental and Water Resources) and three more are being studied by task committees (Construction, Transportation and Coastals, Oceans, Rivers, Ports). The input from the implementation/steering committee would be restricted to issues relating to implementation of ASCE Policy Statement 465. The goal would be to prevent criteria from being implemented for specialty certification that could have an adverse impact on implementation of ASCE Policy Statement 465.

Task 2 – Explore relationships with other professional societies: The implementation/steering committee and Institute(s) should try to develop relationships with other professional societies having an interest in specialty certification. The structural engineers have expressed interest in specialty certification and licensing through the Council of American Structural Engineers (CASE) and the National Council of Structural Engineering Associations (NCSEA). The TC believes that coordination with these two groups, and other like-minded groups, would be advantageous to successful implementation of ASCE Policy Statement 465.

Task 3 – Prepare common criteria: The TC believes three primary elements that are common to both specialty certification and the implementation of ASCE Policy Statement 465. These are educational requirements, professional licensure, and experience requirements. Common criteria should be prepared for these three elements.

Specialty certification will, by its very nature, require formal education beyond the baccalaureate level, once the anticipated grandfathering process is completed. Formal education beyond the baccalaureate level is the prime tenet of ASCE Policy Statement 465. In this regard, specialty certification by the Institutes will probably be more restrictive in the requirements for the post-baccalaureate education than the BS-MOE required by ASCE Policy Statement 465. Specialty certification by a specific institute will probably require advanced study in that specific discipline, or a closely allied field. However, that advanced study in a specific discipline will probably be considered an acceptable subset of the more general BS-MOE.

Professional licensure will also probably be a requirement for specialty certification. However, the sequencing of obtaining the post-baccalaureate education and professional licensure is not critical to specialty certification. (Sequencing is, however, absolutely essential to licensure in that the MOE should be a condition for sitting for the examination). Either one can be obtained prior to the other. The TC believes that the vision of full implementation requires the completion on a BS-MOE as a requisite to professional licensure. This variance in sequencing does not constitute a problem, because the end-effect is the same; the person who is practicing as a specialty certified civil engineer has obtained a MOE.

The experience requirements for obtaining specialty certification are likely to be more extensive than the experience requirements associated with ASCE Policy Statement 465. The professional experience required to satisfy ASCE Policy Statement 465 is identical to that required for professional licensure, which is nominally four years after obtaining the BS degree. It is probable that most licensing jurisdictions will give credit to some, or all, of the degrees and formal education described in the MOE. However, specialty certification will probably require extensive professional experience in the area of certification, significantly beyond that which would be required for satisfaction of ASCE Policy Statement 465.

Task 4 – Pilot the specialty certification program with one Institute: Even with careful creation of criteria and design of a review and certification process, implementation of specialty certification should probably begin with one Institute. Then, after a year or so experience by learning and refinement, other Institutes could begin their efforts (Strategy 5).

Task 5 – Expand the specialty program within other Institutes (Strategy 5): Two or more specialty certification programs could begin and proceed in parallel building on what was learned in the pilot effort.

Task 6 – Encourage practitioners to obtain specialty certification: Public and private sector employers of civil engineers should encourage individuals to seek specialty certification because certification benefits employees, employers, the CE profession and, ultimately, the public (Strategy 5). Employers can support specialty certification through their recruiting, advancement, compensation and recognition policies and procedures.

Task 7 – Encourage users of specialized CE services to require participation by specialty certified civil engineers: Users of CE services are urged to identify sophisticated and/or higher risk service areas and for these adopt policies, procedures and regulations that require specialty certified (e.g., Structural Institute Certified) civil engineers, as employees or consultants, to assume lead roles. Federal, state and other government entities can give widespread impetus to this effort by promulgation of appropriate policies, procedures, regulations and laws. Protection of the safety, health and welfare of the public is the principal purpose of this task.

Closing Thoughts Related to Implementation

While a "no action" option is possible, it would lead to a declining role for the civil engineering profession and its members. More importantly, society would gradually lose the benefit of the civil engineering profession's long and caring tradition of placing the highest priority on protecting public safety, health and welfare.

A Comment for Those Who Oppose Policy Statement 465: The TC offers a challenge in the form of respectful queries to those who oppose ASCE Policy 465 and the TC's recommendations presented in this report. Given the dynamic changes within and around CE, if you do not support the BS-MOE as a prerequisite for licensure and practice at the professional level now, when will you support it? If you do not support the BS-MOE, regardless of when it would be implemented, what do you advocate so that CE can thrive or at least survive, in the rapidly changing environment? How would you have our profession lead, or at least keep up, within the infrastructure and environmental arena and with other professions?

In the opinion of the TC, a "no action" option is possible, but not prudent, feasible but not future focused. "No action" would lead to a diminished role for the civil engineering profession and its members. Paralleling this declining role, society would gradually lose the benefit of the profession's infrastructure and environmental competence and long and caring tradition of placing the highest priority on protecting public safety, health and welfare.

The Task Committee urges the ASCE Board of Direction to quickly adopt and assertively implement the recommendations presented in this report.

The Task Committee's Request to the Board: The TC thanks the ASCE Board of Direction for the opportunity to serve and offers its closing thoughts and recommendations. Civil works will always be in demand—that is unquestionable. To be decided, however, is who will lead the planning, design, construction and operation of civil works in the U.S.; civil engineers or others? Our environment will increasingly need protection. Civil engineers could lead this effort, but will they? The CE profession can engineer its future or others will engineer it for them. The TC strongly endorses the former and recognizes the need for bold action. **With pride in the history and traditions of CE and confidence in the profession's future, the TC urges the ASCE Board of Direction to quickly adopt and assertively implement the recommendations presented in this report**.

ACKNOWLEDGEMENTS

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Many individuals and groups, working diligently and creatively over decades and sharing their convictions and thoughts in a variety of ways, have contributed ideas and information that influenced the TC in preparation of this report. Their efforts laid the foundation for the TC's work. The TC gratefully acknowledges the assistance it received as a result of the contributions of others.

APPENDIX A

ASCE POLICY STATEMENT 465
FIRST PROFESSIONAL DEGREE

Approved by the Educational Activities Committee on September 9,1998
Approved by the Committee on Policy Review on October 2, 1998
Adopted by the Board of Direction on October 17, 1998

Policy

The American Society of Civil Engineers (ASCE) supports the concept of the Master's degree as the First Professional Degree for the practice of civil engineering at a professional level.

ASCE encourages institutions of higher education, governmental units, employers of civil engineers, and other appropriate organizations to endorse, support, and promote the concept of mandatory post-baccalaureate education for the practice of civil engineering at a professional level. The implementation of this effort should occur through establishing appropriate curricula in the formal education experience, appropriate recognition and compensation in the workplace, and congruent standards for licensure.

Issue

The civil engineering profession is undergoing significant, rapid, and revolutionary changes making the baccalaureate civil engineering degree an entry level degree that is inadequate preparation for the practice of civil engineering at the professional level. These changes include the following:

- Globalization has challenged the world-wide geographic boundaries normally recognized in the past, primarily as a result of enhanced communication systems.

- Information technology has made, and continues to make, more information available; however, the analysis and application of this information is becoming more challenging.

- The diversity of society is challenging our traditional views and people skills.

- New technologies in engineering and construction are emerging at an accelerating rate.

- Enhanced public awareness of technical issues is creating more informed inquiry by the public of the technical, environmental, societal, political, legal, aesthetic, and financial implications of engineering projects.

- Civil infrastructure systems within the United States are rapidly changing from decades of development and operation to the renewal, maintenance, and improvement of these systems.

These changes have created a market requiring civil engineers to have simultaneously greater breadth of capability and specialized technical competence than that required of previous generations. For example, many civil engineers must increasingly assume a different primary role from that of designer to that of team leader. This changing market and role for the civil engineer can be addressed by appropriate, formal post-baccalaureate education among other fundamental requirements.

Rationale

Increased educational requirements beyond the baccalaureate degree for the practice of civil engineering at the professional level are consistent with other learned professions. The body of knowledge gained, and the skills developed in the formal civil engineering education process, are not significantly less than the comparable knowledge and skills in these other professions. Is it reasonable in such complex and rapidly changing times to think that we can impart the requisite engineering knowledge and skills in four years of formal schooling while other learned professions take seven or eight years? Four years of formal schooling were considered the standard for three professions (medicine, law, engineering) 100 years ago, and while medicine and law education lengthened with the growing demands of their respective professions engineering education did not. Perhaps this retention of a four-year undergraduate engineering education has contributed to the lowered esteem of engineering in the eyes of society, and the commensurate decline in compensation of engineers relative to medical doctors and lawyers.

Current baccalaureate programs, while constantly undergoing review and revisions, still retain a nominal four-year education process. This length of time limits the ability of these programs to provide a formal education consistent with the increasing demands of the practice of civil engineering at the professional level. There are diametrically opposed forces trying to squeeze more content into the baccalaureate curriculum while at the same time reducing the credit hours necessary for the baccalaureate degree. The result is a production line baccalaureate civil engineering degree satisfactory for an entry level position, but inadequate for the professional practice of civil engineering. The four year internship period (engineer-in-training) after receipt of the BSCE degree cannot make up for the formal educational material that would be gained from a master's degree program.

The implementation of this concept will not happen overnight, nor can ASCE will that it be done in a specified time period. This concept is a legacy for future generations of civil engineers. However, perhaps the most important aspect of the implementation of this policy is already in place. Within the U.S. system of higher education, high quality, innovative and diverse master's degree programs currently exist in colleges and universities to support this concept. The active support of this policy by all of the stakeholders in this process, such as the educational institutions, the registration boards, and the various employers of civil engineers, will be required to develop and promote the elements necessary to eventually implement this concept.

APPENDIX B

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responsible for programs in civil engineering technology, construction engineering technology, building construction technology, construction management, and environmental engineering. Prior to Wentworth Institute of Technology, he was on the civil engineering faculty at Northeastern University in Boston for 16 years where he taught both undergraduate and graduate courses in geotechnology. He was also a faculty advisor to the ASCE Student Chapter for 10 years (awarded ASCE's Robert Ridgway Award as the most outstanding chapter in the United States seven times), was a director of ASCE's Summer Institute for Minority High School Students for 10 years. An Alumnus of Northeastern University, where he earned a B.S.C.E. degree, Kupferman also hold a Masters degree and a Ph.D., Civil Engineering from the University of Massachusetts. He is a registered professional engineer in Massachusetts.

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APPENDIX C

TABULAR SUMMARY OF EDUCATION - EXPERIENCE - LICENSING - CERTIFICATION - CONTINUING PROFESSIONAL DEVELOPMENT REQUIREMENTS FOR VARIOUS PROFESSIONS IN THE U.S.

NOTE: DRAFT FOR REVIEW BY TC ON THE FPL

(6/11/00,Revised 7/3/00, 8/22/00, 10/2/00, 1/29/00, 1/29/01)

PROFESSION	LEVEL	REQUIREMENTS						MISCELLANEOUS			
		COLLEGE EDUC. REQ'D ?	POST COLL. EDUC. REQ'D ?	EXPERI-ENCE REQ'D ?	STATE BOARD EXAM. REQ'D ?	CONTIN. PROF. DEV. REQ'D ?	SPEC. CERTIF. AVAIL/ REQ'D ?	NUMBER OF LICENS-ED INDI-VIDUALS	NO. OF ACCRED. SCHOOL/ PROG.	ACCRED. ORG.	INCOME
Accounting	CPA	Yes	Yes	Yes	Yes	Yes	Yes			AACSB	
(1)		4 yr with accting concen-tration	About 1 yr (need total of 150 hrs)	(e.g., 1 yr in Mich.)		40 hrs./yr.	and more being developed			Interna-tional Assoc. for Manag. Educ. (may be more)	

Architecture (2)	Architect	Yes 4 yr BS or BA of Arch.	Yes 1 yr. (to obtain Bachelor or Master of Arch.)	Yes Varies from state to state	Yes	Yes/No Required in 13 states		110	NAAB National Architect-ural Accredit-ing Bd.	
Civil Engr.	PE	Yes 4 yr with engr concen-	No	Yes 4 yr	Yes	Yes/No Requred in 17 states (9)	Yes/No Rare, e.g., Diplomate in Envir. Engr.	About 220 accred programs	ABET	
Dentistry (10)	DDS DMD	Yes 4 yr in-cluding 2 yr biol, 2 yr chem & I yr physics.	Yes 4 yr with a few schools requiring 5 yrs.	No	Yes		Yes Example areas are orthodon-tics, oral surgery & pediatrics. 2 to 6 yrs additional education		Commis-sion on Dental Accredita-tion of the ADA	Average 1994 in-come of general practition-ers in priv-ate prac-tice: $102,000
Law (3)	Attorney	Yes 4 yr, no pre-law required	Yes 3 yr	No 5 yrs required for recipro-city	Yes	Yes Typically 12 CEU's per yr			ABA American Bar Associa-tion	

Medicine (4)	MD Medical Doctor	Yes 4 yr in any field but with strong science	Yes 4 yr which earns MD	3 to 7 yr Residency under super-vision	Yes Pass 3 step national exam plus other require-ments which vary by state	Yes Required in all states and varies	Yes Diplomate status granted by 24 specialty boards		125	LCME Liason Committee on Medical Education of the AMA	
Nursing (11)	Registered Profession-al Nurse	Yes	No		Yes						
Optometry (5)	OD Doctor of Optometry	4 yr	Yes 4 yr	No Clinical work is part of graduate education	Yes	Yes All states plus DC, VI, Guam, Puerto Rico	No	Less than 32,000	17	Council on Optome-tric Educ	Self-employed in '96: $102,000 employed in '96: $74000.
Pharmacy (6)	Pharm.D. Doctor of Pharmacy	2 yr pre-pharmacy	Yes 4 yr Recently raised education		Yes Required in 48 states	Yes Various specialty certifica-tions avail-ble		180000	81	ACPE American Council on Pharma-ceutical Education	Starting salary: $65,000 - $100,000

			required from 5 to 6 yrs.							
Theology (7)		Yes 4 yr in any field but strong in areas such as phil, logic, ethics	Yes e.g., 3 yr for Master of Divinity						ATS Association of Theological Schools	
Veterinary Medicine (8)	Veterinar-ian	Yes 3-4 yr pre-veterinary medicine program	Yes 4 yr	No Clinical work is part of graduate education. Post grad experience not reqd for licen-sure but some cand complete voluntary internship 2-5 yr internship required for specialty certifica-tion	Yes	Yes/No Required in half of states	Yes 20 specialty areas	27	AVMA American Veterinary Medical Associa-tion	

FOOTNOTES:

1 Source: 2/00 summary by R. O. Anderson, http://www.aicpa.org; http://www.aacsb.edu/

2 Source: 9/15/00 summary by W. E. Kelly, http://www.naab.org; http://www.ncarb.org/continuinged/index.html

3 Source: 1/00 summary by J. A. Wintz.

4 Source: 1/19/00 summary by T. Lenox, http://www.ama-assn.org, http://www.amsa.org, http://www.aamc.org, http://www.fsmb.org, http://www.nbme.org, http://www.dhp.va.us/levelone/med.htm, http://acgme.org, http://accme.org, http://www.abms.org

5 Source: 8/22/00 summary by S.G. Walesh, http://www. aaopt.org, http://www.aoanet.org, http://iabopt.org, http:// optometry.org, http://home.opted.org/asco.

6 Source: 8/22/00 summary by S.G. Walesh, http://www.aacp.org

7 Source: 9/15/00 summary by W. E. Kelly, http:// www.ed.gov/nle/usnei/, http://www.ats.edu, http://religious studies.cua.edu.

8 Source: 8/22/00 summary by S.G. Walesh, http://www.avma.org

9 The states are AL, AR, GA, IA, KS, LA, MN, MT, NV, NH, NM, NC, OK, OR, SC, SD, WY (http://www.ncees. org/)

10 Source: http://www.agd.org, http://www.ada.org, http://dentistry.vh.org/sites.html

11 Source: http://encarta.msn.com/find/ and go to "Registered nurse, nursing"

RANKINGS OF PROFESSIONS BASED ON YEARS OF POST UNDERGRADUATE EDUCATION REQUIRED TO OBTAIN LICENSE:

1 Medicine, Optometry, Pharmacy, Veterinary Medicine (4 yrs)

2 Law, Theology (3 yrs)

3 Accounting, Architecture (1 yr)

4 **Civil Engineering (0 yr),** Nursing(0 yr)

RANKINGS OF PROFESSIONS BASED ON YEARS EXPERIENCE REQUIRED TO OBTAIN LICENSE:

1 Medicine (3 to 7 yrs)

2 **Civil Engineering (4 yrs),** Architecture(variable)

3 Accounting (1)

4	Law, Nursing, Optometry, Veterinary Medicine (0 yrs)	Note: Need information on Theology. Note: Need information on Pharmacy.

RANKINGS OF PROFESSIONS BASED ON CONTINUING EDUCATION REQUIRED TO RETAIN LICENSE:

1	Accounting, Law, Medicine, Optometry (Required in all states)	
2	Pharmacy (required in 48 states)	
3	Veterinary Medicine (Required in half the states)	
4	**Civil Engineering (Required in 17 States)**	Note: Need info on Theology.
5	Architecture (Required in 13 states)	Note: Need info on Nursing.

RANKINGS OF PROFESSIONS BASED ON AVAILABILITY OF SPECIALTY CERTIFICATION (Assuming this is desireable):

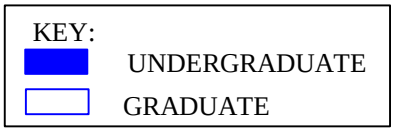
1	Accounting, Medicine(24 areas), Veterinary Medicine(20 areas)	
2	Pharmacy (various specialty certifications available)	
3	**Civil Engineering**	
4	Architecture, Law, Nursing, Theology	Note: Need more information on these professions

APPENDIX D

GRAPHICAL SUMMARY
of
EDUCATION-EXPERIENCE-LICENSING
CONTINUING PROFESSIONAL DEVELOPMENT
REQUIREMENTS
For
VARIOUS PROFESSIONS IN THE U.S.

Post-High School Education Required for State Licensure in the U.S. for Various Professions

PROFESSION	LEVEL	YEARS
ACCOUNTING[a]	CPA	4 5
ARCHITECTURE[a]	ARCHITECT	4 5
CIVIL ENGINEERING	PE	4
DENTISTRY	DDS/DMD	4[b] 8
LAW	ATTORNEY	4 7
MEDICINE	MD	4 8
NURSING	PROFESSIONAL REGISTERED NURSE	4
OPTOMETRY	DOCTOR OF OPTOMETRY	4 8
PHARMACY[a]	PHARM.D.	2 6
VETERINARY MEDICINE	VETERINARIAN	4[c] 8



a) These are recently elevated educational requirements.
b) May be 5 years in a few programs.
c) May be 3 years in a few programs.

Experience
Required for State Licensure in the U.S.
for
Various Professions

PROFESSION	LEVEL	YEARS	COMMENT
ACCOUNTING	CPA	1	---
ARCHITECTURE	ARCHITECT		VARIES FROM STATE TO STATE
CIVIL ENGINEERING	PE	4	---
DENTISTRY	DDS/DMD	NONE	---
LAW	ATTORNEY	NONE	5 YEARS REQUIRED FOR RECIPROCITY
MEDICINE	MD	3 (MIN) 7 (MAX)	---
NURSING	PROFESSIONAL REGISTERED NURSE		---
OPTOMETRY	DOCTOR OF OPTOMETRY	NONE	CLINICAL STUDY IS PART OF GRADUATE EDUCATION
PHARMACY	PHARM.D.		---
VETERINARY MEDICINE	VETERINARIAN	NONE	CLINICAL STUDY IS PART OF GRADUATE EDUCATION AND SOME CANDIDATES COMPLETE A VOLUNTARY INTERNSHIP

Total Post-High School Education and Experience Required for State Licensure in the U.S. for Various Professions

PROFESSION	LEVEL	YEARS
ACCOUNTING	CPA	5 6
ARCHITECTURE	ARCHITECT	5
CIVIL ENGINEERING	PE	4 8
DENTISTRY	DDS/DMD	8
LAW	ATTORNEY	7
MEDICINE	MD	8 11(MIN) 15(MAX)
NURSING	PROFESSIONAL REGISTERED NURSE	4
OPTOMETRY	DOCTOR OF OPTOMETRY	8
PHARMACY	PHARM.D.	6
VETERINARY MEDICINE	VETERINARIAN	8

KEY:
EDUCATION
EXPERIENCE

Continuing Professional Development
Required for State Licensure in the U.S. for Various Professions

PROFESSION	LEVEL	EXTENT OF STATES/ JURISDICTIONS REQUIRING
ACCOUNTING	CPA	ALL
ARCHITECTURE	ARCHITECT	13 STATES
CIVIL ENGINEERING	PE	17 STATES
DENTISTRY	DDS/DMD	43 JURISDICTIONS
LAW	ATTORNEY	ALL (?)
MEDICINE	MD	ALL
NURSING	PROFESSIONAL REGISTERED NURSE	
OPTOMETRY	DOCTOR OF OPTOMETRY	ALL
PHARMACY	PHARM.D.	48 STATES
VETERINARY MEDICINE	VETERINARIAN	HALF OF STATES

APPENDIX E

RESOLUTIONS AND OTHER COMMUNICATIONS SUPPORTING ASCE POLICY STATEMENT 465

1. Resolutions from ASCE Sections and Councils

Presented here, in chronological order, are brief summaries of supportive resolutions. "Supportive" includes resolutions that request a cautious, careful, approach.

Northeast Younger Member Council (2/27/99): Requests the Board study the impact various changes related to the first professional degree would have on the civil engineering profession.

Western Regional Younger Member Council (3/20/99): Requests a more cautious course on the policy of the Masters Degree as the First Professional Degree.

District 14 Council (3/26/99): Recommends proceeding cautiously to further develop the policy on the First Professional Degree.

Austin Branch (8/12/99): Requests that the Board reconsider PS 465 after study and review of the issue by a task committee; that the Task Committee solicit and consider input; and that a summary of input received be made available to members via the web site, *ASCE News* and *Civil Engineering* magazine.

Houston Branch (8/12/99): Requests that the Board reconsider PS 465 after study and review of the issue by a task committee; that the Task Committee solicit and consider input; and that a summary of input received be made available to members via the web site, *ASCE News* and *Civil Engineering* magazine.

Younger Member Council Zone III (2/5/00): Requests that the Task Committee on the First Professional Degree include at least one representative from the Committee on Younger Members.

Younger Member Council Zone III (2/5/00): Supports continuing education to maintain a Professional Engineer's License.

Northeast Younger Member Council (3/4/00): Supports the concept of the Masters Degree as the First Professional Degree.

District 14 Council (9/30/00): Requests that ASCE study and analyze the education and experience needed to be licensed to competently practice the profession of Civil Engineering, explore all possible remedies to increase competency to the necessary level, and report its findings to the membership.

2. Geo-Institute resolution (4/6/99): Encourages institutions of higher learning, governmental units, employers of civil engineers, and other appropriate organizations to endorse, support, and promote the concept of mandatory post-baccalaureate education for the practice of civil engineering at the professional level.

3. April 3, 2000 letter to J. David Waugh, PE, President, National Society of Professional Engineers from Larry A. Blair, PE, President, *New Mexico Society of Professional Engineers.*

4. Win Phillips, President of the American Society of Mechanical Engineers (ASME), offered the following personal professional thoughts on ASCE's Policy Statement 465: "Hats off to civil engineering…ASCE's decision is bold and forward thinking. Perhaps it will nudge the engineering community…to recognize the masters degree as an increasingly valuable credential for new engineers." See Phillips, W. (1999), "First Degree of Primary Importance," Ideas and Opinions, *Civil Engineering-ASCE*, January p. 96.

5. Excerpts from Representative Letters to the Editor From Individuals in Support of ASCE Policy 465.

> *To put it bluntly, today's undergraduates are ill prepared for today's tasks.*
>
> Anil K. Kar, P.E., F. ASCE, Calcutta, India
> in *ASCE News*, September 2000.

> *I support changing the minimum education requirements for professional engineers… Until we have overhauled the curriculum, mandating a master's degree will benefit neither the profession nor the public.*
>
> Michael P. Marino, P.E., M. ASCE, Noblesville, IN
> in *ASCE News*, September 2000.

> *As a California structural engineer, I'm licensed to kill a couple thousand people with one mistake, but a medical doctor, who generally can kill only one at a time, needs twice as much education as I do to get a license. President Delon Hampton is right.*
>
> Ralph G. Gray, M. ASCE, Berkeley, CA
> in *ASCE News*, September 2000.

And just as medical and law school application processes weed out lesser quality applicants, mandating an advanced degree should ensure that only the top minds and personalities enter our profession.

Marc J. Gallagher, Easton, PA
in *ASCE News*, January 1999.

Elevating the current standard offers only good things to the public, the individual and the profession. On the other hand, maintaining the status quo assures us of a place nearer the status of a trade than a learned profession.

Ernest T. Bramwell, PE, M. ASCE, American Fort, UT
in *ASCI News*, December 2000.

APPENDIX F

RESOLUTIONS AND OTHER COMMUNICATIONS OPPOSING ASCE POLICY STATEMENT 465

1. Resolutions from ASCE Sections and Councils

   Presented here, in chronological order, are brief summaries of resolutions.

   Pacific Southwest Council (2/17/99): Recommends that the implementation of the policy of the Masters Degree as the First Professional Degree be halted until the supporting data can be evaluated by the Sections and a higher level of support generated.

   Pacific Northwest Council (3/13/99): Recommends that the policy of the Masters Degree as the First Professional Degree be rescinded, and that the grassroots membership be included in the development of all policies.

   District 7 Council (9/18/99): Requests that a committee be established to consider alternatives to the First Professional Degree Policy that would strengthen the status of the civil engineering profession.

   District 16 Council (6/10/00): Recommends that ASCE abolish the committee studying the First Professional Degree issue and instead spend resources on fighting state legislative mandates to reduce the number of credit hours to earn a Bachelor's Degree in Civil Engineering.

   Pacific Northwest Council (2/9/01): Supports the concept of Academies within the Institutes as an alternate to or interim option to the Masters Degree as the First Professional Degree.

2. Excerpts from Representative Letters to the Editor From Individuals in Opposition to ASCE Policy 465

   > *So, I say to the Board, if you believe that our students are ill prepared, then prove it. I may live in Iowa, but for this purpose you may count me as being from Missouri. So show me.*
   >
   > Wilfrid A. Nixon, P.E., University of Iowa
   > in *ASCE News*, January 1999.

The idea is a mistake… If you want to increase our professional stature, do it through stricter licensing and continuing education requirements so that someday the public will think of passing the P.E. exam in the same vein as passing the bar or medical boards.

Gregory P. Thein, P.E., Cleveland, OH
in *ASCE News*, January, 1999.

I've got some real problems with ASCE's Board of Direction being so gullible as to agree that another formal university degree will give practicing engineers more useful professional information than they'll get in the workplace.

C. "Buddy" West, P.E., Cary, NC
in *ASCE News*, January, 1999.

We are technologists. We are a group with little identity to the eventual beneficiaries of our work…There is little chance that things will change in the near future. Such efforts as the five-year master's professional degree program by the American Society of Civil Engineers are futile.

Richard M. Berry
in *CE News*, December, 2000.

APPENDIX G

SUMMARY OF PRESENTATIONS
BY
TASK COMMITTEE MEMBERS, ASCE STAFF AND ASCE BOARD OF DIRECTION MEMBERS

DATE	CONFERENCE/ EVENT/ ETC.	SPEAKER	LOCATION	TITLE/TOPIC OF PRESENTATION/ DISCUSSION
5/98	ASCE Committee on Society Objectives, Programs and Organization	Michael Kupferman	Reston, VI	***The First Professional Degree***
10/98	Great Lakes Regional Society of American Military Engineers Conference	Michael Kupferman	Urbana, IL	***The First Professional Degree***
2/99	ASCE Zone III Workshop for Student Chapter Leaders	Tom Lenox	Houston, TX	***A Legacy for Future Generations of Civil Engineers***
2/99	ASCE Student Chapter, University of Minnesota	Jeffrey R. Russell	Minneapolis, MN	***MS Degree as the First Professional Degree***
3/99	ASCE Southeast Regional Department Heads' Meeting	Tom Lenox	Blacksburg, VA	***A Legacy for Future Generations of Civil Engineers***
3/99	Civil Engineering Students, University of Kentucky	Tom Lenox	Lexington, KY	***A Legacy for Future Generations of Civil Engineers***
4/99	University of Michigan Civil Engineering Alumni Association	Richard O. Anderson	Ann Arbor, MI	***First Professional Degree***
4/99	ASCE Midwest Regional Canoe & Steel Bridge Competition, University of Wisconsin	Jeffrey R. Russell	Madison, WI	***MS Degree as the First Professional Degree***
6/99	Annual ASCE Water Resources Planning & Management Conference	Michael Kupferman	Tempe, AZ	***The First Professional Degree***
6/99	Institute for Civil Infrastructure Workshop	Michael Kupferman	Brooklyn, NY	***The First Professional Degree***

6/99	American Society for Engineering Education	Michael Kupferman	Charlotte, NC	***The First Professional Degree***
7/99	ASCE Board Committee Week	Michael Kupferman	Denver, CO	***The First Professional Degree***
7/99	National Society of Professional Engineers Annual Convention	Michael Kupferman	Spokane, WA	***The First Professional Degree***
9/99	ASCE Board Orientation	Michael Kupferman	Reston, VI	***The First Professional Degree***
9/99	ASCE Northeast Regional Department Heads' Meeting	Tom Lenox	Boston, MA	***A Legacy for Future Generations of Civil Engineers***
9/99	Younger Member Leadership Symposium (at the ASCE Annual Conference & Exposition)	Tom Lenox	Charlotte, NC	***The First Professional Degree for Civil Engineers - Imagine the Future***
10/99	American Association of State Highway and Transportation Officials Annual Meeting	Michael Kupferman	Tulsa, OK	***The First Professional Degree***
10/99	ASCE National Conference	Jeffrey R. Russell	Charlotte, NC	***MS Degree as the First Professional Degree***
10/99	ASCE National Conference	Michael Kupferman	Charlotte, NC	***The First Professional Degree***
10/99	ASCE National Conference	Luther Graef	Charlotte, NC	***The First Professional Degree***
11/99	Middle Atlantic Section American Society for Engineering Education Fall Conference	Michael Kupferman	Harrisburg, PA	***The First Professional Degree***
11/99	ASCE Student Chapter University of Michigan and Ann Arbor Branch	Richard O. Anderson	Ann Arbor, MI	***First Professional Degree***
11/99	Iowa Section, ASCE	Luther Graef	Ames, IA	***The First Professional Degree***
1/00	ASCE Board Committee Week	Michael Kupferman	San Antonio, TX	***The First Professional Degree***
1/00	ASCE Zone II Workshop for Student Chapter Leaders	Tom Lenox	Nashville, TN	***ASCE Policy 465: What Is It? What Is It . . . NOT!***
2/00	ASCE Zone III Leadership & Management Conference	Jeffrey R. Russell	Denver, CO	***MS Degree as the First Professional Degree***

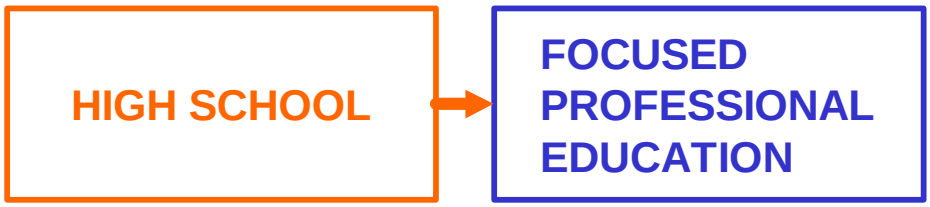
2/00	Midwest Regional Student Conference & Steel Bridge Competition University of North Dakota	Jeffrey R. Russell	Grand Forks, ND	***MS Degree as the First Professional Degree***
3/00	Younger Members Forum ASCE District 7	Richard O. Anderson	Detroit, MI	***First Professional Degree***
3/00	Zone II Management Conference, ASCE	Luther Graef	Pittsburgh, PA	***The First Professional Degree***
3/00	ASCE Mid-Atlantic Regional Department Heads' Meeting	Tom Lenox	Pittsburgh, PA	***The First Professional Degree***
3/00	ASCE Student Chapter, Marquette University	Jeffrey R. Russell	Milwaukee, WI	***MS Degree as the First Professional Degree***
4/00	Oklahoma Section, ASCE	Richard O. Anderson	Oklahoma City, OK	***First Professional Degree***
4/00	Texas Section, ASCE Annual Meeting	Michael Kupferman	Austin, TX	***The First Professional Degree***
4/00	Regional Meeting American Society for Engineering Education	Michael Kupferman	Tucson, AZ	***The First Professional Degree***
4/00	ASCE Pacific Coast Regional Department Heads' Meeting	Tom Lenox	San Francisco, CA	***The First Professional Degree***
5/00	Ithaca/Syracuse Section, ASCE, CE Department, Syracuse University	Michael Kupferman	Ithaca, NY	***The First Professional Degree***
6/00	Annual Conference of the American Society for Engineering Education	Donn Hancher	St. Louis, MO	***An Educational Model for Implementing ASCE Policy 465***
6/00	Annual Conference of the American Society for Engineering Education	Tom Lenox	St. Louis, MO	***ASCE Policy 465: What Is It? What Is It . . . NOT!***
6/00	ASCE West-Southwest Regional Department Heads' Meeting	Tom Lenox	Austin, TX	***The First Professional Degree***
6/00	Annual Conference of the American Society for Engineering Education	H. Gerald Schwartz, Jr.	St. Louis, MO	***The First Professional Degree: A Practicing Engineer's Perspective***
8/00	Exploratory Meeting of Practice-Based Masters, University of Wisconsin	Jeffrey R. Russell	Madison, WI	***MS Degree as the First Professional Degree***
9/00	West Virginia Section, ASCE	Michael Kupferman	Beckley, WV	***The First Professional Degree***

9/00	CE Colloquium	Stuart G. Walesh	Rose Hulman Institute of Technology, Terra Haute, IN	***Engineer Our Future or Others Will Engineer It For Us***
9/00	Florida Section, ASCE Annual Meeting	Michael Kupfermar	Tampa, FL	***The First Professional Degree***
10/00	National Council of Structural Engineers Associations	Luther Graef	Chicago, IL	***The First Professional Degree***
10/00	ASCE National Conference	Luther Graef	Seattle, WA	***The First Professional Degree***
10/00	ASCE National Conference	Jeffrey S. Russell	Seattle, WA	***MS Degree as the First Professional Degree***
10/00	Third Workshop on Global Engineering Education	Stuart G. Walesh	Aachen, Germany	***Engineering the Future of Civil Engineering Education in the U.S.***
11/00	ASCE Roanoke Branch Meeting	Tom Lenox	Roanoke, VA	***ASCE Policy 465: What Is It? What Is It . . . NOT!***
2/01	Capstone Course, University of Wisconsin	Stuart G. Walesh	Madison, WI	***Engineer Our Future or Others Will Engineer It For Us***
3/01	Great Lakes and Ohio Regional Society of American Military Engineers Conference	Stuart G. Walesh	Davenport, IA	***Masters as the First Professional Degree***
6/01	Annual Conference Indiana Society of Professional Engineers	Stuart G. Walesh	Indianapolis, IN	***Point/Counterpoint: The Masters as the First Professional Degree*** (counter position by W. A. Nixon)

APPENDIX H

U.S. Engineering Education Is Parallel to General Undergraduate Education While Most Other Professions Use a Series Model

ENGINEERING

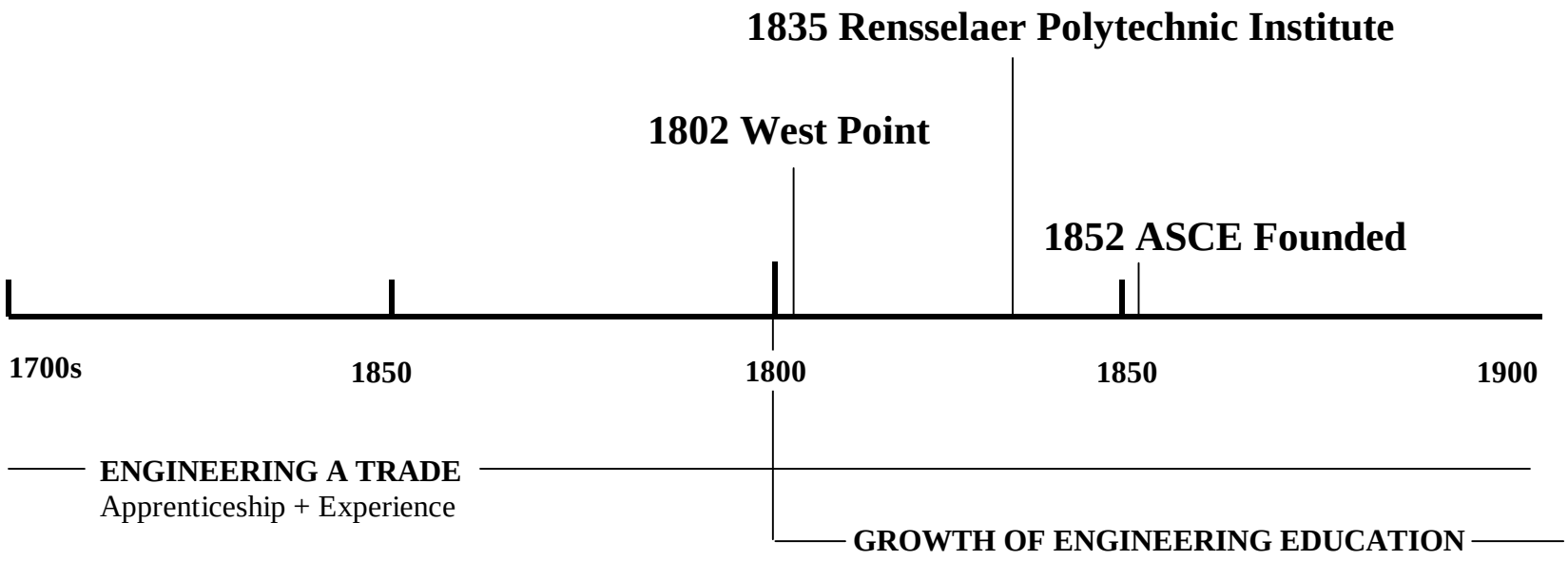


MOST* OTHER PROFESSIONS

* Dentistry, law, medicine, optometry, pharmacy, and veterinary medicine.

APPENDIX I-1

U.S. Engineering Education 1700-1900



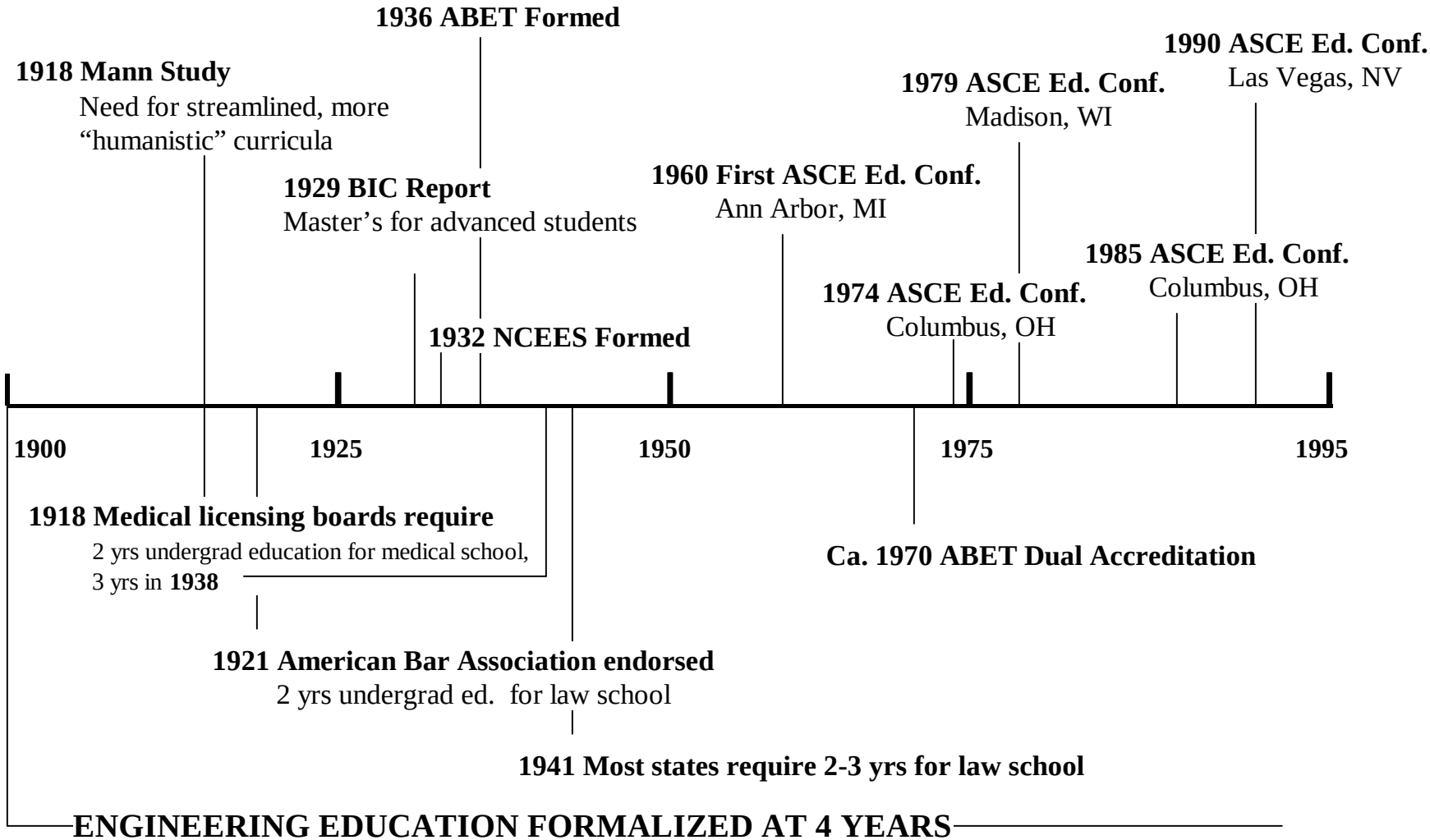
Source: Russell, J. S., 2001

MEDICINE AND LAW: 2-4 yrs education
varies widely with state and decade

ppt/history1700-1900

APPENDIX I-2

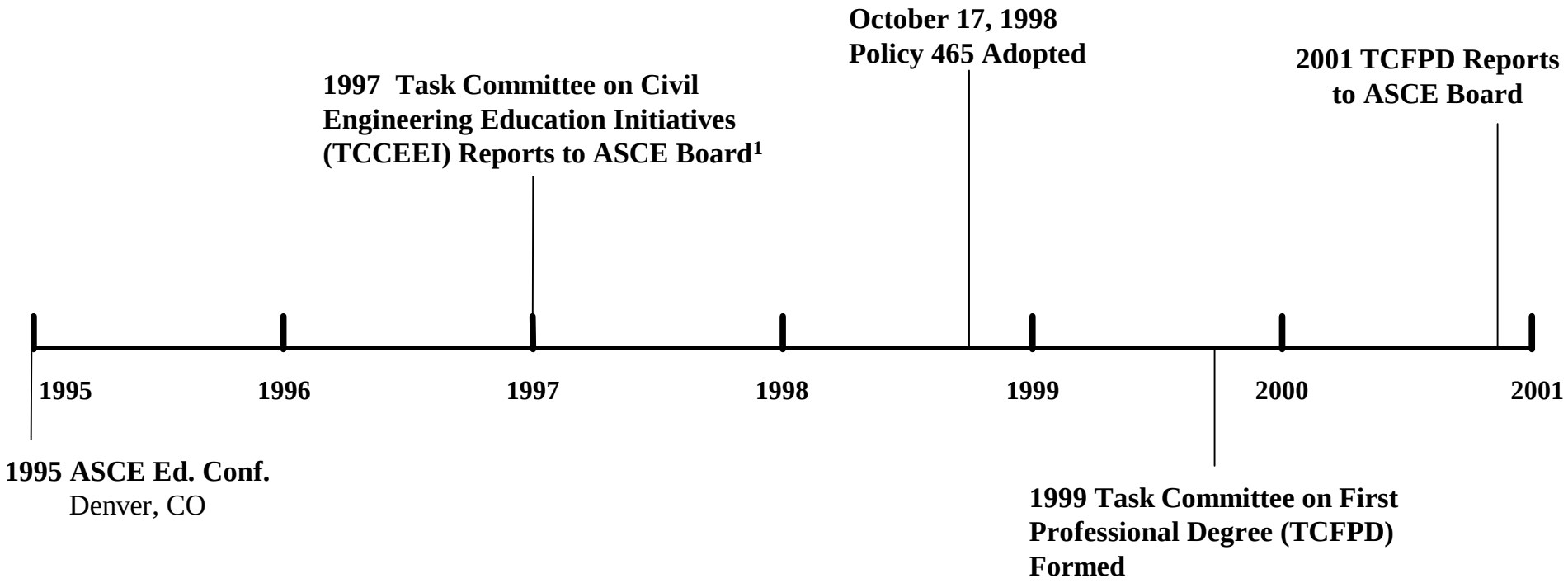
U.S. Engineering Education 1900-1995



Source: Russell, J. S., 2001

ppt/history1900-1995

APPENDIX I-3
U.S. Engineering Education 1995-2001



1) Four primary action areas for profession identified:
- faculty development
- integrated curriculum
- practitioner involvement
- the first professional degree

Source: Russell, J. S., 2001

APPENDIX J

Legal Education in the 20th Century[1]

Categories (1)	1890 (2)	1921 (3)	1970 (4)	2000 (5)
Number of Law School	61	150	147	180
Law School Students per 100,000	7	23	--	--
Prerequisites	2 to 4 years of college	2 to 4 years of college	2 to 4 years of college	2 to 4 years of college
Length of professional education	1 to 3 years	3 years	3 years	3 years

1) Law office apprenticeships provided legal education in the 18th and 19th centuries. At the turn of the century there was a rise in law schools but passing the bar examination, not a law degree, was required for practice. After the 1920's, states gradually started to require both a law degree and bar examination for practice.

Source: Thorne, B. (1973a), "Professional Education in Law," in *Education for the Professions of Medicine, Law, Theology, and Social Welfare*, ed. E.C. Hughes, McGraw-Hill, New York.

APPENDIX K

Medical Education in the 20th Century [1]

Category (1)	1900 (2)	1920 (3)	1940 (4)	1970 (5)	2000 (6)
Number Of Medical Schools	160	87	78	101	125
Physicians per 100,000	157	125	133	--	--
Pre-Medical School Requirements	Generally H.S. (Only 5 schools required 2 or more years of college)	2 years of college	Generally 3 years of college	89% of students had B.A./B.S.	--
Length of Professional Education	1 to 4 years	4 years	4 years	4 years	4 years

- 1) In the 19th century, medical education was highly unstandardized in time, curricula and theory. The Abraham Flexner report issued in 1910:
  - Was a stern critique which had an "immediate overhauling effect"
  - Led to homogeneity
  - Resulted in some schools folding or merging
  - Modeled curricula on Johns Hopkins Medical School
  - Created a new model that "helped the medical profession tighten its control over recruitment, training, and practice"

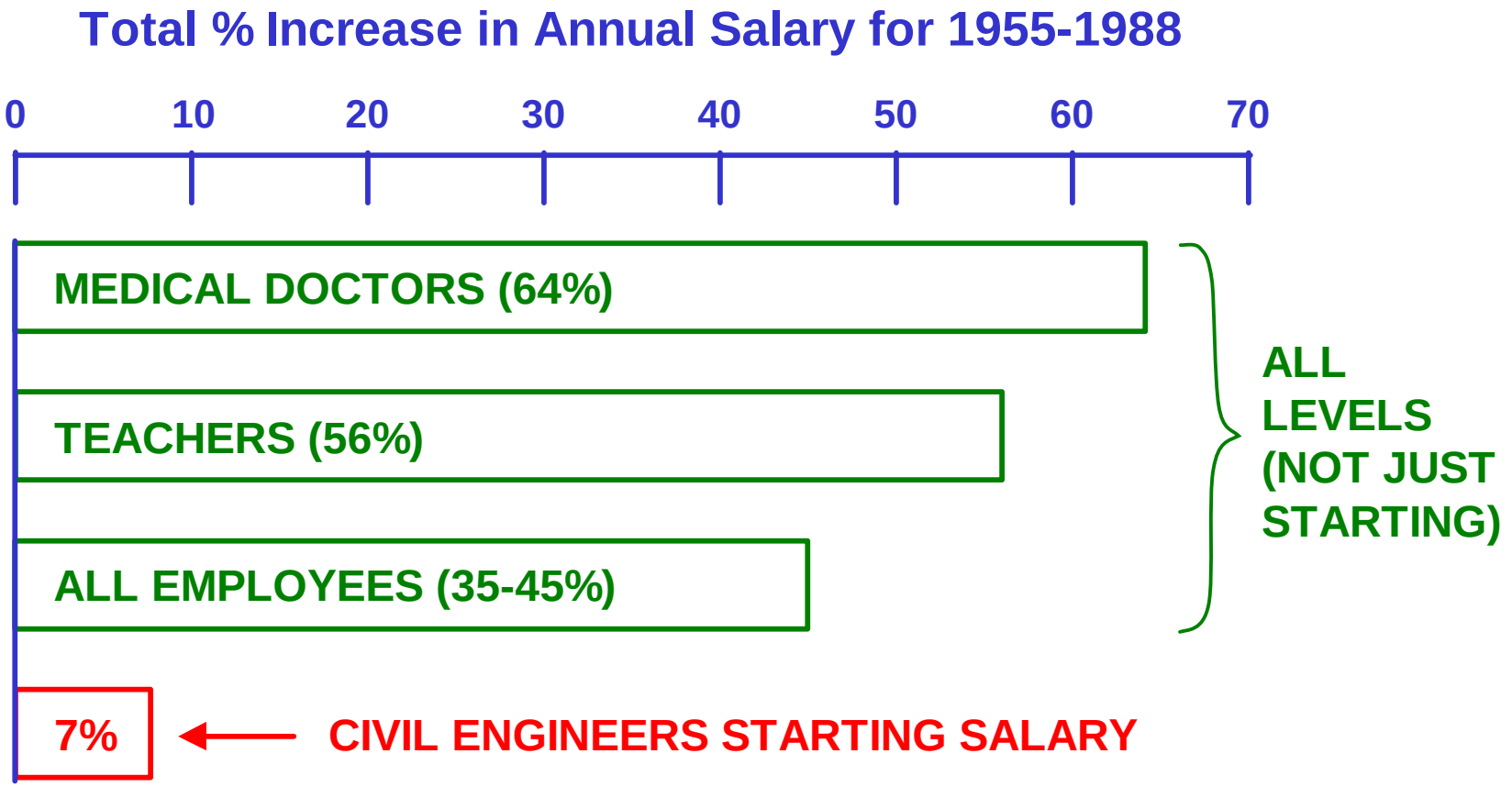
Source: Thorne, B. (1973b), "Professional Education in Medicine," in *Education for the Professions of Medicine, Law, Theology, and Social Welfare*, ed. E.C. Hughes, McGraw-Hill, New York.

APPENDIX L

COMPENSATION DATA AND INFORMATION

APPENDIX L-1

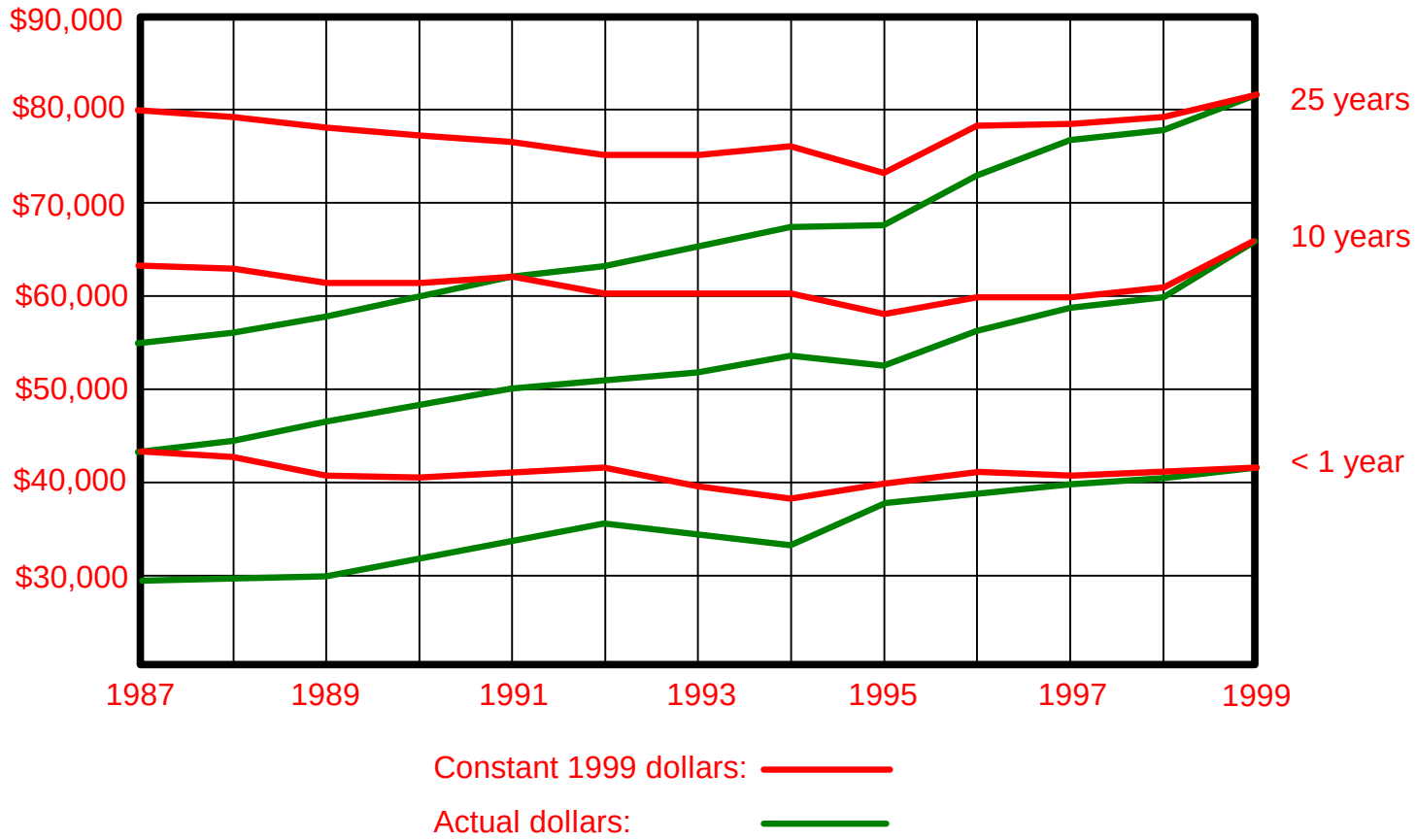
Salary Increases (1955-1988) for Various Employment Sectors



Source: Alexander, 1991

APPENDIX L-2

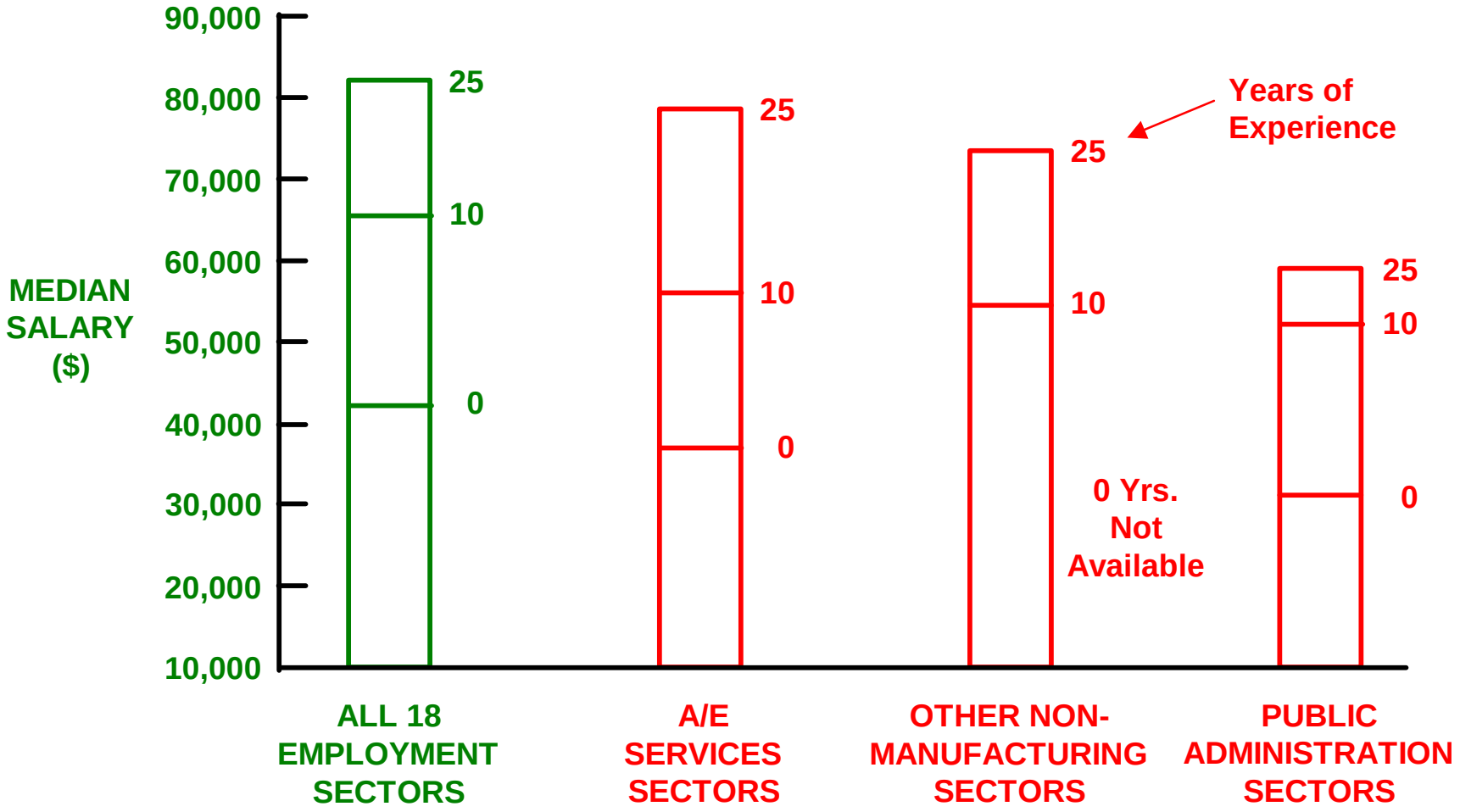
Trends in Median Compensation (1987-1999) for Engineers with Less Than 1 and with 10 and 25 Years of Experience



Source: AAES, 1999

APPENDIX L-3

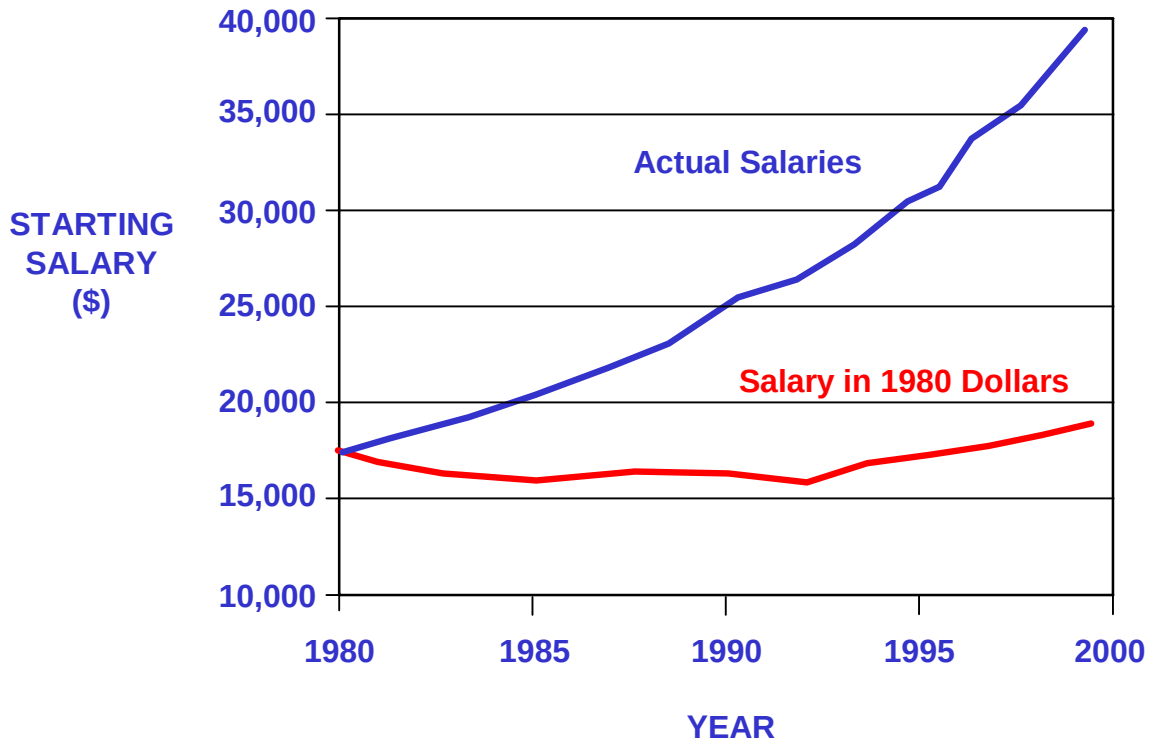
Median Salaries (1999) for All Engineering Employment Sectors Compared to Median Salaries for Sectors Likely to Include Civil Engineers



Source: AAES, 1999

APPENDIX L-4

Inflation - Adjusted Starting Salaries for Civil Engineers Have Increased Only Slightly in the Past 20 Years

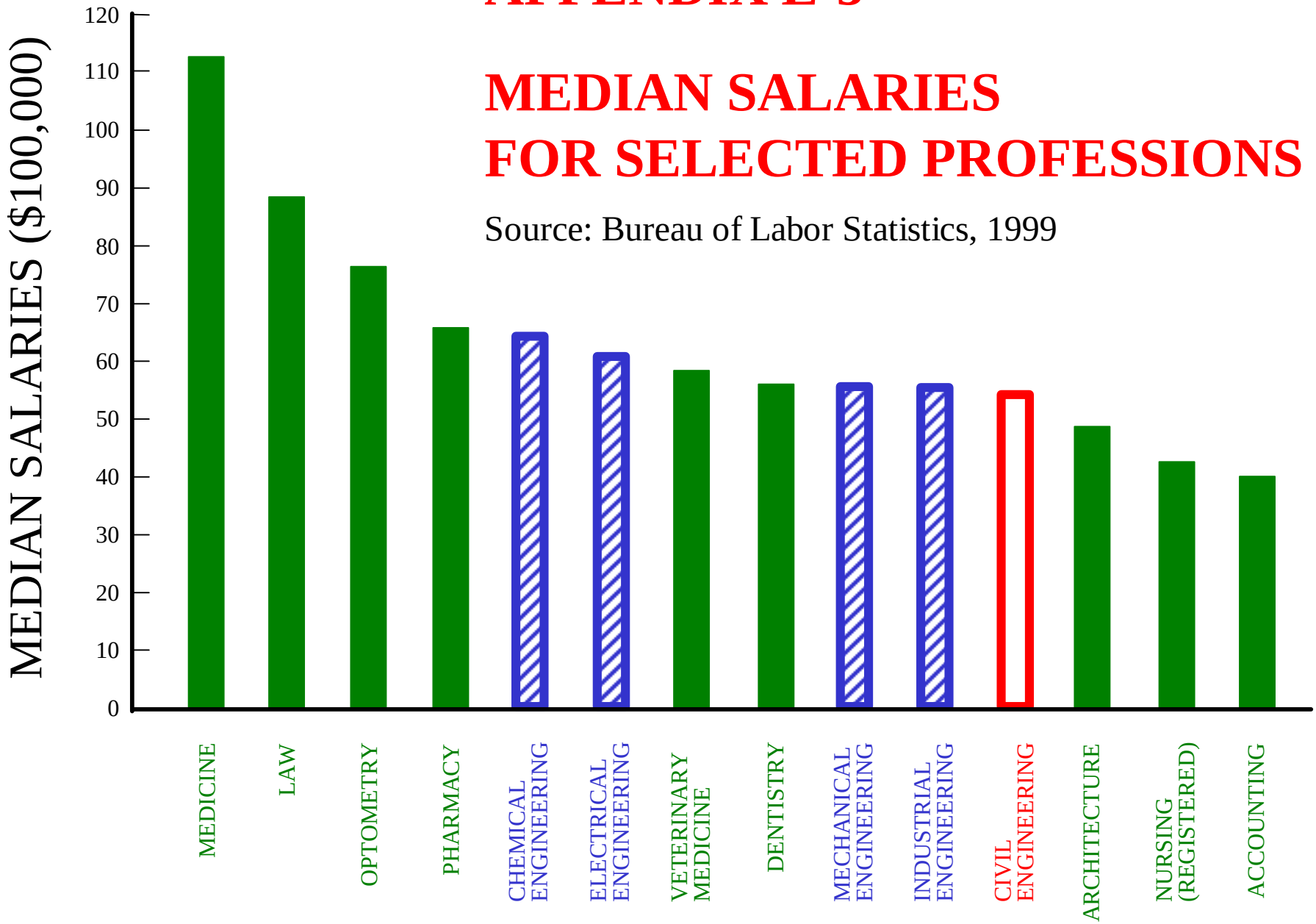


Source: Farr, 2000, Note 31.

APPENDIX L-5

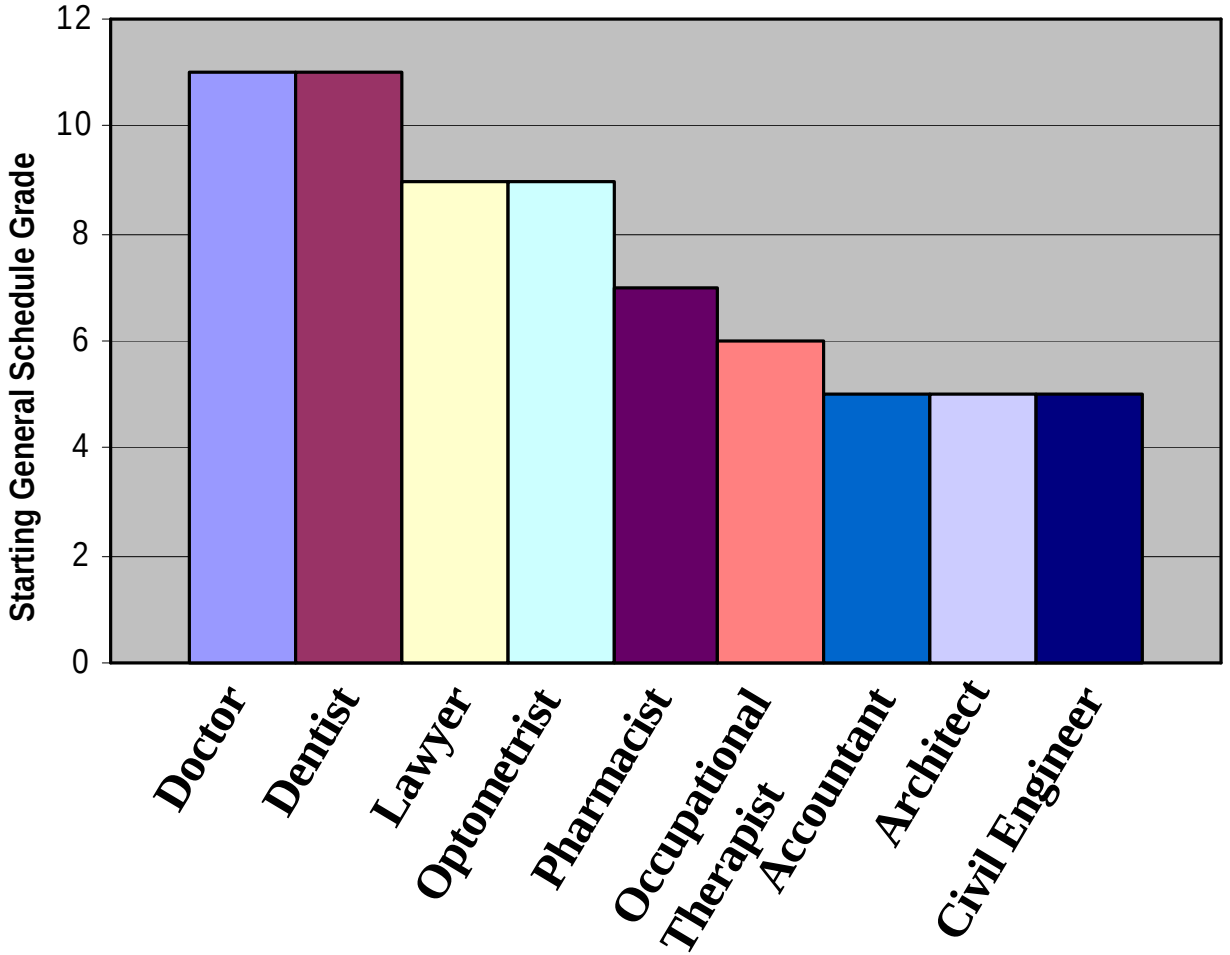
MEDIAN SALARIES FOR SELECTED PROFESSIONS

Source: Bureau of Labor Statistics, 1999



APPENDIX L-6

STARTING GENERAL SCHEDULE GRADES USED BY THE FEDERAL GOVERNMENT



APPENDIX L-7

AVERAGE 1990 AND 2000 STARTING SALARIES FOR SELECTED PROFESSIONS

Profession	Year		Change	
	1990	2000	$	% Increase
Civil Engineering	28,136	37,932	**9,796**	**35**
Accounting	26,391	36,710	**10,319**	**39**
Occupational Therapy	25,644	43,500	**17,856**	**70**
Pharmacy	36,728	64,717	**27,989**	**76**

APPENDIX M

STAKEHOLDER ACTION MATRIX

TC members:

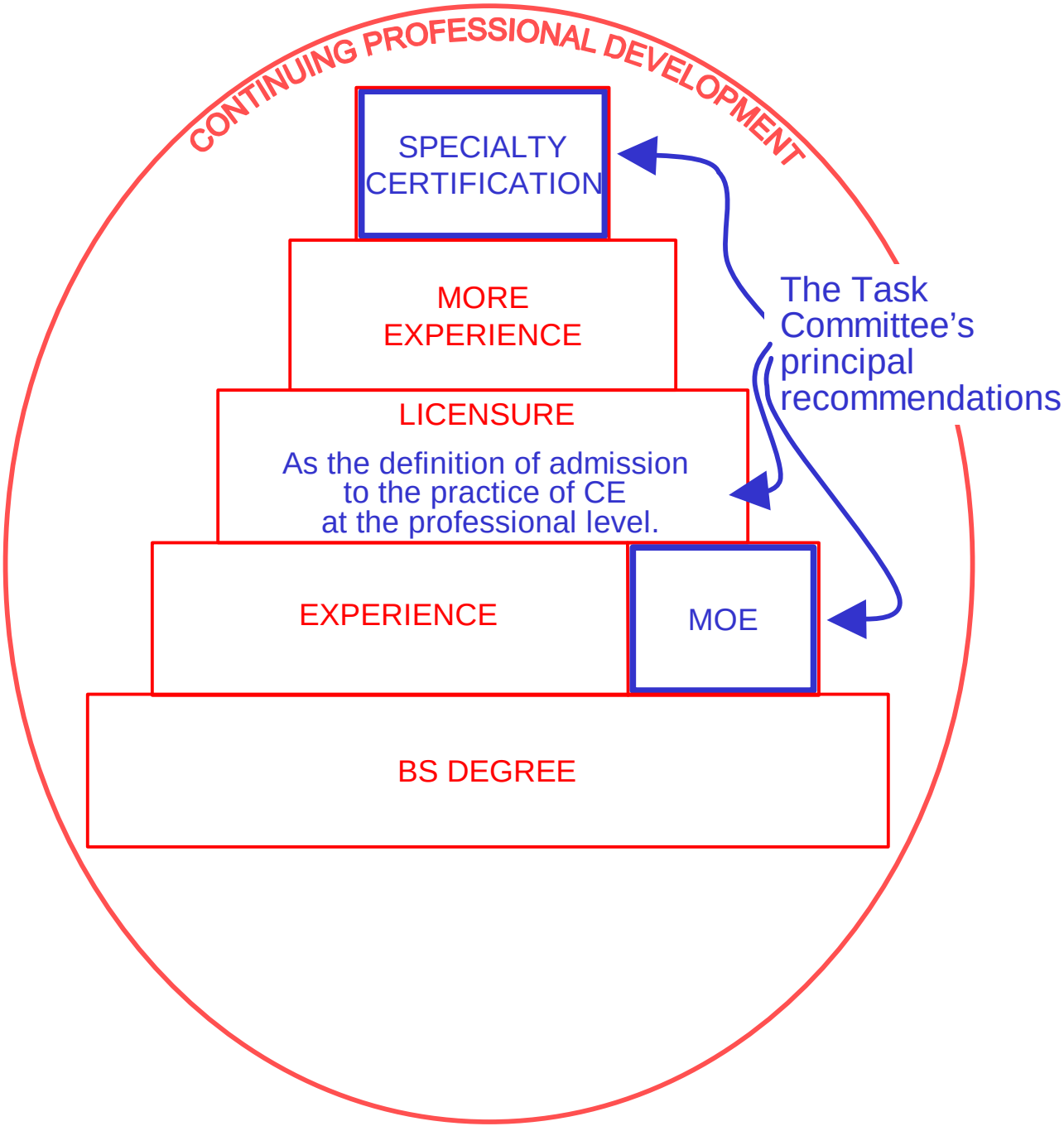
The basic matrix was drafted by Rich and Lou's suggestions are shown in bold within the body of the matrix.

Note: Numbers within the matrix reflect priority.

		ACTIONS BY OTHERS IN APPROXIMATE CHRONOLOGCAL ORDER							
	STAKEHOLDERS	Target these groups for presentations and/or anticles	Seek endorsement from these groups	Seek implementation of dual level accreditation	Seek to have MOE included in model registration law	Identify and target sympathetic registration board for implementation	Explore accreditation of post-baccalaureate, non-traditiona programs or courses	Determine/evaluate "or equal"	Seek Support for Existing 4 Yr Program
1	ABET (Accreditation Board for Engineering & Technology)	**2**	1	1	**2**	**0**	1	**2**	**1**
2	NCEES (National Council of Examiners for Engineering & Surveying)	**2**	3/**2**	**2**	1	1	**2**	**2**	**1**
3	State Registration Boards	3	**3**	**3**	1/**2**	1/**2**	**3**	**2**	**1**
4	Engineering Deans	1	1	1	**3**	**0**	1	**2**	**1**
5	Civil Engineering Department Heads	1	1	2/**1**	**3**	**0**	1	**2**	**1**
6	NSPE (National Society of Professional Engineers)	**3**	1	**2**	1	1	**2**	**2**	**1**
7	Civil Engineering Faculty	1	**2**	**3**	**0**	**0**	2	**2**	**2**
8	Board of Direction of ASCE	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**
9	General membership of ASCE	1	**0**	**0**	**0**	2	**3**	**3**	**1**
10	Leadership of ASCE's Institutes	1	1	**2**	2	**2**	1	**1**	**1**
11	Other professional engineering societies (e.g., ASME, IEEE, & AIChE)	2	2	2	2	2	2	**3**	**2**
12	AAES (American Association of Engineering Societies)	**3**	3/**2**	**2**	**3**	**0**	**0**	**0**	**2**
13	ASEE (American Society for Engineering Education)	**1**	3/**2**	1	**3**	**0**	2	**2**	**2**
14	Employers of civil engineering professionals	2	3/**0**	**3**	3	2	**2**	**2**	**1**
15	Licensed civil engineers	2	**0**	**0**	**0**	2	**3**	**3**	**1**
16	Civil engineers who have yet to become licensed but intend to do so (e.g., young professionals who have yet to complete the education and/or experience requirements for licensure)	3/**1**	**0**	**0**	**0**	**0**	**0**	**3**	**3**
17	Engineering students	3/**1**	**0**	**0**	**0**	**0**	**0**	**0**	**3**
18	High Profile Civil Engineers	**0**	1	**2**	**2**	**2**	**2**	**2**	**1**
19	High Profile Engineers from Other Disciplines	**0**	2	**3**	**0**	**3**	**3**	**3**	**2**
20	State legislators	3	**3**	**0**	3	1	**3**	**0**	**3**
21	Teachers & Counselors of middle schools and high schools	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
22	Public	3	**3**	**0**	**0**	2	**0**	**0**	**3**
23	WFEO (World Federation of Engineering Organizations)	3	**3**	**0**	**0**	**0**	**0**	**0**	**3**
24	NSF/NAE	**2**	**1**	**1**	**3**	**2**	**2**	**2**	**1**
25	Tau Beta Pi/Chi Epsilon	**3**	**1**	**2**	**0**	**0**	**3**	**3**	**1**
26	Unlicensed civil engineering graduates	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**

APPENDIX N

Strengthening the Civil Engineering Structure



Reinforcing the Foundation, Raising the Profile

APPENDIX O

Licensure and Specialty Certification are Different and Complementary

	LICENSURE	SPECIALTY CERTIFICATION
WHAT IS PRIMARY PURPOSE?	PROTECT PUBLIC SAFETY, HEALTH AND WELFARE	ENCOURAGE AND RECOGNIZE ADDITIONAL TECHNICAL EXPERTISE[1]
WHAT CRITERIA ARE USED?	FORMAL EDUCATION, EXPERIENCE, CONTINUING PROFESSIONAL DEVELOPMENT, ETHICAL BEHAVIOR	PRECEDING PLUS MORE EXPERIENCE, EDUCATION, EXAMINATION
WHO CONTROLS?	EXTERNAL TO THE PROFESSION	THE PROFESSION
WHO IN PROFESSION IS AFFECTED?	EVERYONE WHO DESIRES TO PRACTICE AT THE PROFESSIONAL LEVEL	SUBSET WHO CHOOSE HIGHLY TECHNICAL CAREER PATHS

1. A second purpose is to further protect public safety, health and welfare by expanding the cadre of technical experts.

APPENDIX P

MASTERS OR EQUIVALENT MATRIX (1)

KEY:

X = Masters or equivalent (MOE) meeting education requirements for licensure as a civil engineer (Footnote 4 indicates special cases)

O = Not masters or equivalent (Does not meet education requirements for licensure as a civil engineer)

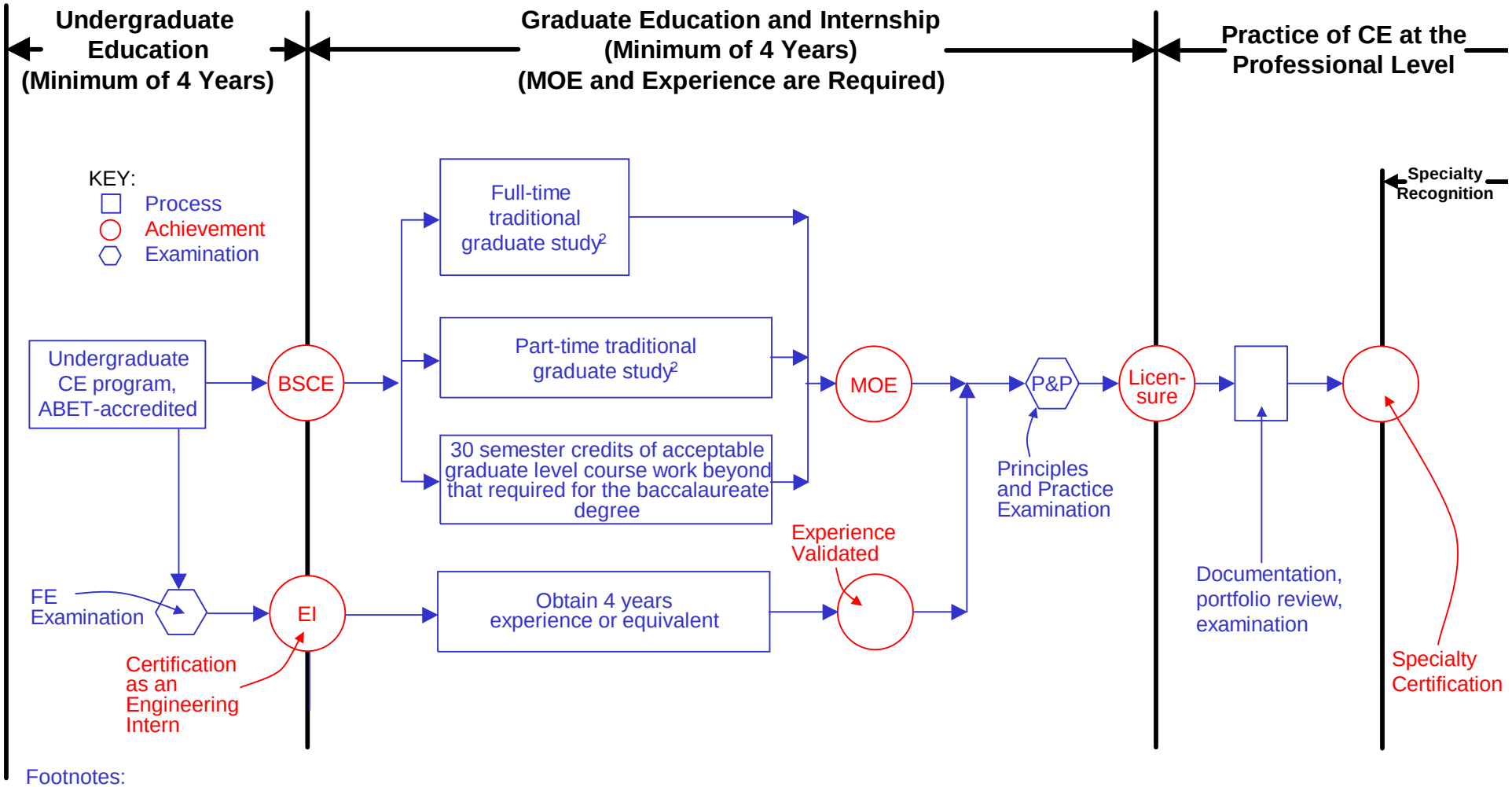
		BACHELORS DEGREE						
		CIVIL ENGINEERING		OTHER ENGINEERING		SCIENCE	CIVIL ENGINEERING TECHNOLOGY	HUMANITIES
GRADUATE DEGREE		ACCREDITED OR SUBSTANTIALLY EQUIVALENT AS DEFINED BY ABET	NOT ACCREDITED	ACCREDITED OR SUBSTANTIALLY EQUIVALENT AS DEFINED BY ABET	NOT ACCREDITED	NOT ENGINEERING (e.g., chemistry, biology)	ACCREDITED OR SUBSTANTIALLY EQUIVALENT AS DEFINED BY ABET	
MEngr or MS in CIVIL ENGINEERING	ABET ACCREDITED	X(2)	X(2)	X(2)	X(2)	X(2)	X(2)	X(2)
	NOT ABET ACCREDITED	X	O	X	O	O	O	O
MEngr or MS in OTHER ENGINEERING	ABET ACCREDITED	X(2)	X(2)	O	O	O	O	O
	NOT ABET ACCREDITED	X	O	O	O	O	O	O
MS in CONSTRUCTION MANAGEMENT	CANNOT BE ABET ACCREDITED	X	O	O	O	O	O	O
MS Not In ENGINEERING		X(3)	O	O	O	O	O	O
MS in ARCHITECTURE		X(3)	O	O	O	O	O	O
MS in CITY & URBAN PLANNING		X	O	O	O	O	O	O
MASTER of BUSINESS or PUBLIC ADMINISTRATION		X(3)	O	O	O	O	O	O
MASTERS in HUMANITIES		O	O	O	O	O	O	O
DOCTOR of MEDICINE		O	O	O	O	O	O	O
LAW		X(3)	O	O	O	O	O	O
30 semester CREDITS of acceptable graduate level course work beyond that required for the baccalaureate degree		X	O	X(3)	O	O	O	O
PhD or DE in CIVIL ENGINEERING		X	X(4)	X	X(4)	X(4)	X(4)	O
PhD or DE in OTHER ENGINEERING		X	O	O	O	O	O	O
PhD in Science		X(3)	O	O	O	O	O	O
PhD in Humanities		O	O	O	O	O	O	O

Footnotes:

1. The commonality to all MOE's is an ABET accredited engineering degree and a civil engineering degree. In a few cases, they are one in the same.
2. These nine options require accredited masters degrees in civil or some other engineering.
3. The candidate for licensure as a civil engineer must demonstrate to the licensing body that the attainment of this degree, in conjunction with an accredited or substantially equivalent undergraduate degree in civil engineering, will promote the health, safety and welfare of the public in the performance of the candidate's professional employment.
4. The candidate for licensure as a civil engineer must demonstrate to the licensing body how his or her education compensates for the lack of an accredited or substantially equivalent undergraduate engineering degree.

APPENDIX Q

MANY OPTIONS WILL BE AVAILABLE TO THE BSCE HOLDER WHO SEEKS TO PRACTICE CIVIL ENGINEERING AT THE PROFESSIONAL LEVEL[1]



Footnotes:

1) These options apply to individuals who elect to start the education-experiencing-licensing-certification process by earning a baccalaureate degree in CE from an ABET-accredited program. For other ways to achieve the goal of practicing CE at the professional level, see Appendix N, Columns 2 through 6.

2) Examples of eligible graduate study areas are CE, other engineering, construction management, science, architecture, and city and urban planning.

APPENDIX R

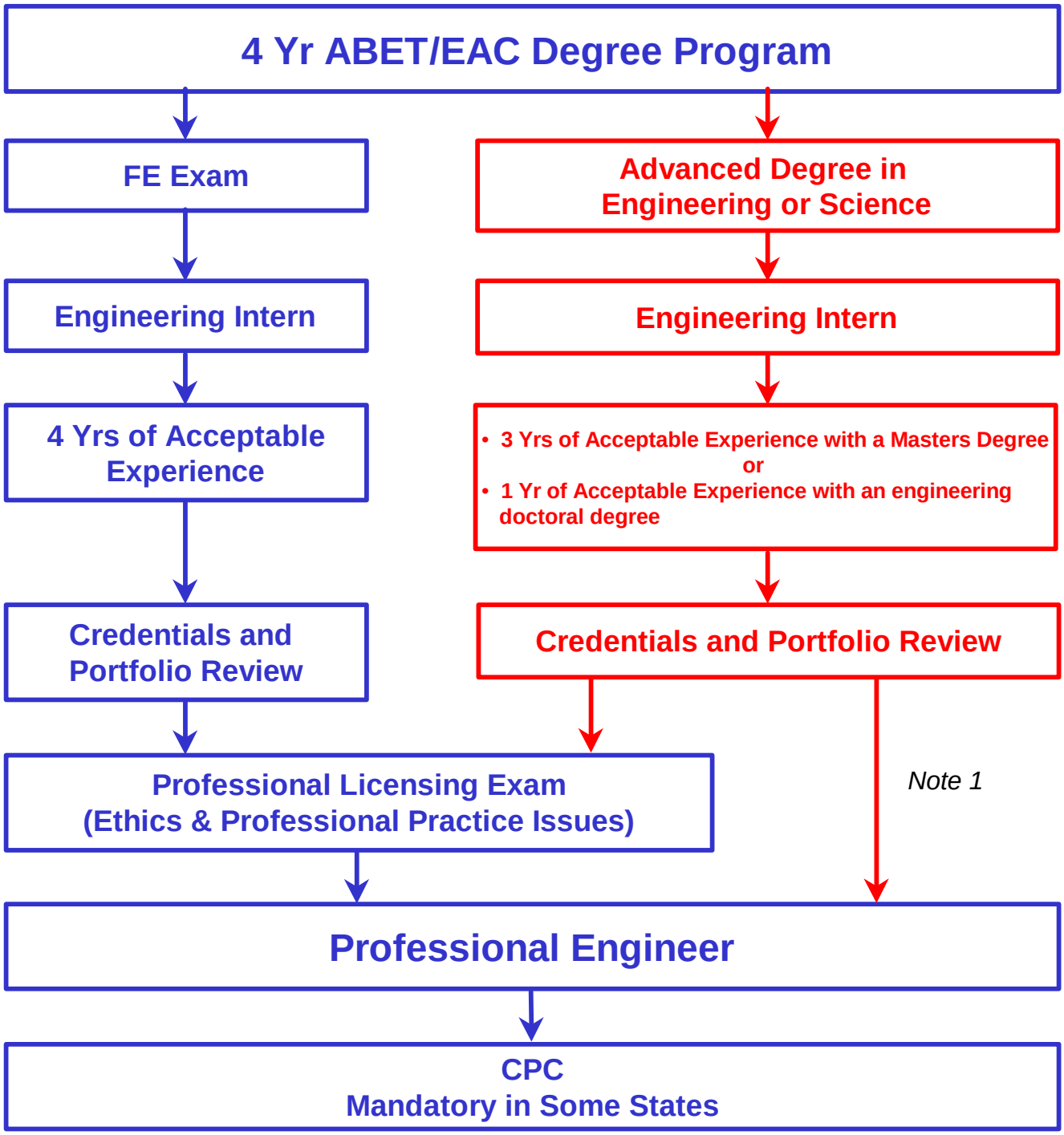
Types of Masters Programs Available to Civil Engineers

FOCUS OF MASTER'S PROGRAM	POSSIBLE CURRICULAR FOCUS AREAS	EXAMPLES OF DEGREES	POSSIBLE CAREER TRACKS
Technical practice/research	Structures, environmental, transportation, materials, construction, water resources, geographic information, and geotechnical	MS MSCE MEnvE	Research Teaching Technical expert
Project management	Human resource management, cost estimation, accounting, logistics, total quality management, and communication	MS MSCE MBA	Project manager Construction manager
Organizational management	Strategic planning, organization design, finance/insurance, and public policy	MS MBA, MPA MA in Planning	Manager of engineering or construction firm or municipal, state or federal entity

Source: Russell, J. S., B. Stouffer and S. G. Walesh (2000), Note 5.

APPENDIX S

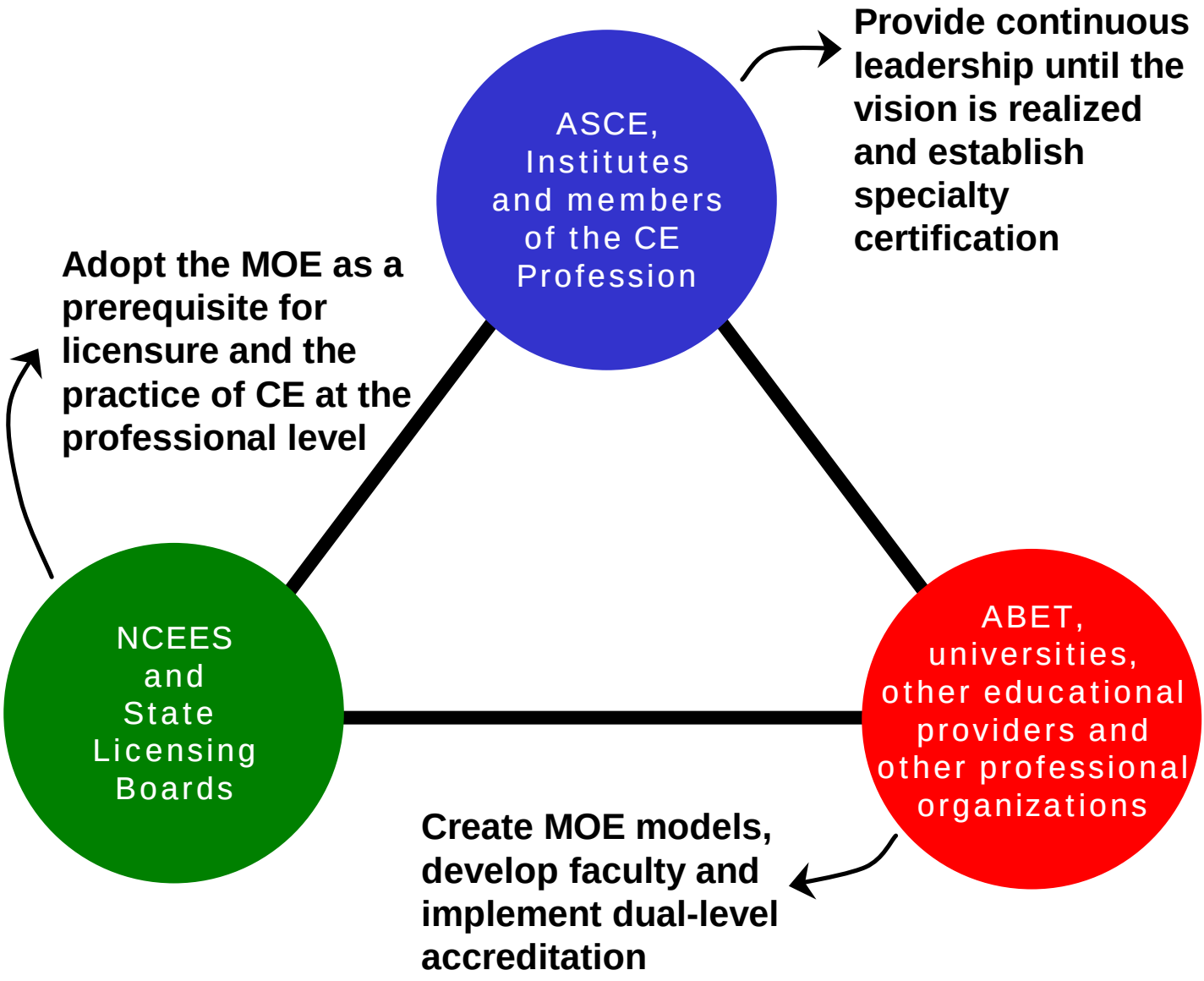
Model Licensure Law, Adopted by NSPE in 2000, Which Includes a New Advanced Degree Path.



Note 1: *The Professional Licensing Exam may be waived if the advanced degree curriculum included substantial ethics and professional practice issues.*

APPENDIX T

Principal Participants in the Partnership to Implement the Baccalaureate-Masters or Equivalent Combination as a Prerequisite for Licensure and Entry Into the Practice of Civil Engineering at the Professional Level



APPENDIX U

IMPLEMENTATION PLAN: ACTION ITEMS SUPPORTING TASKS, PRINCIPAL PARTICIPANTS & SCHEDULE

ACTION ITEM	SUPPORTING TASK	PRINCIPAL PARTICIPANTS						YEARS									
		Group 1		Group 2		Group 3											
		ASCE	Employers	NCEES	State Licensing Boards	ABET and other organiza-tions serving civil engineers	Universities & other educational providers	01 02	03 04	05 06	07 08	09 10	11 12	13 14	15 16	17 18	19 20
A.																	
ASCE leads through continuous interaction with other stakeholders	1. Approve Refined Policy Statement 465	X						X									
	2. Form Implementation/Steering Committee	X						X									
	3. Accept and endorse report	X															
	4. Distribute report to leaders of NCEES, ABET and founder societies and others as appropriate	X						X									
	5. Interact with stakeholders	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	6. Ask the ASCE Committees on Professional Practice and Education Activities and the Institutes to support the report's recommendations	X						X	X	X	X	X	X	X	X	X	X
	7. Ask professional societies and organizations to support the BS-MOE as a prerequisite for the practice of CE at the professional level	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	8. Revisit ASCE membership grade entrance requirements	X						X	X								

ACTION ITEM	SUPPORTING TASK	PRINCIPAL PARTICIPANTS						YEARS									
		Group 1		Group 2		Group 3		01 02	03 04	05 06	07 08	09 10	11 12	13 14	15 16	17 18	19 20
		ASCE	Employers	NCEES	State Licensing Boards	ABET and other organiza-tions serving civil engineers	Universities & other educational providers										
B.																	
Licensing jurisdictions adopt the BS-MOE as a requirement for the practice of CE at the professional level	1. Review the change processes used by other professions	**X**		**X**	**X**			**X**									
	2. Prioritize licensing jurisdictions	**X**		**X**	**X**			**X**									
	3. Prepare fact sheets & guidelines	**X**		**X**	**X**			**X**									
	4. Convince state legislators & regulators	**X**	**X**	**X**	**X**				**X**								
	5. Refine the Model Licensure Law			**X**	**X**			**X**	**X**								
	6. Pass legislation and/or adopt rules	**X**	**X**		**X**				**X**	**X**[1]	**X**	**X**[2]	**X**	**X**	**X**[3]	**X**	**X**[4]
	7. Encourage employees to obtain licensure		**X**					**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
	8. Urge users of CE services to more rigorously require licensed civil engineers to be responsible for CE projects	**X**	**X**	**X**	**X**					**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**

Footnotes:
1. A total of 5 jurisdictions in 5 years.
2. A total of 10 jurisdictions in 10 years.
3. A total of 20 jurisdictions in 15 years.
4. All jurisdictions in 20 years.

ACTION ITEM	SUPPORTING TASK	PRINCIPAL PARTICIPANTS						YEARS									
		Group 1		Group 2		Group 3											
		ASCE	Employers	NCEES	State Licensing Boards	ABET and other organizations serving civil engineers	Universities & other educational providers	01 02	03 04	05 06	07 08	09 10	11 12	13 14	15 16	17 18	19 20
C.																	
ABET, universities & others revise CE curricula, programs & culture	1. Obtain input from individual practitioners and employers		**X**				**X**	**X**									
	2. Emphasize role of employers in partnering with employees on MOE and continuing education		**X**					**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
	3. Select BS-MOE models and design curricula						**X**	**X**	**X**								
	4. Develop BS-MOE certification criteria	**X**	**X**	**X**	**X**	**X**	**X**		**X**								
	5. Provide faculty development	**X**	**X**				**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
	6. Develop accreditation criteria including providing dual level accreditation	**X**				**X**	**X**		**X**	**X**							
	7. Obtain accreditation					**X**	**X**			**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
	8. Explore the professional school model						**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**

ACTION ITEM	SUPPORTING TASK	PRINCIPAL PARTICIPANTS						YEARS									
		Group 1		Group 2		Group 3											
		ASCE	Employers	NCEES	State Licensing Boards	ABET and other organiza-tions serving civil engineers	Universities & other educational providers	01 02	03 04	05 06	07 08	09 10	11 12	13 14	15 16	17 18	19 20
D.																	
ASCE Institutes lead the development of specialty certification	1. Identify interested Institutes	X						X									
	2. Explore relationships with other professional societies	X				X		X	X								
	3. Prepare common criteria	X	X						X	X							
	4. Pilot the specialty certification program with one Institute	X								X	X						
	5. Expand the specialty certification program with other Institutes	X										X	X	X	X	X	X
	6. Encourage practitioners to obtain specialty certifications		X							X	X	X	X	X	X	X	X
	7. Urge users of specialized CE services to require participation by civil engineers	X	X							X	X	X	X	X	X	X	X

APPENDIX V

Suggested Revisions to
ASCE Policy Statement 465

NOTE: Major changes are noted in **BOLD**

ASCE POLICY STATEMENT 465
ACADEMIC PREREQUISITES
FOR
LICENSURE AND PROFESSIONAL PRACTICE

Policy

The American Society of Civil Engineers (ASCE) supports the concept of the Master's degree or Equivalent as a prerequisite for licensure and the practice of civil engineering at a professional level.

ASCE encourages institutions of higher education, governmental units, employers, civil engineers, and other appropriate organizations to endorse, support, and promote the concept of mandatory post-baccalaureate education for the practice of civil engineering at a professional level. The implementation of this effort should occur through establishing appropriate curricula in the formal education experience, appropriate recognition and compensation in the workplace, and congruent standards for licensure.

Issue

The practice of civil engineering at the professional level means practice as a licensed professional engineer. Admission to the practice of civil engineering at the professional level means professional engineering licensing which requires:

- **A body of specialized knowledge as reflected by a combination of a baccalaureate degree and a master's or equivalent (MOE)**
- **Appropriate experience**
- **Commitment to life long learning**

The required body of specialized knowledge includes a technical core, technical electives, a non-technical core and technical and non-technical courses to support individual career objectives. The current baccalaureate civil engineering degree is

an entry level degree that is inadequate preparation for the practice of civil engineering at the professional level.

The civil engineering profession is undergoing significant, rapid, and revolutionary changes that have increased the body of knowledge required of the profession. These changes include the following:

- Globalization has challenged the worldwide geographic boundaries normally recognized in the past, primarily as a result of enhanced communication systems.

- Information technology has made, and continues to make, more information available; however, the analysis and application of this information is becoming more challenging.

- The diversity of society is challenging our traditional views and people skills.

- New technologies in engineering and construction are emerging at an accelerating rate.

- Enhanced public awareness of technical issues is creating more informed inquiry by the public of the technical, environmental, societal, political, legal, aesthetic, and financial implications of engineering projects.

- Civil infrastructure systems within the United States are rapidly changing from decades of development and operation to the renewal, maintenance and improvement of these systems.

These changes have created a market requiring civil engineers to have simultaneously greater breadth of capability and specialized technical competence than that required of previous generations. For example, many civil engineers must increasingly assume a different primary role from that of designer to that of team leader. **The knowledge required to support this new market is found in the combination of an appropriate baccalaureate education and the completion of post-graduate courses sufficient to attain a master's degree or its equivalent.**

Rationale

Requiring education beyond the baccalaureate degree for the practice of civil engineering at the professional level is consistent with other learned professions. The body of knowledge gained, and the skills developed in the formal civil engineering education process, are not significantly less than the comparable knowledge and skills **required** in these other professions. **It is not reasonable in such complex and rapidly changing times to think that we can impart the specialized body of knowledge and skills required of professional engineers in four years of formal schooling while other learned professions take seven or eight years.** Four years of formal schooling were considered the standard for three professions (medicine, law, and engineering) 100

years ago, and while medicine and law education lengthened with the growing demands of their respective professions engineering education did not. Perhaps this retention of a four-year undergraduate engineering education has contributed to the lowered esteem of engineering in the eyes of society, and the commensurate decline in compensation of engineers relative to medical doctors and lawyers.

Current baccalaureate programs, while constantly undergoing review and revisions, still retain a nominal four-year education process. This length of time limits the ability of these programs to provide a formal education consistent with the increasing demands of the practice of civil engineering at the professional level. There are diametrically opposed forces trying to squeeze more content into the baccalaureate curriculum while at the same time reducing the credit hours necessary for the baccalaureate degree. The result is a production line baccalaureate civil engineering degree satisfactory for an entry-level position, but inadequate for the professional practice of civil engineering. The four-year internship period (engineer-in-training) after receipt of the BSCE degree cannot make up for the formal educational material that would be gained from a master's degree **or equivalent** program.

The implementation of this concept will not happen overnight, nor can ASCE mandate that it be done in a specified time period. This concept is a legacy for future generations of civil engineers. However, perhaps the most important aspect of the implementation of this policy is already in place. Within the U.S. system of higher education, high quality, innovative and diverse master's degree programs currently exist in colleges and universities to support this concept. **A growing number of organizations now offer high quality on-site and distance learning educational opportunities.** The active support of this policy by all of the stakeholders in this process, such as the educational institutions, the registration boards, and the various employers of civil engineers, will be required to develop and promote the elements necessary to eventually implement this concept.

NOTES

BACKGROUND

1. For discussion of the history of civil engineering education, see Florman, S.C. (1985). "Why Can't We Be Better Than We Are?", *The Bent of Tau Beta Pi*, Winter, pp. 26-27; Florman, S.C. (1987). *The Civilized Engineer*, St. Martins Press, New York, NY; and Kerr, O.S. (1995). "The Economics and History of Engineering Education," *The Bent of Tau Beta Pi*, Fall 1995, pp. 9-11.

2. Tarkov, J. (1989), "Engineering the Erie Canal," *Sons of Martha: Civil Engineering Readings in Modern Literature*, Collected and edited by A.G. Fredrich, ASCE, pp. 279-286.

3. Florman, S.C. (1987). *The Civilized Engineer*, St. Martins Press, New York, NY.

4. Kerr, O.S. (1995). "The Economics and History of Engineering Education," *The Bent of Tau Beta Pi*, Fall 1995, pp. 9-11.

5. Russell, J.S., B. Stouffer and S.G. Walesh (2000). "The First Professional Degree: A Historic Opportunity," *Journal of Professional Issues in Engineering Education and Practice - ASCE*, Vol. 126, No. 2, April, pp. 54-63.

6. ASCE (1995). *Summary Report – 1995 Civil Engineering Education Conference*, Denver, CO, June.

THE ISSUE

7. Russell, J., J.T.P. Yao, J.V. Farr, J.C. Bishop and S. Walesh (1996). "Consensus! Students Need More Management Education," *Journal of Management in Engineering - ASCE*, Vol. 12, No. 6, November/December, pp. 17-29 and Walesh, S. G. (2000), *Engineering Your Future: The Non-Technical Side of Professional Practice in Engineering and Other Technical Fields*, ASCE Press, Chapter 1. The leadership, management and production functions can also be labeled deciding, directing and doing.

8. Walesh, S.G. (2000). "Engineering a New Education," *Journal of Management in Engineering - ASCE*, Vol. 16, No. 2, March/April, pp. 35-41.

9. Walesh, S.G. (2000). "Engineering a New Education," *Journal of Management in Engineering - ASCE*, Vol. 16, No. 2, March/April, pp. 35-41.

10. For examples see Hissey, T. W. (2000). "Enhanced Skills for Engineers," *Proceedings of the IEEE*, Vol. 88, No. 8, August. The author interviewed industry executives and managers, government leaders, and academic leaders from around the

world during the three year 1997 through 1999 period. The message: graduate engineers do not possess soft skills in either the quantity or quality required. These skills include "…written and oral communications aptitude, marketing-related knowledge, and familiarity with business and financial matters."

11. For additional discussion of inadequacies, see Dahir, M. (1993). "Educating Engineers for the Real World: Survey of Engineer's Educational Experience," *MI's Technological Review,* Vol. 96, No. 6, p. 14; Florman, S.C. (1996). "The Whole Engineer, Role of Non-Technical Subjects in the Engineering Curricula," *MIT's Technological Review,* Vol. 99, No. 3, p. 67; Kersten, R.K. (1996). "Engineering Education: Paragon or Paradox," *Journal of Professional Issues in Engineering Education and Practice - ASCE,* Vol. 122, No. 4, pp. 147-150; Russell, J.S., S.K.A. Pfatteicher, and J.R. Meier (1997). "What You Can Do to Improve Engineering Education," *Journal of Management in Engineering - A*SCE, Vol. 13, No. 6, pp. 37-41; and Walesh, S.G. (2000). "Engineering a New Education," *Journal of Management in Engineering - ASCE,* Vol. 16, No. 2, March/April, pp. 35-41.

12. Walesh, S.G. (2000). "Engineering a New Education," *Journal of Management in Engineering - ASCE,* Vol. 16, No. 2, March/April, pp. 35-41.

13. Russell, J.S., B. Stouffer and S.G. Walesh (2000). "The First Professional Degree: A Historic Opportunity," *Journal of Professional Issues in Engineering Education and Practice - ASCE,* Vol. 126, No. 2, April, pp. 54-63.

14. Accreditation Board for Engineering and Technology (ABET), (1997). *Engineering Criteria 2000*, Third Edition, December. What ABET calls the Professional Component specifies subject areas (not specific courses) and consists of one year of mathematics and basic sciences, one and one-half years of engineering sciences and design, and a complementary general education component. This is essentially unchanged.

15. "Develop leadership to broaden our members' perspectives and to enhance their career growth" is the first of four ASCE goals. See ASCE (2000). *Building ASCE's Future: Strategic Plan*.

16. L. Botstein, in his short article "Original Ideas Come From Reassembling Knowledge in New Ways," (*Fast Company*, October, 2000, p. 104), argues that the educational breadth of technology professionals should include the humanities. He says:

> *Contrary to what today's focus on high technology might imply, the humanities are more relevant than ever. Subjects like philosophy, history, and literature teach you how to interpret information and how to argue a point of view. That kind of sophisticated learning is a requirement for innovation and for entrepreneurship. Not only the written arts but also music and the visual arts will become increasingly important. Music, for example, teaches*

valuable lessons about time and space. Similarly, visual thinking is critical to using computers and to manipulating images across multiple dimensions.

17. Elliot, R.P. (1998). "Crisis in Engineering Education: Survey of Civil Engineering Curriculums," Forum, *Journal of Professional Issues in Engineering Education and Practice - ASCE*, Vol. 124, No. 1, January, pp. 8-10.

18. Russell, J.S., B. Stouffer and S.G. Walesh (2000). "The First Professional Degree: A Historic Opportunity," *Journal of Professional Issues in Engineering Education and Practice - ASCE,* Vol. 126, No. 2, April, pp. 54-63.

19. Barter, M. S. (2000). "Is Separate Licensing Feasible Without Education Reform?", *STRUCTURE*, Fall, pp. 7-8. Marc S. Barter, President of the National Council of Structural Engineers Associations, argues that even if separate licensing of structural engineers occurs, it will be less than optimum if not linked to educational reform. He states " An ordinary four-year engineering program no longer provides graduates with the advanced-level expertise necessary to enter the workforce as structural engineering interns."

20. Porter, M. L. (2001). "Employing Big," *Structure*, March, p. 4.

21. Drucker, P. R. (1999). "Beyond the Information Revolution," *The Atlantic Monthly*, Vol. 284, No. 4, pp. 47-57, available on line at http://www.theatlantic.com/issues/99oct/9910drucker.thm.

22. Gibbons, J. H. (2000). "Editorial – Toward Equilibrium." *The Bridge*, Vol. 30, No. 3 & 4, Fall/Winter 2000, pp. 3-4, available on line at http://www.nae.edu/nae/naehome.nsf/weblinks/NAEW-4STKP9?OpenDocument.

23. Wulf, W. A. (2000). " Great Achievements and Grand Challenges." (a revised version of a talk given on October 22 at the 2000 NAE Annual Meeting, available on line at http://www.nae.edu/nae/naehome.nsf/(attachmentweb)/WulfSpeech.pdf/$FILE/WulfSpeech.pdf.)

24. See Davis, R. (2000). "Supervision Debate Roils PE's in Government," *Engineering Times*, Vol. 22, No. 10. According to the author, "troubling to engineers across the country are the reported cases of non-engineers replacing PE's in government positions and, in the worst cases, influencing or making engineering decisions that they may not be qualified to deliver." The argument for non-engineers increasingly managing engineers is that "individuals who may not be PE's—but possess exceptional leadership, communication, and business skills—can lead a department of engineers more effectively than PE's if they are not performing engineering and are stronger in these other key areas." An editorial in the same issue of *Engineering Times* suggests possible solutions including more widespread licensure, promoting the engineer's image and developing business and communication skills.

25. Civil Engineering Research Foundation (no date). "The Future of the Design and Construction Industry: Where Will You Be In 10 Years?", ASCE.

26. The federal Office of Personnel Management (OPM). "…is responsible for establishing and enforcing federal government hiring policies." According to OPM guidelines, completion of 60 semester credits in an engineering curriculum is sufficient to be titled an engineer within the federal government. Neither an engineering degree nor an engineering license are required. In contrast, use of the titles physician and attorney requires licensure. This is an example of a federal policy that falls short of protecting the public and places engineering in a secondary status. Source: Ruggieri, J. (2001). "Nonlicensure Criteria Tantamount to Playing Regulatory Roulette," *Engineering Times*, April, p. 31.

27. Alexander, J. A. (1991). "Professionalism and Marketing of Civil Engineering Profession," *Journal of Professional Issues in Engineering Education and Practice – ASCE,* Vol. 117, No. 1, January, pp. 10-20.

28. American Association of Engineering Societies, Engineering Workforce Commission. (1999). *Engineers*, October, 8 pages.

29. American Association of Engineering Societies, Engineering Workforce Commission. *Professional Income of Engineers: 1998.*

30. *Civil Engineering* (2001). "Civil Engineering Project Managers Are Among the Best Paid," February 2, p. 18. The Project Management Institute conducted a survey of its 70,000 worldwide members and received 1,290 responses. Mean year 2000 compensation for engineering project managers was as follows:

Industrial	$88,435
Electrical	87,097
Civil	84,187
Mechanical	81,067
Electronics	76,725
Other	74,278
Environmental	72,780

31. Farr, J. V. (2000). "Commodities and Value Based Pricing of Engineering Services," draft paper to be published in the *Journal of Management in Engineering – ASCE* (The author states the following about the graph: "This information was pieced together from a wide variety of sources to include ASCE magazine, http://www.jobweb.org and NSPE. For current version of the paper and other matters, contact the author at jfarr@stevens-tech.edu.)

32. Bureau of Labor Statistics salary data are available at http://stats.bls.gov/oes/1999/oes170000.htm.

33. Murphy, C. (2001). "How Can Your Firm Overcome the Shortage?", *Structural Engineer*, January, pp. 30-34. According to the author, U.S. CE enrollments are dropping partly because of low starting salaries compared to computer science and other engineering fields. From 1994 to 1999, total undergraduate civil and environmental engineering enrollment dropped by 27.8 percent, from 48,167 to 34,769. Source: ASCE (2000). *1999 Civil and Environmental Engineering Enrollment Data*, November, p. 3. Bachelor's degrees awarded annually in civil and environmental engineering peaked in 1996 at 11,747 and, by 1999, had dropped 10.6% to 10,498. Source: ASCE (2000). *1999 Civil and Environmental Engineering Degree Data*, revised edition, July, p. 3.

34. See Michael, H. L. (1989). "Attracting Students to a Professional Career in Transportation Engineering," *Proceedings of the 75th Annual Road School*, Purdue University, March 7-9, pp. 4-15. Michael reports on the quality of CE students compared to other engineering students. He observes "…civil engineering students are at the bottom," compared to other engineering students, in academic ability, by-high school rank, SAT scores and freshman grade-point average. He refers to another study, saying "…McDonough of the University of Cincinnati…surveyed 127 engineering schools and found both ACT composite scores and SAT combined math/verbal scores of civil engineering students were lower than those of chemical, electrical and mechanical engineering students."

IMPLEMENTATION OF THE VISION

35. See Lewis, Jr., L. G. (1999). "A Model for Engineering Practice In the Twenty-First Century," *THE BENT of Tau Beta Pi*, Summer, pp. 12-15. He also argues for base level licensing, referring to it as generic licensure, followed by specialty certification.

36. Confederation of European Rector's (1999). "Trends in Learning Structures in Higher Education," background paper for the Bologna Forum, June, 1999.

37. Liang, D., W. Shepherd, and B. Manhire (2000). "Changes in Engineering Education in the United Kingdom," ASEE Annual Conference, St. Louis, MO. (http://www.asee.org/conferences/search/20059.pdf).

38. Grose, T.K. (2000). "Re-Engineering in Germany," *PRISM on-line*, March, (http://www.asee.org/prism/march00/germany.cfm; Available only to ASEE members).

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40. Detert, K. (1999). "New Engineering Curricula in Germany: An Attempt to Modernize and Globalize Engineering Education," *Global Journal of Engineering Education*, Vol. 3, No. 2, pp. 85-93, (http://www.eng.monash.edu.au/uicee/gjee/vol3no2/paper3.pdf).

41. Organization for Economic Cooperation and Development (OECD), (1995). (http://www.oecd.org/els/edu/first_years/index.htm).

42. Ascher, B. (2001). "Engineers Get Organized to Face Obstacles in International Mobility," *Engineering Times*, February, p. 5.

43. Mallea, J.R. (1998). *International Trade in Professional and Educational Services: Implications for the Professions and Higher Education*, Center for Educational Research and Innovation (CERI), OECD, p. 26, (http://www.oecd.org/els/pdfs/Ceri/docs/mallea.pdf).

44. Philips, V., and C. Yager (hosts), Adult Education and Distance Learner's Resource Center, (http://www.geteducated.com).

45. Moore, M., and G. Kearsley (1996). *Distance Education: A Systems View*, Wadsworth Publishing, CA.

46. Georgia Tech Continuing Education and Distance Learning Center, (http://conted.gatech.edu/distance).

47. The University of Wisconsin-Madison offers the Masters of Engineering in Professional Practice (MEPP) via distance learning. Two one-week on-campus summer sessions are required. Applicants must be admitted to the graduate school and those who complete the program receive a graduate degree. For additional information, go to http://www.epd.engr.wisc.edu/mepp/.

48. National Technological University (NTU) offers courses from 52 engineering and information technology (IT) schools. These courses can count toward one of NTU's 18 masters degrees. Courses are available in one or more of these distance learning formats: web-based training, via satellite, videotape and CD-ROM. For additional information see http://www.ntu.edu/eng04.

49. ASCE (2000). *1999 Civil and Environmental Engineering Enrollment Data*, November, p. 3.

50. Russell, J.S., B. Stouffer and S.G. Walesh (2000). "The First Professional Degree: A Historic Opportunity," *Journal of Professional Issues in Engineering Education and Practice - ASCE*, Vol. 126, No. 2, April, pp. 54-63.

51. For engineering professional school information and ideas, see Guy, L. L. 1986. "I Accuse U.S. Practicing Engineers, Myself Included, of Shameful Neglect of Engineering Education," *Engineering Times*, September, p. 5; Lewis, Jr., L. G. (1999). "A Model for Engineering Practice in the Twenty-First Century," *THE BENT of Tau Beta Pi:*, Summer, pp. 12-15; Meyer, C. (1990). "Shouldn't We Have Professional Schools for Professional Engineers?", *Proceedings National Forum, Educating and Continuing Development for the Civil Engineer: Setting the Agenda for the 90's and Beyond*, pp. 811-886; Pletta, D. H. (1974). "The Making of a "Pro" – A Faculty Viewpoint," *Engineering Issues – Journal of Professional Activities – ASCE*, Vol. 100, No. E13, July, pp. 217-223; Pletta, D. H. and J. B. Eades (1997). "What If," *Journal of Professional Issues in Engineering Education and Practice – ASCE*, Vol. 1, No. 1, January, pp. 35-37; Russell, J.S., B. Stouffer and S.G. Walesh (2000). "The First Professional Degree: A Historic Opportunity," *Journal of Professional Issues in Engineering Education and Practice - ASCE*, Vol. 126, No. 2, April, pp. 54-63; and Yao, J.T.P. and J.M. Roesset (1999). "Civil Engineering Curricula for the First Professional Degree," *Forming Civil Engineering's Future*, J. Rogers and B. Brenner, Editors, Reston, VA, pp. 89-94.

52. American Institute of Certified Public Accountants, "Background Information on the 150-Hour Education Requirement for CPA Certification and Licensure," http://www.aicpa.org/members/div/career/150bkg.htm; "Frequently Asked Questions," http://www.aicpa.org/members/div/career/150faq.htm; and "States That Have Passed the 150-Hour Education Requirement," http://www.aicpa.org/states/uaa/150chart.htm.

53. The website for the National Architectural Accreditation Board (NAAB) is http://www.naab.org.

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61. National Society of Professional Engineers (2000). "Engineering Education/Licensure Model Task Force Report," May 15, 6 pp. See also *Engineering Times*, (2000). "Proposed Changes to Model Law for Licensing of Engineers," November.

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65. http://ncees.org

66. For an example of the frequently asked questions approach, refer to those being used by the AICPA which are available at http://www.aicpa.org/members/div/career/150faq.htm.

67. According to L. G. Lewis, Jr., past president of the National Council of Examiners for Engineering and Surveying (NCEES), "A concept that deserves consideration is a model which mandates licensure for those in responsible charge of engineering service units." Lewis goes on to say that engineering service units "…would exist in all private engineering organizations and within many of the industrial organizations, government agencies and utility companies." The intent of this action is to increase the protection of public safety, health and welfare by reducing use of the industrial exception. For additional information, see Lewis, Jr., L.G. (1999). "A Model for Engineering Practice in the Twenty-First Century," *THE BENT of Tau Beta Pi*, Summer, pp. 12-15.

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Good, M.L. (1993). "Industry's Needs and the Curriculum: Point," *Issues in Engineering Education*, Bulletin of the Board on Engineering Education, National Research Council, Vol. 2, No. 2, October, p. 3. (The author, who at the time of the article was with the U.S. Department of Commerce, expressed the view that "In the future, the complexity of engineering design tasks will require engineers with a doctorate degree.")

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Streett, W.B. (1993). "Industry's Needs and the Curriculum: Counterpoint," *Issues in Engineering Education*, Bulletin of the Board on Engineering Education, National Research Council, Vol. 2, No. 2, October, p. 3. (The author, who at the time of the article was Cornell University's Engineering Dean, indicated that the answer to the overly stressed undergraduate curriculum was "not further restructuring and compression." Instead, engineering should move in the direction of law, business and medicine which have a broadly based undergraduate degree followed by a professional degree, work experience and sometimes an internship.)

Tribus, M. (no date). "Technical Education as a Handicap in Public Service." (This engineer claims that engineering education, because of its almost exclusive focus on "logical analysis," "suppression of emotions," and "impatience with ambiguity," destines engineers to be "on tap, not on top.")

Walesh, S.G. (1998b), "Short on Image, Short on Substance," *Engineering Times*, December 1998. (Instead of adopting the Rodney Dangerfield engineers "get no respect." posture, this author calls for "…substantially upgrading engineering education—increasing the duration [to six years], expanding the breadth [humanities, social sciences, management and internship] and elevating the expectations.")

Weingardt, R. (2000). "Professional Status: Debating the Five-Year Degree," *Structural Engineer*, Vol. 1, No. 9, October, p. 12. (The author summarizes the arguments against the five-year degree as offered by employers, educators, and already licensed engineers. Noting that engineers can't have it both ways, prestige – high compensation and continuing the present narrow and short formal education, he then quotes Norm Augustine, former head of Lockheed Martin. Augustine said "One needs more training to give my neighbor's basset hound a vaccination than one needs to design a structure." The author concludes by suggesting a two-tiered formal education model, a four-year technical degree program model and a longer professional degree program.)