ASCE

American Society of Civil Engineers

THE VISION FOR CIVIL ENGINEERING IN 2025

BASED ON THE SUMMIT ON THE FUTURE OF CIVIL ENGINEERING
June 21 – 22, 2006

Prepared
by the
Task Committee to Plan a Summit
on the
The Future of the Civil Engineering Profession

January 12, 2007
(Final draft prepared by TC)

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Executive Summary

It is a great profession.
There is the fascination of watching a figment of the imagination emerge through the aide of science to a plan on paper.
Then it brings jobs and homes…it elevates the standards of living and adds to the comforts of life.
That is the engineer's high privilege.

(Herbert Hoover, engineer, humanitarian,
and 31st U.S. President)

Civil engineering leaders gathered in June 2006 to articulate a global vision for civil engineering.

A diverse group of civil engineering and other leaders, including international guests, gathered in June 2006 to actively participate in the Summit on the Future of Civil Engineering. Their purpose: articulate an aspirational global vision for the future of civil engineering addressing all levels and facets of the civil engineering community.

Today's status of civil engineering served as the Summit's benchmark. Examples of current issues and trends noted at the Summit include the poor condition of the infrastructure in many nations, occurrence of corruption in the global engineering and construction industry, minimal involvement of civil engineers in the political process, the need to more fully embrace sustainability, the globalization of engineering practice, and the desire to attract the best and brightest to the profession.

The civil engineer's world of 2025 will be even more challenging than today.

Summit participants see a very different world for civil engineers in 2025. An ever-increasing global population that continues to shift to urban areas will require widespread adoption of sustainability. Demands for energy, drinking water, clean air, safe waste disposal, and transportation will drive environmental protection and infrastructure development. Society will face increased threats from natural events, accidents, and perhaps other causes such as terrorism.

Dealing with the preceding problems and opportunities will require intra-disciplinary, cross-disciplinary, and multi-disciplinary collaboration on projects and in research and development. More advances in areas such as information technology, intelligent infrastructure, and digital simulation will be needed.

Informed by the preceding status of civil engineering and the challenges and opportunities facing it, the aspirational global vision developed as a result of the Summit is:

Entrusted by society to
create a sustainable world and enhance the global quality of life,
civil engineers
serve competently, collaboratively, and ethically as master:

- **planners, designers, constructors, and operators of society's economic and social engine, the built environment;**
- **stewards of the natural environment and its resources;**
- **innovators and integrators of ideas and technology across the public, private, and academic sectors;**
- **managers of risk and uncertainty caused by natural events, accidents, and other threats; and**
- **leaders in discussions and decisions shaping public environmental and infrastructure policy.**

In 2025, civil engineers will serve as master builders, environmental stewards, innovators and integrators, managers of risk and uncertainty, and leaders in shaping public policy.

Leaders of civil engineering organizations around the globe should move the civil engineering community toward the vision.

Summit organizers and participants want the preceding vision to guide policies, plans, processes, and progress within the civil engineering community and beyond – and around the globe. The engineering community, especially the civil engineering community, is global and, as such, should share a common vision and work together to achieve it.

Now that the Summit is complete, the vision articulated, and the report completed, leaders of civil engineering organizations around the globe should move the civil engineering community toward the vision. Active engagement on a variety of fronts related to the environment and infrastructure are required in response to the challenge laid before the profession.

2006:
Status, Concerns, and Opportunities in the Civil Engineering Profession

Unless we hasten,
we shall be left behind.

(Lucius Annaeus Seneca, Roman philosopher)

Civil engineers are rightfully proud of their legacy. Over the past century, clean water supplies have extended general life expectancies. Transportation systems serve as an economic and social engine. New bridges, blending strength and beauty, speed transport and bring communities closer together. Public and private construction, for which engineers provide the essential underpinnings of design and project oversight produces hundreds of thousands of jobs and drives community development. From the functional and beautiful Golden Gate Bridge in the U.S., Petronas Towers in Malaysia, and Pont du Gard in France to the largely hidden water supply and sanitary sewer systems, civil engineers have made their mark, day in and day out, in many aspects of the daily life of essentially everyone around the globe.

Issues and Trends

Proud of its legacy, the global civil engineering community cannot rest on its laurels. Public health, safety, and welfare require giving even more attention to infrastructure and the environment.

Civil engineers know they cannot rest on their laurels. Current trends pose questions about the future of the profession. These questions address the role that civil engineers play, and could play, in society, in the ultimate integrity of the world's infrastructure, and in the health of the natural environment.

For many years, civil engineering leaders sounded the alarm about the lack of investment in maintaining and improving the infrastructure. Some of those shortcomings were tragically illustrated by the death and destruction caused by failures in which engineering designs, government funding, and the community oversight systems were all called into question. Civil engineers are painfully aware of the repercussions for public health, safety, and welfare when the infrastructure gets short shrift.

Civil engineers must be more active in the policy-creating and decision-making process.

Yet those same engineers also know that they could do better in speaking out in the social and political arena, and in becoming leaders in the policy-creating and decision-making process, so that the process is based on a sound technical foundation. Civil engineers know they must step up to the political and public service plate.

The public has become increasingly aware that development need not come at the price of a compromised and depleted environment. Enlightened citizens see sustainability, not as an unattainable ideal, but as a practical goal. To answer that call, civil engineers realize that they must increasingly transform themselves from designers and builders to project life-cycle "sustainers."

Such broadened responsibilities, along with the increasing breadth, complexity, and rate of change of professional practice, all put greater emphasis not only on continuing education but also on what a basic civil engineering education must deliver up front. The body of knowledge necessary to effectively practice civil engineering at the professional level is beyond the scope of the traditional bachelor's degree, even when coupled with the mandated early-career experience. Education must meld technical excellence with the ability to lead, influence, and integrate, preparing the engineer to weigh the diverse societal issues that shape the optimal approaches to planning, design, and construction.

New Pressures

Pressures felt by the civil engineering profession include the role of software in design, commoditization of services, and impact of globalization.

Technology and market forces bring additional pressures on how civil engineers play out their roles. Knowledge-based civil engineering software increasingly shifts routine engineering tasks from the realm of the engineer to that of the technologist and technician. How will this trend play out in the years ahead? Will civil engineers move further into a systems role?

Civil engineering risks becoming increasingly commoditized. Clients and owners may increasingly use low bid procurement—and thus the lowest innovation denominator—rather than qualifications-based selection and its opportunities to provide the best life-cycle options.

And how will civil engineers in advanced nations react as the need to have project teams all in one place continues to shrink, and lower-cost engineers from rapidly expanding

technological workforces around the world vie for a piece of the global economic pie? Will economic forces make that pie expand, with more work for all engineers, or will barriers be proposed to slow the negative local employment impacts? How will civil engineers gain the needed knowledge of international business practices and cultural and linguistic issues and will they further address corruption in the global engineering and construction industry? In the future, some, now dominant countries may have a diminishing global role in engineering research and education and in application of new technology.

Civil engineers can contribute to world stability.

Civil engineers, because of their work with infrastructure and the environment, can contribute to world stability. Consider one example: Virtually every nation on earth is either facing, or within 20 years will face, some type of water supply challenge. That demand for this life-giving resource, coupled with the need to share it across national boundaries, could make for an explosive situation. The application of civil engineering knowledge and skills to enhance water supply and improve distribution could very well become one of civil engineering's greatest challenges.

Career Appeal

The profession has struggled with appealing to young people as a desirable profession.

All these issues represent critical tests for civil engineers, with new responsibilities looming for a new generation. For many years, the profession has wrestled with its career appeal to a diverse population of the best and brightest. How can pre-college students learn more about the civil engineering opportunities for both helping mankind and building a fulfilling life for themselves at a competitive compensation? And when on-the-job assignments do not match the promise of stimulating work, how can management step in to help while still building the bottom line?

Future Directions

Civil engineers thus find themselves as keepers of an impressive legacy while raising concerns about future directions. They know they must take more risks. They know they must show more leadership. They know they must control their own destiny and not let events control them.

The Summit on the Future of Civil Engineering in 2025 represented an ambitious step on the road to that new future. Participants asked: What will the civil engineering world be like

20 years from now? What aspirational role will civil engineers play in that radically transformed world?

The visionary gauntlet has been thrown down.

Clearly, looking ahead toward the unknown presents considerable risk. Future realities may not be captured and some aspects of the vision may prove to be a mirage. But the visionary gauntlet has been thrown. A diverse group of accomplished individuals gathered at the Summit to look beyond today's strategic issues—which were outlined here—to place their signposts for what the civil engineering profession should attain by 2025. The march toward those markers, and the enlightened struggles that will be needed to get there, are only just beginning. The global civil engineering profession has taken up the challenge.

Why a Summit?

Never doubt that a small group of committed people
can change the world.
It is the only thing that ever has.

(Margaret Mead, anthropologist)

Leaders gathered at the summit to articulate a global vision for civil engineering.

The Summit on the Future of Civil Engineering was convened in response to the status of, concerns with, and opportunities for the civil engineering profession as described, for example, in the previous chapter. A highly-varied group of civil engineers, engineers from other disciplines, architects, educators, association and society executives, and other leaders, including participants from eight countries other than the U.S.,[7] attended. All gathered in Landsdowne, Virginia from June 21 to 23, 2006 to participate in the Summit.

The Summit's purpose was to articulate an aspirational global vision for the future of civil engineering addressing all levels and facets of the civil engineering community, that is, professional (licensed) civil engineers, non-licensed civil engineers, technologists and technicians. The Summit's goal reflects the organizers' and the participants' preference of choice over chance. Statesman William Jennings Bryan highlighted those options when he said: "Destiny is not a matter of chance; it is a matter of choice."[1] Broadly speaking, there are only two futures for civil engineering around the globe; the one the profession creates for itself or, in the void, the one others create for civil engineering. Civil engineers came to the Summit to choose their profession's future.

This report presents thoughts of leaders who participated in the highly-interactive Summit.

The purpose of this report is to outline the highly-interactive process used during the Summit and more importantly, to present, in detail, the Summit's results. The report's primary audience is any individual or organization that can help to achieve the vision that resulted from the Summit, as presented later in this report.

The Summit on the Future of Civil Engineering in 2025 proved to be a stimulating, uplifting, collaborative, and creative experience for participants. Breakout groups generated wide-ranging discussions and post-Summit synthesis of the ideas that were generated yielded the final vision.

The civil engineering community is global and should share a common vision.

As valuable as that may be, the Summit is intended to be just the beginning of an on-going influencing process. Summit organizers, and probably the vast majority of participants, want the global vision, as presented in this report, to guide policies, plans, processes, and progress within the global civil engineering community. This vision can exert influence within civil engineering around the globe and possibly within other engineering disciplines and other professions. The civil engineering community is global and, as such, could and perhaps should share a common vision.

The Vision for Civil Engineering

Far better it is to dare mighty things,
to win glorious triumphs,
even though checkered by failure,
than to rank with those poor spirits who
neither enjoy much nor suffer much,
because they live in the gray twilight that
knows not victory nor defeat.

(Theodore Roosevelt, 26th U.S. President)

Vision

The Summit produced a series of aspirational visions stimulated by participant views of the world of 2025. The resulting integrated global aspirational vision is:

In 2025, civil engineers will serve as master builders, environmental stewards, innovators and integrators, managers of risk and uncertainty, and leaders in shaping public policy.

Entrusted by society to
create a sustainable world and enhance the global quality of life,
civil engineers
serve competently, collaboratively, and ethically as master:

- **planners, designers, constructors, and operators of society's economic and social engine, the built environment;**
- **stewards of the natural environment and its resources;**
- **innovators and integrators of ideas and technology across the public, private, and academic sectors;**
- **managers of risk and uncertainty caused by natural events, accidents, and other threats; and**
- **leaders in discussions and decisions shaping public environmental and infrastructure policy.**

As used in the vision, "master" means to possess widely-recognized and valued knowledge and skills and other attributes acquired as a result of education, experience, and achievement. Individuals, within a profession, who have these characteristics are willing and able to serve society by orchestrating solutions to

society's most pressing current needs while helping to create a more viable future.

Profile of the 2025 Civil Engineer

Personal attributes--knowledge, skills, and attitudes—must expand to meet the challenges of 2025.

The Summit addressed this question: What could civil engineers be doing in 2025? Addressing this question naturally led to describing the profile of the 2025 civil engineer, that is, the attributes possessed or exhibited by the individual civil engineer of 2025 consistent with the preceding aspirational vision for the profession.

Attributes may be defined as desirable knowledge, skills, and attitudes. As used here, knowledge is largely cognitive and consists of theories, principles, and fundamentals. Examples are geometry, calculus, vectors, momentum, friction, stress and strain, fluid mechanics, energy, continuity, and variability.

In contrast, skills refer to the ability to do tasks. Examples are using a spreadsheet; continuous learning; problem solving; critical, global, integrative/system, and creative thinking; teamwork; communication; and self-assessment. Formal education is the primary source of knowledge as defined here, whereas skills are developed via formal education, focused training, and certain on-the-job experiences.

Attitudes reflect an individual's values and determine how he or she "sees" the world, not in terms of sight, but in terms of perceiving, interpreting, and approaching. Examples of attitudes conducive to effective professional practice are commitment, curiosity, honesty, integrity, objectivity, optimism, sensitivity, thoroughness, and tolerance.

The Summit identified many and varied attributes, organized into the preceding knowledge, skills, and attitudes categories. The results are presented here.

The civil engineer is **knowledgeable**. He or she understands the theories, principles, and/or fundamentals of:

- ***Mathematics, physics, chemistry, biology, mechanics, and materials*** which are the foundation of engineering
- ***Design*** of structures, facilities, and systems
- ***Risk/uncertainty*** such as risk identification, data-based and knowledge-based types, and probability and statistics

The civil engineer is knowledgeable about technical and professional, as well as socio-economic, topics.

- ***Sustainability*** including social, economic, and physical dimensions
- ***Public policy and administration*** including elements such as the political process, laws and regulations, funding mechanisms
- ***Business basics*** such as legal forms of ownership, profit, income statements and balance sheets, decision or engineering economics, and marketing
- ***Social sciences*** including economics, history, and sociology
- ***Ethical behavior*** including client confidentiality, codes of ethics within and outside of engineering societies, anti-corruption and the differences between legal requirements and ethical expectations, and the profession's responsibility to hold paramount public health, safety, and welfare

The civil engineer is **skillful**. He or she knows how to:

The civil engineer possesses many and varied skills.

- ***Apply basic engineering tools*** such as statistical analysis, computer models, design codes and standards, and project monitoring methods
- ***Learn about, assess, and master new technology*** to enhance individual and organizational effectiveness and efficiency
- ***Communicate*** with technical and non-technical audiences, convincingly and with passion, via listening, speaking, writing, mathematics, and visuals
- ***Collaborate*** on intra-disciplinary, cross-disciplinary, and multi-disciplinary traditional and virtual teams[8]
- ***Manage*** tasks, projects, and programs so as to provide expected deliverables while satisfying budget, schedule, and other constraints
- ***Lead*** by formulating and articulating environmental, infrastructure, and other improvements and build ***consensus*** by practicing inclusiveness, empathy, compassion, persuasiveness, patience, and critical thinking

The civil engineer embraces a range of attitudes that supplement knowledge and skills and facilitating effective professional practice within industry, education, and government.

The civil engineer embraces **attitudes** conducive to effective professional practice. He or she exhibits:

- ***Creativity*** and ***entrepreneurship*** that leads to proactive identification of possibilities and opportunities and taking action to develop them
- ***Commitment*** to ethics, personal and organizational goals, and worthy teams and organizations
- ***Curiosity*** which is a basis for continued learning, fresh approaches, development of new technology or innovative applications of existing technology, and new endeavors
- ***Honesty*** and ***integrity,*** that is, telling the truth and keeping one's word.
- ***Optimism*** in the face of challenges and setbacks recognizing the power inherent in vision, commitment, planning, persistence, flexibility, and teamwork
- ***Respect*** for and ***tolerance*** of the rights, values, views, property, possessions, and sensitivities of others
- ***Thoroughness*** and ***self-discipline*** in keeping with the public health, safety, and welfare implications of most engineering projects and the high-degree of interdependence within project teams and between such teams and their stakeholders

Many of the preceding attributes are shared with other professions. Civil engineering's uniqueness is revealed in how the attributes enable the profession to do what it does and, more importantly, to become what it wants to be. This is inherent in the global aspirational vision.

2025:
The Civil Engineer's World

In a time of drastic change,
it is the learners who inherit the future.
The learned usually find themselves equipped to
live in a world that no longer exists.

(Eric Hoffer, self-taught philosopher)

Civil engineers can determine the roles they will play in the world of 2025.

The Summit generated many and varied ideas as a result of discussing the civil engineer's world of 2025. More specifically, the breakout groups addressed these two questions:

- What will be different in the world of 2025?
- What could civil engineers be doing in that different world?

The answer to the first question defines the stage on which civil engineers will perform two decades from now. The second question's answer defines roles civil engineers could play. While civil engineers will not be able to greatly influence the stage, they can determine the acts in which they will appear and the roles they will play.

Consistent with the vision, a 2025 scenario was developed.

Using Summit results and a pre-Summit ASCE member survey regarding aspirations and visions for civil engineering in 2025, the following scenario was developed.

The Scenario Begins

The year is 2025. At the 2nd World Civil Engineering Societies Triennial Symposium in Rio de Janeiro, Brazil, engineers from industry, education and government met to continue the collaboration started six years ago in Oporto, Portugal. At the conclusion of deliberations, conference organizers submitted the following reports regarding the status of the sustainability of the world, research and development, risk management, innovation and integration, and reform in the preparation of engineers.

A Sustainable World

Civil engineers have helped raise global expectations for sustainability and for environmental stewardship.

The global civil engineering profession has increasingly recognized the reality of shrinking resources, the desire for sustainable practices and design, and the need for social equity in the consumption of resources. Civil engineers have helped raise global expectations for sustainability and for environmental stewardship. The profession has led world acceptance of green design and has been at the forefront in making environmental considerations part of life-cycle and cost-benefit analyses. Civil engineers have urged clients to use new, environmentally-friendly technologies to improve the quality of life in urban environments. Designs routinely incorporated recycling, either by using recycled materials, or by making project components recyclable at the end of their useful life. New processes, less harmful to the environment, have been implemented, and most new construction is based on green- and smart-building technologies. Many new buildings actually produce more energy that they consume.

On the demographic front, the world is well on its way to a population exceeding ten billion people in 2050. Today, people occupy more space on the planet than they did 30 years ago, and they are straining the earth's environment, particularly the needs for energy, fresh water, clean air, and safe waste disposal. Over the past 30 years, gradual global warming has profoundly impacted the more than half of the world's population that lives within 50 miles of coastal areas. These areas have become much harsher places to live because of sea level rise, increased storm activity, and greater susceptibility to flooding. Growing population, shrinking resources, and climate change have led to sustainability and have put sustainability at the forefront of issues requiring global attention.

The shift of people from rural to urban areas increasingly strained the overburdened infrastructure.

Shifting demographics and population growth continue to strain the overburdened infrastructure. The shift of people moving from rural areas to cities and ex-urban areas has accelerated causing increased population density around the world. In the developed world, infrastructure is aging, and maintenance or replacement has not kept pace with its deterioration. In the developing world, the need for new infrastructure outstrips society's ability to put it in place. Influenced by civil engineering leadership, people now better understand the crucial link between infrastructure and quality of life, which has caused a major public policy shift in favor of

improved infrastructure maintenance and accelerated infrastructure construction.

Twenty-five years after promulgation of the Millennium Development Goals, some progress has been made, but the goals remain for the most part un-met against a backdrop of increasingly urgent global demand for environmental security and restoration. Improved understanding of the environment and the acceptance of broadly shared environmental values have led to an increased understanding that global environmental problems must be solved with global solutions. Nations unwilling to accept these values face worldwide pressure to conform to global norms for sustainability to improve the quality of life around the world.

Demands for sustainable energy, fresh water, clean air, and safe waste disposal drive global infrastructure development.

Demands for sustainable energy, fresh water, clean air, and safe waste disposal drive infrastructure development on a global scale. Constrained resources and growing energy demands have led to the need for prioritizing energy resources and for use of alternative fuels. The use of clean coal along with carbon sequestration; nuclear energy; and renewable sources such as wind, solar, waves, and geothermal have made it possible to meet growing demands. In addition, increased urbanization has led to greatly increased use of mass transit and much less reliance on personal automobiles, which has greatly reduced demands for fossil fuels. Most vehicles now use fuel cell technology or renewable resources such as ethanol.

The need for fresh water continues to be a global issue. Rapid urbanization in developing countries has made it a challenge to meet ever-growing demands for clean water. Improved water purification methods, desalination technologies, and increasing use of closed-loop systems have helped meet needs. There is growing use of gray-water systems, and a changing philosophy to purify water at the point-of-use in de-centralized systems, which has reduced the need to treat large quantities of water to drinking water standards when only a small fraction is taken internally by humans. This has also led to energy savings for water treatment.

Life cycle design philosophies have been widely adopted

The principles of sustainability have also driven demands for safe waste disposal and for increased recycling and re-use to make substantial reductions in the waste stream. Advances in nuclear technology have changed the requirements for disposal of highly radioactive nuclear waste. Life-cycle design philosophies have taken hold resulting in nearly zero net waste

and great savings in energy consumed for waste disposal. Virtually everything is recycled and re-used.

As a result of leadership and collaboration, the gaps between advanced, developing, and underdeveloped nations have been reduced.

New global standards for sustainable design, promulgated by non-government organizations (NGOs), have been implemented to meet the global demand for sustainability, overtaking the ability of any one country to maintain its own unique standards. Adoption of these international standards and best practices for sustainability has been facilitated by a growing awareness of liability concerns on a global scale. Increasingly, drivers for individual projects address regional and global issues as well as local issues because of converging environmental outlooks in the global community, and the need for the sustainability and project integrity.

One key to stability in the world is better equalizing of the standard of living. Ahead of plan, leadership and collaboration with major stakeholders around the world have closed the gap between advanced, developing, and underdeveloped nations. Innovative approaches have resulted in infrastructure addition, removal, repair, or replacment based on the changed societal requirements. Engineers are recognized as leaders, teachers, and learners in a wide range of environmental and infrastructure topics. Infrastructure financing routinely involves life-cycle costing analysis with public debate as to tradeoffs for different issues.

Research and Development

Civil engineers provide critical guidance for determining public policy and defining the research agenda.

Facing daunting issues following multiple global natural and manmade disasters in the first decade of the 21st century and the seeming lack of data pertaining to design, maintenance, and lessons learned, an international commission was established to define a strategic direction for global investment in research and development. Civil engineers have led the shift from a remedial to preventive approach.

The profession has defined a balanced view in driving the research agenda, spearheading intra-disciplinary, cross-disciplinary, and multi-disciplinary collaboration in prioritizing basic research needs on national and global levels. Civil engineers provide critical technical guidance in defining public policy throughout the government and global commissions.

Civil engineering has helped define the nanoscience, nanotechnology, and biotechnology research agenda.

At the turn of the century, a major challenge in the area of risk assessment of technological innovation lay in validation of results where the body of knowledge was minimal at best. A protocol established over the last decade, which embraces the practice of conducting clinical trials, has led to breakthrough advances in research for application in the manmade and natural environments. In addition, the methodology calls for greater transparency and sharing of information with the public sector.

Civil engineering quickly moved to the forefront to define the research agenda for nanoscience, nanotechnology, and biotechnology applications in the 2025 infrastructure environment. Engineers recognized that nanoscience and nanotech products are the vehicles for major technological innovation across a spectrum of products affecting virtually every industry sector. Civil engineers from across industry, academia, and government worked on the development of instrumentation, metrology, and standards to realize a robust nanomanufacturing capability. This permitted the physical dimensions, properties, and functionality of the materials, processes, tools, systems, and products that constituted nanomanufacturing to be measured and characterized. This in turn enabled production to be controlled, predicted, and scaled to meet market needs.

The profession's advancements in information technology and data management have improved the design, construction, and maintenance of facilities.

In 2025, the civil engineering enterprise is focused on fast-track development and deployment of technologies. Steps taken by the profession over the past two decades in the areas of information technology and data management, have significantly improved how facilities are designed, engineered, built, and maintained.

Civil engineers and the profession are now within the "tornado of the learning curve" focused on using application to drive technology. That being said, research now shows that technology improvements today may enable applications not yet identified. Civil engineers have reversed the image of being risk averse to new technology, instead relying on and leveraging real-time access to living databases, sensors, diagnostic tools, and other advanced technologies to ensure informed decisions are made.

Highly-integrated planning and construction tools, supported by four-dimensional databases, have been enabled by significant research investment in expanded computing capability. Data flows freely and is available at all times,

representing current conditions. Latent defects are addressed early in the design, and flowed back into the parent database.

Intelligent infrastructure (e.g., embedded sensors, real-time onboard diagnostics) have led to this transformation of rapidly advancing and adapting high-value technologies in the material fixed "pre-preg"[9] and design phases. Real-time monitoring, sensing, data acquisition, storage, and modeling, has greatly enhanced prediction time leading to informed decisions. Robotics, emulating the human factors, provide another greater dimension for non-human intervention in high-risk areas of infrastructure.

Intelligent sensors have put productivity at an all-time high. Smart chip technologies enhance materials tracking, speed construction, and reduce costs. Wearable computing devices facilitate communication among onsite engineers, workers, and inspectors and provide access to remote documents, and resources across global divides.

Managing Risk

The effort to manage and mitigate risk is led by civil engineers.

The world of 2025 presents a high-risk environment, with the ongoing threat of large-scale natural disasters and possible acts of terrorism. Civil engineers are at the forefront in developing appropriate approaches and designs to managing and mitigating risk, realizing that high reward can come from high-risk solutions. Project-specific risk decisions are made at multiple levels as engineers become leaders of enterprise risk management, with some carrying the title of Chief Risk Officer.

Risk is clearly a major driver of innovation, as engineers evaluate what new materials, processes, and designs might be used while weighing the potential for failure—balancing risk versus reward. Engineers reduce risk and, therefore, liability exposure by building living models of major structures that incorporate untried technologies, investigating in a flexible way the long-term performance. To aid the process, governments have instituted faster turn-around times for new regulations, permitting ever accelerating innovation.

Civil engineers have been in the forefront in developing and applying global, performance-based codes and standards.

The application of global, performance-based codes and standards has become widespread in enhancing the world's infrastructure, and civil engineers have been at the forefront in developing such guidelines. To address heightened threats and threat variability from place to place, the global codes and

standards have become risk-based, thereby more readily addressing local conditions. Natural and terrorist threats continue to change as world conditions evolve, and developers of codes and standards have become more proficient and proactive in adapting standards accordingly. In addressing the variations of local risk, engineers are also educating society on the limitations of new technology so that educated decisions can be made on adapting the way infrastructure is constructed while also managing expectations. However, such realistic management of expectations has not degraded the standard of care.

Multi-national corporations are now major drivers of global environmental standards.

Large, multi-national corporations have continued to expand and become major economic forces on a global scale. The total revenues of these corporations exceed the GDP of many nations, and the interrelated nature of their global production and supply network has given them great influence over environmental norms and standards across nations. These multi-national corporations are now major drivers of global environmental standards, and the opportunity for promoting tougher standards in all countries has grown. Economic forces help drive such environmental improvement, but less stringent environmental standards still prevail in some lesser developed countries. Local compliance issues also remain a challenge.

Master Innovators and Integrators

In the civil engineering profession, project delivery has become an increasingly complex and diverse process. Twenty-five years ago, an owner often hired a design professional to develop a detailed design that was given to a contractor who transformed it into a finished product. The design team of 2025 includes a multitude of participants, many of whom are not in the engineering profession, but in related areas of management, environmental sciences, social sciences, legal, planning, geographic and other disciplines. Likewise, the contractor's team no longer comprises a few trades, but dozens of trades that are specialized in particular areas coming together in a managed process to complete the constructed project.

Civil engineers lead in adapting and integrating new technologies into design and construction.

As the master innovators and integrators, civil engineers are the leaders that help develop and implement new technologies to create appropriate competitive advantages. Civil engineers are educated, trained, and well-equipped to be at the forefront of adapting and integrating these new technologies into both the design and construction areas. Civil engineers recognize that a narrowly focused perspective of the construction

project is no longer valid. The focus must be multi-faceted, multi-disciplined, and holistic.

Civil engineers are also the leaders in developing and implementing appropriate continuing education that encompasses the master builder/integrator concept. The team and integrator attributes are a part of the continuing education curriculum.

Many improvements in project management, especially involving virtual teams, are attributed to civil engineers.

As master innovators and integrators, the real-time exchange of ideas between engineers and other professionals has facilitated great team work in decentralized work environments. In those locations where cyberspace is still not available, the provision of wireless hand-held, voice-activated devices has kept engineers connected. Projects are now staffed and managed as if the project team were its own company. This has greatly cured the "curse of the matrix" as well as clarified, unambiguosly, the role, responsibilty, and accountability for each team member. Some have reported that the focus on the project outcome, not which discipline was in charge, has led to dramatic changes. The civil engineer, as a master integrator, facilitated this improvement.

Reform in the Preparation of Engineers

The widely-accepted body of knowledge is now the basis for the formal education and pre-licensure experience of civil engineers.

Led by civil engineers, the global engineering profession has implemented broad changes to the academic prerequisites to professional practice. Today, those seeking admission to the professional practice of engineering must demonstrate that they have fulfilled the appropriate body of knowledge through education and experience. The process of change to gain acceptance of the body of knowledge concept took over 20 years, but is now common practice over much of the globe.

Civil engineering education and early experience have been reformed. Part of this change was driven by the recognition that academia and industry need to cooperate and partner in the delivery of baccalaureate, post-baccalaureate, and lifelong learning educational activities. Industry has aggressively brought real-world issues into university classrooms and has implemented broad steps to ensure continuing professional development of engineers throughout their careers. The academic-industrial partnership has enabled formal education to keep pace with new technologies and rapidly-changing current practices.

Civil engineers are widely recognized as opportunity identifiers and problem solvers.

The sea change in engineering education, both formal and on-the-job, has transformed civil engineering into a "learning profession," further enhancing its image as a problem-defining and problem-solving profession in the eyes of the public. This enhanced reputation as a learning profession that identifies opportunities and addresses major problems has been cited as a key reason why great numbers of young people are making civil engineering their career of choice. Civil engineering's outreach to help build capacity in the developing world has "put a human face" on the profession, which in turn has attracted more women, minorities, and people interested in social justice to the ranks of civil engineers. Because of this influx of new faces, the civil engineering profession today mirrors the population it serves.

Civil engineering professionals led the way, within engineering, in specialty certification.

In addition to requiring body of knowledge fulfillment for entry into professional practice, the civil engineering profession has led the way in recognizing specialty certification as a means of demonstrating competency in specialized areas of civil engineering. Over the past 20 years, specialty certification has become widely recognized, both within and outside the profession, as a measure of proficiency in a technical field. As a result of both board certification, and reform in the preparation of civil engineers, the public perception of civil engineers as knowledgeable professionals has steadily improved.

Civil engineers have also been at the forefront of curbing corruption in the construction industry worldwide. Engineering ethics is one of the cornerstones and academia and industry have fostered lifelong learning in this key area.

Now back to 2007…

What Next?

When we build, let it not be for present use alone.
Let it be such work as our descendants will thank us for.

(John Ruskin, philosopher)

The vision presented in this report is intended to inspire the global civil engineering community.

The aspirational vision presented in this report represents a beginning—the springboard to launch a sustainable, influential process so that the vision for civil engineering in 2025 can be attained. The Summit's sole goal was to define this aspirational vision; it was not to create the roadmap on how to achieve it. That map-making begins now—with you. If we are to succeed, we must rally everyone in the engineering community to help move this process forward.

Now that the vision has been set and the future envisioned, leaders have a target to guide their policies, plans, processes, and progress on a broad and diverse front, within and outside the engineering community. After all, simply publishing the vision for the future will accomplish little.

In moving forward, leaders in the civil engineering community should recognize that:

- A variety of partners must be engaged, and opportunities for collaboration and action identified.
- The international engineering community must also be engaged to maximize the reaches of the vision to the global civil engineering community.
- The public and policy-makers must be engaged so that the profession serves society to the fullest.
- The education and training of future civil engineers and the continued development of today's civil engineers must include and go beyond the required technical competencies.

Forging a long-term action plan to achieve the vision will require input and cooperation from a diverse group of leaders and organizations. Individual leaders within the civil engineering community must build awareness and excitement for achieving the vision. Additionally, civil engineering organizations have to create momentum toward the attainment of the vision within

their organizations. Specific opportunities to present the vision for 2025 at board meetings, annual conferences, and the like must be identified and pursued. Organizations need to share knowledge and work together to make measurable progress toward the vision. For example, within the U.S., ASCE, the American Association of Engineering Societies, the American Council of Engineering Companies, and others might collaborate, holding joint workshops or conferences that focus on how to accomplish the vision for the civil engineering profession. Partnering with sister organizations such as the American Institute of Architects, the American Planning Association, and others will also maximize the success in meeting the goals for civil engineering. In addition to technical and professional organizations, client-related organizations must also be engaged. Finally, civil engineers must also obtain input from the public—the primary beneficiaries of civil engineering services. Such efforts among individuals and organizations around the world will be key to the achievement of our vision.

Today's civil engineers will need to transform themselves to meet the challenges of tomorrow. They must stay abreast of changing technologies, market trends, and business developments. Civil engineers need to develop and implement new methods and products which are sustainable and sensitive to the environment. Moreover, they must cultivate the new technologies, direct the market, and develop new business practices to lead the transformation into tomorrow.

Educating future civil engineers is also an essential component of the vision for the civil engineering profession in 2025. Fulfilling the vision requires an expanded set of knowledge, skills, and attitudes, highlighting the need for curricula reform today to develop that knowledge and those skills and attitudes needed in 2025. Colleges and universities must examine their curricula as they relates to the future civil engineer so advancement toward the vision can be realized. In the U.S., ABET, Inc would be a targeted partner in this area.

Civil engineers must commit to meeting milestones in achieving the vision.

Several aspects of the vision relate to the civil engineer's interaction with the public. Civil engineers aim to be—and be perceived as—trusted advisors to the public and policy-makers regarding infrastructure. To accomplish this, civil engineers must show the public how their services daily touch the public and improve lives. In particular, the civil engineering community must increasingly seek opportunities to influence more lives in more areas of world with our services. Now is the time to

develop workable and economically feasible solutions to the world's infrastructure needs. The public must be engaged in this continuing process to raise the quality of infrastructure.

U.S. civil engineers can be catalysts in sharing the vision with the global civil engineering community. The surest path to success is the integration of knowledge from civil engineers within a broad range of economies, cultures and circumstances. Conferences conducted by international engineering groups, such as the World Federation of Engineering Organizations, are excellent vehicles for obtaining concurrence and determining a direction for the international civil engineering profession of 2025.

Collective, long-term actions to help achieve the vision might include:

- A more robust educational path for civil engineers that prepares them for leadership and provides the multifaceted non-technical skills to serve on projects affecting the public good.
- A more clearly defined organizational structure for the engineering team, where the licensed civil engineer takes on the role of master program/project integrator.
- More civil engineers involved in public policy forums where future directions for society are developed and where civil engineers can gain the public's trust.
- More civil engineers elected to public office where they can directly influence infrastructure and sustainability policy and legislation.
- A greater level of collaboration and communication among civil engineers and those non-engineer stakeholders, seeking to balance a sustainable environment with needed infrastructure.
- Increased research and development to mitigate the effects of natural disasters, with civil engineers playing a leading role in devising and implementing the innovations.
- Greater education and training of engineers in ethics and a greater emphasis on ethics in global engineering practice, allowing engineers to serve as role models.
- Sharing the vision with pre-college students, and their parents and counselors, to better inform them about the profession and thus attract even more of the best and brightest to the profession.

We hope that through these first sketches of possible action, you, the reader, will begin to contemplate how you, your organizations, and your countries can begin planning and implementing the next steps to making this vision a reality. This will be no small task. However, a united civil engineering community can start the hard work that will ultimately fulfill that promise.

Acknowledgements

ASCE gratefully acknowledges the support of many individuals and organizations that made the summit possible.

ASCE gratefully acknowledges the supporters of the Summit on the Future of Civil Engineering without whom this gathering would not have been possible. They are:

- Stephen D. Bechtel, Jr.
- AECOM
- ASCE Foundation
- B & E Jackson & Associates
- The Charles Pankow Foundation
- CH2M HILL
- DuPont
- Fluor Corporation
- Judith Nitsch Engineering, Inc.
- The Port Authority of New York/New Jersey
- University of Illinois at Champaign-Urbana
- Whitney, Bailey, Cox & Magnani, LLC

Similarly, the efforts of Co-Chairs Stephen D. Bechtel, Jr., Ph.D., Hon.M.ASCE, Chairman Emeritus of the Bechtel Corporation and Patricia Galloway, Ph.D., PE, F.ASCE, Past-President of ASCE, CEO, The Nielsen-Wurster Group, Inc. are appreciated.

APPENDIX A

Abbreviations

ABET	Formerly Accreditation Board for Engineering and Technology (now simply ABET, Inc.)
ASCE	American Society of Civil Engineers
BS	Bachelor of Science
CAD	Computer-Aided Design (or Drafting)
CAE	Computer-Aided Engineering
CTO	Chief Technical Officer
DBO	Design, Build, Operate
DOD	Department of Defense
E&C	Engineering and construction
FIATECH	Fully Integrated and Automated TECHnology
GDP	Gross domestic product
GNP	Gross national product
IT	Information Technology
MNC	Multinational corporation
NGO	Non-governmental organization
NSF	National Science Foundation
PPP	Point-to-Point Protocol
TC	Task Committee (Task Committee to Plan a Summit on the Future of the Civil Engineering Profession)

APPENDIX B

Summit Participants

No.	Table No.	First Name	Last Name	Name and Organization
1	3	Sam	Amod	Sam Amod President, South African Institution of Civil Engineering (SAICE)
2	2	Richard	Anderson	Richard O. Anderson, P.E., Hon.M.ASCE SOMAT Engineering, Inc.
3	1	Kamel	Ayadi	Kamel Ayadi President, World Federation of Engineering Organizations (WFEO) Tunis, Tunisia
4	2	Omer	Aydan	Omer Aydan, Ph.D. Tokai University, Japan Secretary Japan Society of Civil Engineers (JSCE)
5	1	John	Bachner	John Bachner Bachner Communications
6	6	Donald	Basham	Donald Basham, P.E. Chief, Engineering and Construction, Civil Works Directorate, U.S. Army Corps of Engineers
7	2	Stephen	Bechtel	Stephen D. Bechtel, Jr., Ph.D., Hon.M.ASCE Chairman Emeritus Bechtel Corporation
8	7	Carol	Bowers	Carol Bowers, P.G., M.G-I Director, Geo-Institute ASCE
9	2	Anne	Canby	Anne Canby President Surface Transportation Policy Project
10	1	Richard	Capka	J. Richard Capka, P.E., M.ASCE Administrator for Federal Highway Administration
11	1	Michael	Chajes	Michael J. Chajes, Ph.D., P.E., M.ASCE Professor and Chair Department of Civil and Environmental Engineering University of Delaware
12	0	Amar	Chaker	Amar Chaker, Ph.D., M.ASCE Director, Architectural Engineering Institute ASCE
13	3	Jenn-Chuan	Chern	Jenn-Chuan Chern, Ph.D. Past President, Chinese Institute of Civil and Hydraulic Engineering (CICHE) Chair, Executive Comm., ACECC
14	4	Loreen	Choate	Loreen Choate, P.E., M.ASCE Project Manager, Interstate Construction, Florida DOT
15	2	Buddy	Cleveland	Buddy (Alton B. Jr.) Cleveland SVP, Bentley Software Systems
16	5	Timothy	Coleman	Timothy D. Coleman

No.	Table No.	First Name	Last Name	Name and Organization
				EPIC Technologies, LLC
17	8	Wendy	Cowan	Wendy Cowan, CAE, Aff.M.ASCE Managing Director, Membership ASCE
18	7	Marla	Dalton	Marla Dalton, P.E., M.ASCE Director, Critical Infrastructure ASCE
19	3	David	Daniel	David E. Daniel, Ph.D., P.E., M. ASCE University of Texas at Dallas
20	1	Casey	Dinges	Casey Dinges, Aff.M.ASCE Managing Director, External Affairs ASCE
21	4	John	Dionisio	John Dionisio, P.E., M.ASCE President and CEO, AECOM Technology Corp.
22	3	Albert	Dorman	Albert Dorman, P.E., L.S., FAIA, Hon. M.ASCE Founding Chairman, AECOM
23	8	John	Durrant	John Durrant. P.E., M.ASCE Managing Director, Engineering Programs ASCE
24	2	Deepal	Eliatamby	Deepal Eliatamby, P.E., M.ASCE Alliance Consulting Engineers, Inc.
25	8	Meggan	Farrell	Meggan Farrell, CMP Director, International Relations ASCE
26	5	Linda	Figg	Linda Figg, A.M.ASCE President, CEO and Director of Bridge Art FIGG Engineering Group
27	0	Mark	Fitzgerald	Mark Fitzgerald Associate Editor, *ASCE News*
28	4	Marion	Fowlkes	Marion Fowlkes, FAIA Fowlkes and Associates | Architects
29	3	Arthur	Fox	Arthur J. Fox, Jr., F.ASCE Editor Emeritus ENR, Past President ASCE
30	5	Gerald	Galloway	Gerald E. Galloway, Jr., Ph.D., P.E., F.ASCE Glenn L Martin Institute Professor of Engineering University of Maryland, College Park
31	3	Patricia	Galloway	Patricia Galloway, Ph.D., P.E., F.ASCE CEO, The Nielsen-Wurster Group, Inc. Past President ASCE
32	4	Christopher	Garlick	Christopher Garlick, P.E., PMP, M.ASCE Florida's Turnpike Enterprise, PBSJ Toll Services Group
33	7	Mike	Goode	Michael Goode, P.E., M.ASCE ASCE 1801 Alexander Bell Drive Reston, VA 20191
34	5	Barry	Grear	Barry Grear President Elect, World Federation of Engineering Organizations Australia
35	2	Masanori	Hamada	Masanori Hamada, Ph.D. Waseda University, Japan President, Japan Society of Civil Engineers

No.	Table No.	First Name	Last Name	Name and Organization
				(JSCE)
36	6	Preston	Haskell	Preston H. Haskell, P.E., M.ASCE Chairman, The Haskell Company
37	2	Henry	Hatch	Lt. Gen. Henry J. Hatch, P.E., Hon.M.ASCE Chair, International Activities Committee, ASCE
38	6	William	Hayden	William M. Hayden Jr., Ph.D., P.E., F.ASCE Management Quality By Design, Inc.
39	1	Bill	Howard	William Howard. P.E., M.ASCE Executive Vice President and Chief Technical Officer of Camp Dresser & McKee
40	6	Dom	Izzo	Dominic Izzo, P.E., F.ASCE Vice President, Marine Engineering Business Line DMJM Harris
41	4	Birdel	Jackson	Birdel F. Jackson, III, P.E., M.ASCE B&E Jackson & Assoc
42	8	Jeanne	Jacob	Jeanne Jacob, CAE, CFRE Executive Vice President ASCE Foundation
43	8	Stefan	Jaeger	Stefan Jaeger, CAE, Aff.M.ASCE Managing Director ASCE
44	2	Linda	Katehi	Linda P.B. Katehi, Ph.D. Provost, Vice Chancellor for Academic Affairs Univ. of Illinois at Urbana-Champaign
45	1	Rik	Kunnath	Rik Kunnath, A.M.ASCE CEO, Pankow Operating
46	2	Michael	Kupferman	Michael Kupferman, Ph.D., P.E., M.ASCE Associate Provost, Wentworth Institute of Technology
47	3	Peggy	Layne	Margaret (Peggy) Layne, P.E., M.ASCE Project Director, Advance VT Virginia Polytechnic Institute and State University
48	2	Tom	Lenox	Tom Lenox, Ph.D., M.ASCE Managing Director ASCE
49	3	Blaine	Leonard	Blaine D. Leonard, P.E., F.ASCE Research Division, Utah DOT
50	2	Ed	Link	Lewis E. (Ed) Link, Ph.D. Dept. of Civil & Environmental Engineering University of Maryland
51	3	Frank	Lombardi	Francis (Frank) Lombardi, P.E., M.ASCE Chief Engineer, The Port Authority of New York & New Jersey
52	6	William	Marcuson	William Marcuson, Ph.D., P.E., Hon.M.ASCE President Elect, ASCE
53	7	Walt	Marlowe	Walt Marlowe, P.E., M.ASCE Executive Director Building Security Council
54	4	Dennis	Martenson	Dennis Martenson, P.E., BCEE, F.ASCE President, ASCE
55	6	Oliver	McGee	Oliver G. McGee, Ph.D.

No.	Table No.	First Name	Last Name	Name and Organization
56	5	David	Mongan	David G. Mongan, P.E., F.ASCE President, Whitney, Bailey, Cox & Magnani, LLC
57	6	Get	Moy	Get W. Moy, Ph.D., P.E. Director, Installation Requirements and Management, ODUSD
58	5	Michael	Mucha	Michael Mucha, P.E., M.ASCE Director - Public Works, City of Olympia
59	1	Pat	Natale	Pat Natale, P.E., F.ASCE Executive Director, ASCE
60	6	Priscilla	Nelson	Priscilla P. Nelson, Ph.D., M.ASCE Provost and Senior Vice President for Academic Affairs New Jersey Institute of Technology
61	5	Debbie	Niemeier	Debbie A. Niemeier, Ph.D. Director, John Muir Institute of the Environment Assoc. Vice Chancellor, Office of Research Univ. of California – Davis
62	1	Judith	Nitsch	Judith Nitsch, P.E., M.ASCE President, Judith Nitsch Engineering, Inc.
63	4	Jim	O'Brien	Jim O'Brien, P.E., M.ASCE Managing Director, Professional and Education Activities ASCE
64	0	Marvin	Oey	Marvin Oey, Ph.D., P.E., M.ASCE Director, CI ASCE
65	1	Jay	Padgett	Jay Padgett, Jr., P.E., F.ASCE President, Geoservices Corporation
66	5	Jorge	Padilla	Jorge Díaz Padilla, Ph.D., P.E., M.ASCE President, International Federation of Consulting Engineers, FIDIC Mexico City, Mexico
67	7	Brian	Pallasch	Brian Pallasch, CAE Director, Government Relations ASCE
68	1	Ralph	Peterson	Ralph R. Peterson, P.E., M.ASCE Chairman & CEO, CH2M HILL
69	0	Anne	Powell	Anne Powell Editor-in-Chief, ASCE Publications
70	7	Melissa	Prelewicz	Melissa Prelewicz, P.E., M.ASCE Director, Professional Practice ASCE
71	5	Robert	Prieto	Robert Prieto Senior Vice President, Fluor Corporation
72	1	Thomas	Rachford	Thomas M. Rachford, P.E., Ph.D., F.ASCE Vice President & Corporate Quality Officer Gannett Fleming, Inc.
73	4	Ghani	Razaqpur	Ghani Razaqpur, Ph.D. President-Elect of Canadian Society for Civil Engineering (CSCE)
74	5	Ed	Richardson	Ed Richardson, P.E., F.ASCE Sr. VP and Manager of Engineering, Bechtel Group, Inc.

No.	Table No.	First Name	Last Name	Name and Organization
75	6	Bruce	Ripley	Bruce Ripley BC Hydro, Canada
76	5	Michael	Rogers	Michael Rogers Practical Futurist
77	6	Larry	Roth	Larry Roth, P.E., G.E., F.ASCE Deputy Executive Director, ASCE
78	3	Jeff	Russell	Jeffrey S. Russell, Ph.D., P.E., F.ASCE Professor and Chair, Civil and Environmental Engineering University of Wisconsin-Madison
79	8	Mike	Sanio	Michael Sanio, M.ASCE Director, International Alliances ASCE
80	3	Ben	Schwegler	Benedict R. Schwegler, Jr., Ph.D Vice President and Chief Scientist Walt Disney Imagineering
81	0	John	Segna	John Segna, P.E., M.ASCE Director, Technical Activities ASCE
82	0	Pete	Shavalay	Pete Shavalay, CPA Chief Financial Officer ASCE
83	5	Sue	Skemp	Sue Skemp, A.M.ASCE Executive Vice President Civil Engineering Forum for Innovation
84	3	Tom	Smith	Tom Smith, CAE, M.ASCE Assistant Executive Director ASCE
85	4	Bob	Stevens	Robert (Bob) D. Stevens Executive VP & Director Transportation Practice ARCADIS
86	8	Carol	Vargas	Carol Vargas Director, Partner Programs ASCE
87	6	Jean	Venables	Jean Venables, OBE Vice President, Institution of Civil Engineers, London
88	6	John	Voeller	John G. Voeller Senior Vice President, Chief Knowledge Officer and Chief Technology Officer, Black & Veatch
89	4	Stuart	Walesh	Stuart G. Walesh, Ph.D., P.E., Hon.M.ASCE Consultant, Englewood, FL
90	4	Norbert	Young	Norbert Young, FAIA President, McGraw Hill Construction

APPENDIX C

Members of the Task Committee to Plan a Summit on the Future of the Civil Engineering Profession

Members

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Stefan JAEGER, CAE, Managing Director, Strategic & International Initiatives, ASCE, Reston, VA.

APPENDIX D

Process Used to Plan, Facilitate, and Follow-Up on the Summit

The idea of holding a Summit on the Future of Civil Engineering surfaced a number of years ago with detailed planning beginning in earnest in the summer of 2005. A Task Committee (TC) of 17 people was selected to plan, conduct, and report on the Summit. The individuals on the TC were chosen because of their past involvement in discussions about a Summit as well as their expertise in conducting strategic planning efforts and similar activities. As indicated by the list of TC members in Appendix C, a diverse group representing various elements of industry, government, academia, age, and gender was assembled.

The first major task of the committee was to define the format for the Summit which was determined to be a series of facilitated roundtables on various topics. The Summit would begin with an overall vision of the future provided by a noted futurist. Each roundtable would be preceded by a presentation on a specific topic and a concluding Summit activity would focus on crafting a series of visions.

Parallel to the Task Committee's activities, the ASCE Foundation began an effort to raise the necessary funds to conduct the Summit. Stephen Bechtel, Jr. and Patricia Galloway were invited to serve as honorary co-chairs of the Summit.

To support Summit planning, ASCE conducted an e-mail survey of the membership to determine their opinions on aspirations and visions for civil engineering in 2025. The actual Summit could only accommodate a limited number of individuals, so ASCE believed it was important to solicit the opinions of a wide selection of the membership in order to ensure broader input to the Summit discussions.

ASCE received 4,382 valid responses to the survey. Respondents were demographically representative of the entire spectrum of the ASCE membership. The results included over 12,000 individual written comments submitted in response to the questions asked. The information was tabulated and used by the TC planning for the Summit. A summary of the results of the survey is included in Appendix E.

Invitations were extended to approximately 60 individuals selected to provide as diverse as possible representation at the Summit. The TC sought representation from large, medium and, small consultants; industry and government (both federal and local); academia; entities from other nations; technologists; architects; contractors; and younger members. Prior to the Summit, each invitee received four mailings of reports and other materials to help prepare them for the conference. See Appendix B for a list of the 51 invitees who, in addition to the TC, attended the Summit.

A key factor in the Summit's success was the use of ASCE staff as trained facilitators. In addition to the primary facilitator, a secondary facilitator served as a recorder. Facilitators prepared by reading the advance material sent to the Summit participants and by participating in training which included separate mock facilitation session.

The TC believed that the traditional process of having reports after each breakout by a member of each breakout group would not be effective. Having a recorder take real time notes allowed the creation of theme teams. Each theme team consisted of four members of the TC and after each of the breakouts, a theme team met and, using the notes from the various breakout tables, orally compiled a consolidated report. That report was then presented to a plenary session for feedback and comments. This process was very effective and captured a great deal of information.

Immediately after the conclusion of the Summit, the TC met to review the information and determine the next steps for writing the report. Writing and other tasks were assigned and a schedule for completion of the initial document was established.

Once the draft report was completed, it was circulated to the Summit participants for their review and comment. Subsequent drafts were reviewed by a wider audience, both within and outside of ASCE.

APPENDIX E

Summary of Survey

ASCE Survey on the Future of Civil Engineering
January 2006

Background and Methodology

As input to the Summit on the Future of Civil Engineering, ASCE conducted an electronic survey of its membership. ASCE e-mailed to 43,075 demographically selected of its members on January 18, 2006 an invitation to participate in the survey and directions to the electronic survey site. Of these, 36,898 were successfully sent with 4,382 valid responses[1] — a respectable 11.9% response rate. ASCE did not send a follow-up e-mail, and the survey site was available until February 1, 2006.

The results of the survey were made available to the Planning Committee to assist in the development of the program. By reviewing the results of the survey, the Committee was able to ensure that the concerns of the membership at-large would be addressed during the Summit. There was no attempt on the part of the Steering Committee to pre-judge what should be considered an important issue for the Summit prior to the survey, but the Committee did believe it was important to listen to the concerns of the collective membership prior to the Summit.

The survey had three (3) main parts:

(1) Demographic Information
- Geographic Location
- Area of practice
- Civil engineering work experience
- Age
- Gender

(2) Questions 5 and 6 concerned the ranking or the perceived importance of suggested issues/developments/trends and factors influencing the choice of a civil engineering career.

(3) Questions 7 and 8—open-ended questions on issues/trends and on aspirational visions.

[1] With a total of 4,383 valid responses, the error interval using a 95%, level of confidence is ± 1.39.

This summary report has three (3) sections. The first section is the demographic profile of the respondents, the second, the cross-tabulation of the responses to questions 5 and 6 based on demographic information, and the third is the interpretation of the results of the open-ended questions.

Survey Respondent Profile

Geographic Location[2]

More than 82% of the respondents live in the United States (See table below) and almost 18% outside the United States.

TABLE E-1

	Count	%	ASCE Global %
US	3,610	82.38	89.86
Intl	772	17.62	10.14
Total	4,382	100.00	100.00

The overall makeup of ASCE membership is slightly different, however, where 9.5% are international members. In previous surveys of this nature, ASCE international members have always responded at a higher rate than domestic (U.S.-based) members.

Area of Practice

TABLE E-2

	Count	%	ASCE Global %
Private Practice	2,238	51.07	54.40
Government	791	18.05	12.80
Industry	512	11.68	
Education	459	10.47	32.80
Other	347	7.92	
No response	35	0.80	
Total	4,382	99.99	100.00

More than half of the respondents are in private practice, which correlates well with the overall ASCE membership. The large percentage of ASCE membership (32.8%) that is indicated as "education" is indicative of students that are counted in this category. As far as the 'other' category for respondents is concerned, more than half of these are students. The respondent percentage of 10.47% in education is reflective of the actual percentage of ASCE members who are employed in education fields.

[2] The survey did not specifically ask for the respondents' location.

Civil Engineering Work Experience

TABLE E-3

	Count	%
Civil Engineering Student	397	9.06
1-2 years	292	6.66
3-5 years	441	10.06
6-15 years	1,053	24.03
16-25 years	2,090	47.70
Not a civil engineer	85	1.94
No response	24	0.55
Total	4,382	100.00

More than 70% of the respondents have six (6) or more years of experience. A majority of those under 'no response' have more than 25 years of experience.

Age

TABLE E-4

	Count	%	ASCE Global %
17-23 years	380	8.67	9.73
24-35 years	1,282	29.26	22.28
36-50	1,449	33.07	27.61
51-65 years	1,179	26.91	24.43
More than 65 years	74	1.69	15.96
No response	18	0.41	0
Total	4,382	100.00	100.00

Almost 60% of the respondents are between 24 and 50 years old, which is the age group of current civil engineers that is most likely to be affected by the results of this Summit. Although the survey demographics do not precisely match the ASCE membership profile, the Steering Committee was satisfied that the respondents as a group are representative of the ASCE membership.

Gender

TABLE E-5

	Count	%	ASCE Global %
Male	3,670	83.75	88.05

Female	693	15.81	10.63
No response	19	0.43	1.32
Total	4,382	100.00	100.00

The table above shows that female participation is strong in this survey. However, the Society's gender field on applications or membership renewals is completed on a voluntary basis and for the most part is left blank resulting in the percentage of males to females being interpretive. Thus, the percentage of Society members listed as female is not statistically valid.

Summary of Responses to Questions 5 and 6

Questions 5 and 6 asked the respondents to rank a list of various issues that could impact the practice of civil engineering through 2025. These rankings were then tabulated according to the demographic categories identified in the previous section. Trends were then identified to determine what issues were important and to whom.

Question 5: How important do you believe the following issues/developments/trends will be in impacting the civil engineering profession over the next 20 years?
1 = not important at all, 10 = extremely important

A) Number of students entering the civil engineering pipeline
B) Number of civil engineers involved in the decision-making process for infrastructure policy
C) Advances in, and applications of, nanotechnology
D) Development of non-traditional project delivery systems
E) Diversity of US civil engineers
F) Advances in, and applications of, engineering software/hardware
G) Use of global civil engineering talent in developing projects
H) Incorporation of sustainability into civil engineering solutions
I) Civil engineering services viewed as a commodity and not as a professional service
J) Advances in, and applications of biotechnology
K) Maintenance of existing infrastructure
L) Dealing with natural disasters
M) Emergence of additional civil engineering specialties
N) Ability of US engineering schools to teach the broad range of skills needed to practice successfully as civil engineer
O) Importance of the engineering license in the practice of civil engineering
P) Advances in, and applications of, on-site construction technologies
Q) Dealing with terrorist threats
R) Engineering ethics and business practice ethics
S) Advances in, and applications of, worldwide electronic communication and electronic collaborative capabilities

T) Pro bono work by engineers to improve the basic infrastructure of developing countries
U) Advances in, and applications of, information technology

The following table presents a summary of the results. The top 5 ranked items and the bottom 3 ranked items are presented along with their mean scores.

TABLE E-6

SUMMARY RESULTS FOR QUESTION #5									
DEMOGRAPHIC CATEGORY	TOP 5 RANKED ISSUES/DEVELOPMENTS/TRENDS					BOTTOM 3 RANKED ISSUES/DEVELOPMENTS/ TRENDS		
Overall Results	**K-**8.85	**L-**8.45	**B-**8.40	**O-**8.32	**R-**8.30	**E-**6.59	**C-**6.10	**J-**6.07
Geographic								
United States	**K-**8.93	**B-**8.43	**L-**8.39	**O-**8.39	**N-**8.30	**T-**6.44	**J-**6.01	**C-**5.99
International	**L-**8.73	**R-**8.50	**K-**8.49	**U-**8.43	**F-**8.40	**C-**6.61	**J-**6.35	**I-**6.15
Area of Practice								
Private Practice	**K-**8.83	**B-**8.36	**O-**8.43	**L-**8.29	**N-**8.23	**T-**6.37	**J-**5.92	**C-**5.89
Government	**K-**9.05	**B-**8.56	**L-**8.52	**O-**8.50	**R-**8.43	**I-**6.55	**C-**6.22	**J-**6.22
Industry	**K-**8.76	**L-**8.51	**R-**8.41	**B-**8.36	**F-**8.32	**I-**6.63	**C-**6.28	**J-**6.10
Education	**L-**8.80	**K-**8.73	**H-**8.46	**B-**8.40	**R-**8.31	**C-**6.32	**I-**6.31	**J-**6.20
Civil Engineering Work Experience								
Civil Engineering Student	**L-**8.96	**K-**8.63	**O-**8.47	**R-**8.46	**F-**8.44	**E-**6.87	**J-**6.53	**I-**6.49
1-2 Years	**K-**8.63	**L-**8.63	**F-**8.50	**N-**8.41	**O-**8.28	**I-**6.50	**C-**6.29	**J-**6.14
3-5 Years	**K-**8.83	**L-**8.50	**H-**8.32	**F-**8.30	**O-**8.26	**E-**6.66	**C-**6.06	**J-**5.96
6-15 Years	**K-**8.88	**B-**8.44	**L-**8.44	**O-**8.35	**R-**8.22	**T-**6.56	**J-**5.80	**C-**5.71
16-25 Years	**K-**8.93	**B-**8.50	**R-**8.35	**L-**8.32	**O-**8.31	**T-**6.41	**C-**6.10	**J**-6.10
Not a Civil Engineer	**L-**8.67	**K-**8.65	**F-**8.49	**R-**8.47	**B-**8.36	**I-**6.90	**J-**6.86	**C-**6.55
Age of Respondent								
17-23 Years	**L-**8.85	**K**-8.55	**F-**8.44	**N-**8.43	**O-**8.35	**C-**6.72	**I-**6.61	**J-**6.43
24-35 Years	**K-**8.84	**L-**8.53	**O-**8.35	**B-**8.31	**N-**8.26	**E**-6.53	**C-**5.98	**J-**5.88
36-50 Years	**K-**8.83	**B-**8.45	**L-**8.33	**O-**8.27	**R-**8.21	**T-**6.49	**J-**5.97	**C-**5.93
51-65 Years	**K-**8.99	**B-**8.55	**R-**8.47	**N-**8.40	**L-**8.35	**T-6.43**	**J-**6.24	**C-**6.19
65+ Years	**K**-9.06	**L-**8.94	**R-**8.86	**N-**8.31	**F-**8.28	**C-**6.75	**J-**6.38	**I-**5.51
Gender								
Male	**K-**8.84	**B-**8.40	**L-**8.39	**O-**8.32	**R-**8.30	**E-**6.47	**C-**6.04	**J-**6.00
Female	**K-**8.92	**L-**8.77	**N-**8.47	**B-**8.44	**H-**8.44	**I-**6.82	**J-**6.41	**C-**6.39

Far and away, the most important issue that will be impacting civil engineering over the next two decades, in the opinion of the respondents, is "Maintenance of the existing infrastructure." (K) This is followed by "Dealing with natural disasters." (L) The only demographic groups that differed with this overall opinion were the international respondents and the students and very young members. For these groups, the ratings were reversed, with the international group ranking "Engineering ethics and business practice ethics" (R) ahead of the infrastructure (K) category, but behind natural disasters. (L) Recent catastrophes notably the tsunami in the Indian Ocean and the earthquake in the Kashmir region which received a lot of international press may have a lasting effect to the international respondents compared with US-based respondents. ASCE's periodic Infrastructure Report Card is directly addressing the #1 issue in the minds of civil engineers.

Another interesting trend is the importance of the natural disasters category (L) relative to age. For both the age and experience demographic categories, the importance of this category declines with age, until they retire, and then it again gains in importance. This may be reflective of the number of retirees who retire to the hurricane-prone areas of the United States.

Civil engineers are concerned with the "Number of civil engineers involved in the decision-making process for infrastructure policy." (B) More engineers will have to have a background in public policy decision making and then seek employment that will permit them to have an effective voice in the decisions that are being made.

Professional licensure (O) and engineering ethics (R) will continue to be important to civil engineers in the future, as evidenced by their relatively high standing in the survey.

On the other hand, the respondents believe that nano (C) and bio-technology (J) will not be critical issues for the civil engineer of 2025.

The overall results for Question #5 for all respondents are tabulated in the following table.

TABLE E-7

Mean		
8.85	K)	Maintenance of existing infrastructure
8.45	L)	Dealing with natural disasters
8.40	B)	Number of civil engineers involved in the decision-making process for infrastructure policy
8.32	O)	Importance of the engineering license in the practice of civil engineering
8.30	R)	Engineering ethics and business practice ethics
8.25	N)	Ability of US engineering schools to teach the broad range of skills needed to practice successfully as civil engineer
8.09	F)	Advances in, and applications of, engineering software/hardware
7.97	H)	Incorporation of sustainability into civil engineering solutions
7.93	P)	Advances in, and applications of, on-site construction technologies
7.75	U)	Advances in, and applications of, information technology
7.70	A)	Number of students entering the civil engineering pipeline
7.63	S)	Advances in, and applications of, worldwide electronic communication and electronic

		collaborative capabilities
7.08	G)	Use of global civil engineering talent in developing projects
6.97	D)	Development of non-traditional project delivery systems
6.82	I)	Civil engineering services viewed as a commodity and not as a professional service
6.78	Q)	Dealing with terrorist threats
6.73	M)	Emergence of additional civil engineering specialties
6.66	T)	Pro bono work by engineers to improve the basic infrastructure of developing countries
6.59	E)	Diversity of US civil engineers
6.10	C)	Advances in, and applications of, nanotechnology
6.07	J)	Advances in, and applications of biotechnology

Question 6. To what extent do you believe the following factors would be important in making individuals more excited about a civil engineer in 2025?
1 = not important at all, 10 = extremely important

A) Greater diversity in the profession
B) Greater involvement in infrastructure policy-making
C) More competitive pay in relation to other leading professions
D) Greater public respect
E) Less involvement in applying routine software design applications
F) More respect from company management
G) More opportunities to be leader of a project team
H) Fewer hours worked per week
I) More opportunities for researching and applying new civil engineering technologies
J) Broader and more extensive education before becoming a practicing civil engineer
K) More leadership opportunities in community and national affairs
L) Ability to advance to higher pay and stature in parity with senior management engineers while still doing design

The following table presents a summary of the results. The top 5 ranked items and the bottom 3 ranked items are presented along with their mean scores.

TABLE E-8

SUMMARY RESULTS FOR QUESTION #6								
DEMOGRAPHIC CATEGORY	TOP 5 RANKED FACTORS MAKING CIVIL ENGINEERING MORE EXCITING IN 2025					BOTTOM 3 RANKED FACTORS MAKING CIVIL ENGINEERING MORE EXCITING IN 2025		
Overall Results	**C-**8.77	**D-**8.34	**L-**7.95	**G-**7.83	**B-**7.67	**A-**6.48	**E-**6.10	**H-**5.96
Geographic								

	United States	**C-**8.82	**D-**8.34	**L-**7.95	**G-**7.75	**B-**7.60	**A-**6.25	**E-**6.04	**H-**6.04
	International	**C-**8.50	**D**-8.37	**I-**8.31	**G-**8.20	**B-**8.40	**A-**7.64	**E-**6.05	**H**-5.52
Area of Practice									
	Private Practice	**C-**8.78	**D-**8.32	**L-**7.91	**G-**7.70	**B-**7.50	**A-**6.23	**E-**6.00	**H-**5.94
	Government	**C-**8.74	**D-**8.37	**B-** 7.92	**L-**7.91	**G-**7.86	**J-**6.52	**H-**6.05	**E-**6.00
	Industry	**C**-8.94	**D-**8.47	**F-**8.17	**G-**8.09	**L-**8.08	**J-**6.74	**E**-6.21	**H-**5.89
	Education	**C-**8.60	**D**-8.33	**I**-8.09	**L-**8.00	**G-**7.97	**A-**7.04	**E-**6.39	**H-**5.76
Civil Engineering Work Experience									
	Civil Engineering Student	**C-**8.64	**D-**8.36	**L-**8.33	**I-**7.95	**G-**7.94	**A-**6.80	**E-**6.58	**H-**6.46
	1-2 Years	**C-**8.86	**D-**8.45	**L-**8.27	**G-**8.04	**I-**7.85	**J-**6.55	**E-**6.35	**H-**6.25
	3-5 Years	**C-**9.00	**D-**8.29	**L-**8.27	**G-**7.99	**F-**7.75	**J-**6.45	**H-**6.31	**E-**6.28
	6-15 Years	**C-**8.86	**D-**8.38	**L-**7.94	**G-**7.77	**B-**7.59	**A-**6.39	**H-**6.07	**E-**5.98
	16-25 Years	**C-**8.70	**D-**8.34	**B-** 7.81	**L-**7.79	**G-**7.77	**A-**6.43	**E-**6.00	**H-**5.70
	Not a Civil Engineer	**C-**8.29	**D-**7.90	**I-**7.84	**L-**7.83	**G-**7.79	**A-**6.94	**E-**6.28	**H**-5.74
Age of Respondent									
	17-23 Years	**C-**8.64	**D-**8.48	**L-**8.28	**G-**7.92	**I-**7.85	**A-**6.68	**E-**6.56	**H-**6.36
	24-35 Years	**C-**8.94	**D-**8.36	**L-**8.18	**G-**7.89	**F-**7.68	**A-**6.45	**H-**6.22	**E-**6.18
	36-50 Years	**C**-8.79	**D-**8.29	**L-**7.79	**G-**7.77	**B-**7.71	**J-**6.50	**E-**5.95	**H-**5.93
	51-65 Years	**C-**8.62	**D-**8.36	**B-** 7.88	**L-**7.82	**G-**7.79	**A-**6.40	**E-**6.07	**H-**5.62
	65+ Years	**C-**8.36	**D-**8.17	**F-**7.91	**G-**7.91	**L-**7.80	**A-**6.35	**E-**5.89	**H-**5.18
Gender									
	Male	**C-**8.75	**D**-8.32	**L-**7.88	**G-**7.81	**B-**7.67	**A-**6.37	**E-**6.07	**H-**5.85
	Female	**C-**8.88	**D-**8.50	**L-**8.35	**G-**7.94	**F-**7.81	**H-**6.53	**J-**6.49	**E-**6.23

The homogeneity of the responses to this question are quite remarkable. For all demographic categories the #1 factor is "More competitive pay in relation to other leading professions" (C), and the runner-up is "Greater Respect" (D). The third most important factor is "Ability to advance to higher pay and stature in parity with senior management engineers while still doing design." (L) Obviously, these three factors are interrelated.

Leadership is also important as evidenced by the high rankings of "More opportunities to be leader of a project team" (G) and "Greater involvement in infrastructure policy-making." (B)

On the other hand, hours worked is not important as evidenced by the last place ranking of "Fewer hours worked per week" (H). This was followed closely by "Less involvement in applying routine software design applications." (E)

"Greater diversity in the profession" (A) was also ranked near the bottom when determining what factors would be important in making individuals more excited about being a civil engineer in 2025.

The overall results for Question #5 for all respondents are tabulated in the following table.

TABLE E-9

Mean		
8.77	C)	More competitive pay in relation to other leading professions
8.34	D)	Greater public respect
7.95	l)	Ability to advance to higher pay and stature in parity with senior management engineers while still doing design
7.83	G)	More opportunities to be leader of a project team
7.67	B)	Greater involvement in infrastructure policy-making
7.66	F)	More respect from company management
7.49	I)	More opportunities for researching and applying new civil engineering technologies
7.35	K)	More leadership opportunities in community and national affairs
6.57	J)	Broader and more extensive education before becoming a practicing civil engineer
6.48	A)	Greater diversity in the profession
6.10	E)	Less involvement in applying routine software design applications
5.96	H)	Fewer hours worked per week

Question 7: This question asked of the respondent – "What do you think will be the most important issues/developments/trends that will impact US civil engineering and/or the US civil engineer over the next 20 years?"

The respondents were supplied space to provide three answers. A total of XXX first choice answers were provided; a total of XXX second choice answers were provided; and a total of XXX third choice answers were provided.

Question 8: Question 8 consisted of 6 parts, all relating to various aspects of visions for civil engineers and civil engineering. The 6 starter statements and the number of responses to each are as follows:

8a: I aspire to a vision of civil engineers who will… (2404 responses)
8b: I aspire to a public that will… (2365 responses)
8c: I aspire to a future in which civil engineering is… (2289 responses)
8d: I aspire to a vision of civil engineers who leverage technology by… (1800 responses)
8e: I aspire to a vision of civil engineers who deal with globalization by…(1838 responses)
8f: I aspire to a vision of civil engineers who assume a leadership role by. (1920 responses)

Obviously, with thousands of responses, each of which is at least a phrase, and many are sentences, it is impractical to reproduce all of them in this summary. Even reproducing a small percentage of them would not be necessarily representative or meaningful.

Therefore, it was decided to analyze all of them by using a word search tool and searching for key words or phrases. For instance, if the 2404 responses of 8a are searched for the word "lead", then in addition to "lead", the derivatives "leader" and "leadership" are also highlighted, as well as any other word with "lead" in it. This resulted in 505 occurrences that included some variation of the word "lead" out of the 2404 responses.

It was assumed by the Committee that the frequency of these key words and phrases was indicative of the importance of these key word or key phrases in the responses to this question. This information was then used by the Committee to ensure that key words, phrases, or concepts were factored into the planning and framing of the issues for the Summit.

The results are as follows:

8a: I aspire to a vision of civil engineers who will… (2404 responses)

KEY WORD OR PHRASE	NUMBER OF OCCURRENCES
lead, leader, leadership	505
respect, respectful	210
decision, decision maker	160
technical	114
vision, visionary	37
team, teamwork, team player	25

APPENDIX F

Annotated Bibliography

Prior to the Summit on the Future of Civil Engineering, participants received selected documents and annotations of books, reports, articles and other resources relevant to some aspect of the future. These materials are presented here, largely as they were sent to the participants, for possible use by others.

- ASCE Task Committee to Plan Conference on Civil Engineering Research Needs, 1988. ***Civil Engineering in the 21st Century: A Vision and a Challenge for the Profession,*** ASCE, Reston, VA. (12 pages). (Suggests changes in practice, education, research, policy. This is the most recent ASCE vision report prior to the June 2006 Summit.)

- ASCE Body of Knowledge Committee, 2004. ***Civil Engineering BOK for the 21st Century,*** ASCE, Reston, VA. Executive Summary (8 pages). (Prompts thought about where we ought to prepare civil engineers for entry into the practice of civil engineers as viewed by an increasing number of educators and practitioners.)

- ASME Council on Education, 2004. **"A Vision of the Future of Mechanical Engineering Education,"** ASME, November. (Cites the need for critically examining engineering education. Indicates that mechanical engineering is moving from "generation and application of heat and mechanical power and the production design, and use of machines and tools" to addressing "societal concerns through analysis, design, and manufacture of systems.")

- Barker, J. A., 1989. ***Discovering the Future: The Business of Paradigms,*** ILI Press, St. Paul, MN. (Warns of the danger of paradigm paralysis and advocates paradigm pliancy. Provides many examples of dramatic paradigm changes.)

- Birnberg, H., 2002. **"Forecast 2000/2001 and Beyond,"** *Engineering Times*, NSPE, Vol. 22, No. 3, March. (Predicts increased emphasis on project managers in design and construction organizations apparently due to increased project complexity, expanded outsourcing of design and construction, more use of independent contractors in the private sector to match fluctuating work loads, continued consolidation of E/A firms, growth in design-build, higher service expectations, expanded web-based project management, and even broader role for civil engineers. The author is Executive Director of the Association for Project Managers.)

- Bradley, R. M., 2005. **"Survival of International Civil Engineering Consultancies: The Need to Adjust to Reality,"** *Leadership and Management in Engineering - ASCE,* October. (Describes the challenges faced by American civil engineering consulting firms trying to operate successfully in developing countries given that indigenous firms are acquiring the knowledge and skills needed to do most of the engineering. Success requires improved productivity and greater localization.)

- Center for Strategic and International Studies, 2006. **"Seven Revolutions: What Will the World Look Like in 2025?"** http://www.7revs.org/sevenrevs_content.html. (This website explores these seven revolutions or drivers of change: population, resources and the environment, technology, knowledge, economics, conflict, and governance. Leaders can use this website to expand and stimulate their thinking and that of their colleagues.)

- Collins, J., 2001. ***Good to Great,*** Harper-Collins, New York, NY. (Argues that having the right people "on the bus," engaged in frank, open-minded, out-of-the-box thinking is a key to developing ideas and strategies for a successful future. Honest evaluation and informed discussion will yield continuous improvement. Notes that true leaders are steady, consistent, non-flashy individuals with vision, tenacity, and long-term patience. They are passionate about their organization and are willing to pay the price for improvement and share the glory with others. They see the big picture, are willing to hear and digest facts, and aren't driven by short-term gain.)

- Diamond, J. M., 2005. ***Collapse: How Societies Choose to Fail or Succeed,*** Penguin Books, New York, NY. (Analyses five ancient, collapsed, societies and four ancient, surviving, societies, each beset with ecological crisis; lays the groundwork for understanding the importance of the crucial choices made by those populations; and offers a perspective for the problems plaguing our modern world. Because globalization now makes it impossible for societies to collapse in isolation, these insights into some of the deepest mysteries of the past offer hope for the future and a framework for our decisions and actions.)

- *Engineering Times,* 2000. **"Engineers, Scientists Share Their 2020 Vision,"** February. ("Engineers and scientists at Battelle predict that the next two decades will bring a world of microscope cancer-eating machines, personalized public transportation, energy and green technology revolutions, cloned human organs, intelligent appliances, and computers everywhere, maybe even embedded in our clothes or under our skin.")

- Friedman, T. L., 2005. ***The World is Flat,*** Farrar, Stauss and Giroux, New York, NY. (New technologies, new business practices, and new players are converging globally and will markedly change the way business is conducted. Chapter 6 suggests loss of American dominance partly because fewer young people are

pursuing mathematics, science, and engineering careers and because of a decline in ambition of American youth relative to counterparts in other countries.)

- Graham, L. R., 1993. ***The Ghost of the Executed Engineer: Technology and the Fall of the Soviet Union,*** Harvard University Press, Cambridge, MA. (Argues that the Soviet Union failed to become a modern industrialized country, in spite of its vast natural resources and huge number of engineers, because of "misuse of technology and squandering of human energy," including its engineering talent, until its demise at the end of 1991. As the U.S. increasingly participates in a global economy, might our country's self interest be better served if we more fully utilized our engineering talent? Maybe we can learn a lesson from the Soviets who did not practice good stewardship with their engineers.)

- Heenan, D. A., 2005. ***Flight Capital: The Alarming Exodus of America's Best and Brightest,*** Davies-Black, Mountain View, CA. (Describes how emerging economies are luring their native born, highly-educated professionals from the U.S. back to their home countries. Outlines 12 actions the U.S. could take to reverse the "brain drain.")

- Minnesota Supreme Court, 2004. **"Professional Aspirations: Aspiration Standards of Conduct for the Bench and Bar of Minnesota,"** January. (Memorializes the obligations of lawyers and judges to the legal system, to clients, to each other, and to citizens. Stresses values and attributes including respect, dignity, honesty, education, judgment, civility, courtesy, cooperation, and punctuality.)

- National Academy of Engineering, 2004. ***The Engineer of 2020: Visions of Engineering in the New Century,*** Washington, D.C. (Concludes that if the engineering profession wants to determine its future, the profession must agree on a vision, transform engineering education, present engineers as broad-based technology leaders, accommodate innovations from non-engineering fields, and become more interdisciplinary.)

- National Academy of Engineering, the National Academy of Sciences, and the Institute of Medicine, 2006. ***Rising Above the Gathering Storm: Energizing America for a Brighter Future – Executive Summary,*** Washington, D.C. (Warns that the U.S. increasingly risks losing jobs to global competitors and advocates more mathematics, science, research, and innovation.)

- Rogers, M., 2002. **"The Practical Futurist: Boiling the Ocean,"** *Newsweek*. (Observes that, because of the increasing rate of technologic change, "the future happens much more quickly" and concludes that "we're all futurists now—practical futurists, trying to map the shortest path between today and a point not that far in the distance.")

- Silberglitt, R., P. S. Antón, D. R. Howell, and A. Wong, 2006. ***The Global Technology Revolution 2020, In-Depth Analyses,*** Technical Report, RAND National Security Division. (Reports on the results of a study that identified "technologies and applications that have the potential for significant and dominant global impacts by 2020.")

- **The World Future Society,** http://www.wfs.org. (The World Future Society is "an association of people interested in how social and technological developments are shaping the future." Publishes the bi-monthly *The Futurist.*)

- Toffler, A., 1980. ***The Third Wave,*** Bantam Books, New York, NY. (Describes three types of societies and, using waves as a metaphor, claims that each successive society pushes the preceding one aside. The First Wave Society is the agrarian which replaced the hunter-gatherer culture. The Second Wave Society is the "mass" culture, that is mass production, distribution, consumption, education, media, recreation, entertainment, and weapons of destruction. This "mass" model is now being replaced by the Third Wave, the post-industrial society. This wave is characterized by ready access to information, diverse life styles, fluid organizations, and customization. Toffler also authored *Future Shock,* (1970).)

Acknowledgements

Many individuals helped identify resources listed in the Annotated Bibliography. The assistance of the following is gratefully acknowledged: Richard O. Anderson, SOMAT Engineering; Neil Grigg, Colorado State University; W. M. Hayden, Management Quality by Design; Robert Houghtalen, Rose-Hulman Institute of Technology; Thomas A. Lenox, ASCE; Blaine Leonard, Utah Department of Transportation; Rick McCuen, University of Maryland; and Stuart G. Walesh, Consultant.

APPENDIX G

Vision: What It Is and Isn't

Prior to the Summit, the organizers researched and discussed the meaning of vision. Some vision definitions discovered during this process are:

- "A mental model of a future state of a process, a group, or an organization."[2]

- "A cognitive image of the future which is positive enough to members so as to be motivating and elaborate enough to provide direction for future planning and goal setting."[3]

- "A mental image of something that is not perceived as real and is not present to the senses" "…produced by the imagination."[4]

- "An image (not just an idea) of an attractive (compelling) future state unique to a group, organization, or community that gives meaning to effort [and] motivates people to work together in the turmoil of a changing world."[5]

- "A useful vision statement answers these questions: How will we be different or better? What new roles or areas will we cover? What new measures of success will we have achieved?"[6]

Based on input like the preceding, vision as used in this report is mental, cognitive—not reality, or even close to reality, as we know it today. It is influenced, at least in part, by imagination, reflective of actual or desired values, and focused on "what," not "how." Finally, vision is stimulating, energizing, engaging, and inclusive.

In contrast, a vision is not, and does not contain, the means to achieve it. Nor is a vision the next logical or evolutionary improvement in a process, group, or organization, as important as that may be.

APPENDIX H

The Summit Program

Date	Time	Function
Wednesday		
June 21	6:00 – 7:00 PM	Cocktail Reception
	7:00 – 10:00 PM 7:00 – 7:15 PM	Dinner Welcome from • *ASCE President Dennis Martenson* • *Co-chairs, Pat Galloway and Stephen Bechtel*
	9:00 – 10:00 PM	Keynote Presentation by Michael Rogers Q&A
Thursday		
June 22	7:30 – 8:15 AM	Breakfast
	8:15 – 8:25 AM	Welcome by ASCE President
	8:25 – 8:35 AM	Purpose of the Summit
	8:35 – 8:50 AM	Overview of breakout team procedures
	8:50 – 9:20 AM	First Discussion Topic - Globalization and the Civil Engineer of 2025 Presenter: Ralph Peterson, Chairman, CH2M Hill
	9:20 – 9:35 AM	Refreshment Break
	9:35 – 11:00 AM	Group Breakouts
	11:00 – 11:05 AM	Transition to plenary
	11:05 – 11:35 AM	Second Discussion Topic - Technology and the Civil Engineer of 2025 John G. Voeller, Senior Vice President, Chief Knowledge Officer, Chief Technology Officer; Black & Veatch
	11:35 – 11:40 AM	Transition to lunch room
	11:40 – 12:40 PM	Lunch
	12:40 – 1:10	Report on 1st Group Breakout, Discussion
	1:10 – 2:20	Group Breakouts
	2:20 – 2:35 PM	Refreshment Break
	2:35 – 3:05 PM	Third Discussion Topic - Leadership and the Civil Engineer of 2025 Presenter: Hank Hatch, Hon.M.ASCE
	3:05 – 4:15 PM	Group Breakout
	4:15 – 4:20 PM	Transition to plenary
	4:20 – 4:50 PM	Report on 2nd Group Breakout, Discussion
	4:50 – 5:00	Wrap up of day
	5:00 PM	Adjourn for the day
	6:00 – 9:00 PM	Cocktails and dinner

Friday		
June 23	7:30 – 8:15 AM	Breakfast
	8:15 – 8:30 AM	Summit recap
	8:30 – 9:00 AM	Report on 3rd Group Breakout, Discussion
	9:00 – 9:15 AM	Charge to Attendees for Final Breakout—Aspirational Visions
	9:15 – 10:30 AM	Group Breakouts
	10:30 – 10:50 AM	Refreshment Break
	10:50 – 12:20 AM	Breakout reports on aspirational visions– 10 minutes per group. For each related set of visions (for 3 topic areas), 10 minutes of consensus seeking.
	12:20 – 12:30 PM	Closing remarks, with recap and next steps
	12:30 PM	Adjourn

APPENDIX I

Keynote Presentations

Looking Ahead:
How Do We Think About 2025?

Michael Rogers
Futurist

Good evening, ladies and gentlemen.

I deeply regret that circumstances have made it impossible for me to travel and join you in person at dinner tonight. But hopefully through the miracle of modern technology I'll still be able to provide a somewhat ethereal voice of the future.

The situation reminds me a bit of a speech I gave late last year in Japan, where there was a translator and wireless headphones for most of the audience. The speaker ahead of me was also American and midway through his speech, he told a joke—which I always consider rather risky in Japanese translation—but after a moment he got a nice round of laughter. I gave my speech and afterwards went up to the translator and congratulated him on his skill at translating so well that even the joke got a laugh. "I must tell you the truth," the translator told me. "What I said was: 'Now the speaker has told a joke.'"

So please don't be surprised if every once in a while during this speech I say, "Now the speaker is waving his arms."

Ever since I began discussing this occasion with David and Meggan, months ago, I've looked forward to being in such distinguished company and helping in some small way to launch what I think is a terrific and admirable mission. On a personal level, as well, I saw this as an opportunity to do something that would have made my late father proud. He was an engineer of the generation that went through school on the GI bill in aeronautical engineering and then found himself drawn to the space program and then ultimately to weapons work, at which he did well and advanced quite far professionally. In his late forties he began to have increasing moral qualms about the work—one day he found himself using the word *megadeaths* in casual conversation. He left weapons and retrained in civil engineering and spent the rest of his career working for the county of San Bernardino in southern California—starting over pretty much at the bottom, but nonetheless he'd tell anyone that he found that work vastly more satisfying and meaningful than anything he'd done at Cape Canaveral or for the DOD, because he what he did palpably changed lives for the better, at the time and more importantly for him, far into the future.

And the future is what I want to talk about tonight—or at least the part of it that will fit into forty minutes or so. So I'll leave much untouched but I know from the schedule that over the next two days you'll cover all the rest and much more.

First, a bit of personal perspective on thinking about the future. I spent twenty years at The Washington Post Company helping a very conservative organization move into the future and in the course of it made enough false steps to greatly enhance my appreciation of just how hard it is predict what's going to happen next.

Two things that I did learn: the first, that very often the future doesn't happen as quickly as the experts say it will. Technologists are terribly good at looking ahead and seeing how all the pieces of the technology puzzle are going to fit together and produce some spectacular, society-changing circumstance. But what they're *not* good at seeing is all the little bumps and obstacles on the road to the future—social restraints, financial limitations, the general tendency of the status quo to maintain itself.

The visions of futurists too often remind me of a spot in central California, where you can stand and see Mt. Whitney, the tallest mountain in the lower 48 states, as clear and sharp as if it's just a few miles distant, and it appears that you could stroll out to the foothills in a pleasant afternoon. But should you actually set out on that stroll, you'd find that between you and Mt. Whitney is the very long expanse of Death Valley. I think it's safe to say that far too many organizations have started out with that clear vision in mind and not long thereafter found themselves mired in some Death Valley of technology.

But that's not to say that the vision itself isn't something important to maintain—and indeed I think the choice of the word "vision" for your efforts here over the next two days is an excellent one indeed.

And that leads to my second thought about predicting the future. In a sense, I think what your profession does—like many others today—is practice the art of being *practical futurists*. That's actually the name of a column I started at *Newsweek* and initially I have to say that I chose the phrase because it seemed a bit of a humorous oxymoron; I certainly didn't consider myself to be anything like a professional futurist. But the more I thought about it the more I realized that there was something to the phrase.

Like a professional futurist, the practical futurist has to make some assumptions about what the future will be like. But then *unlike* the professional futurist (whose predictions are probably long forgotten by the time the future actually happens, and thus incurs no penalty for error), the practical futurist has to place some bets—with their projects, budgets, staffing, technology choices, education and so on. And if the practical futurist is wrong, he or she pays a price.

Practical futurism is a bit like sailing upwind. First you need to determine an end point—your best guess as to where you want to end up in the future. But you rarely have the chance to sail directly to your destination. Maybe the technology you need isn't ready for prime time yet; perhaps your current budget won't cover everything you'd like to do; maybe you haven't yet convinced top management that your vision is correct; perhaps you haven't fully amortized your existing infrastructure—or any of dozens of other potential impediments to direct progress.

So the practical futurist moves forward by tacking to one side, then the other, all the while keeping the end destination in mind. The one absolute: make sure you're never heading directly opposite from where you ultimately want to land. In the end, the future happens incrementally, not all at once.

Now, with all those caveats about the future in place, let me try to suggest some structures and models within which to conjure up a sense of 2025. I'd like to do that from two specific perspectives: the first, the impact of the automobile on infrastructure and society in the previous century, and then the impact of the next generation—the first generation raised never knowing a world without the Internet—on this century.

First, the automobile. I think that if you were a practical person at the turn of the previous century, circa 1905, you would have looked at the early automobile and said, "Yes, I can see how this will be a somewhat useful invention, at some point in time. Of course it's still too hard to use, and gasoline is difficult to come by, and there are relatively few roads good enough to even support the device, but sooner or later, I can see that this will catch on with some people. I might even be able to use it in my business at some point."

Very few people, I'll contend, at that point in time would have said: "This invention will rapidly reshape the landscape of America. It will change where we live, where we work, how we shop, even how we meet our mates." Yet that's exactly what the automobile did in the first half of the last century. And I'm going to argue that that's what the intersection of cheap computing and ubiquitous Internet access will do to our country during the first half of this century—perhaps not on such a grand physical scale, but most certainly capable of exerting as fundamental a retooling of our economic infrastructure.

How will the information revolution accomplish this?

To being with the obvious: over the next twenty years, computing power will become both enormous and tiny. Moore's law of doubling yields and falling prices now looks good through 2020; and Texas Instruments just announced yesterday yet another way to reduce transistor size on wafers. The result will be very powerful computers on a chip, integrating both processors and memory components, that can be built into almost any object on earth.

Perhaps even more important than the increase in computing power and memory, however, will be the rise of intelligent sensors: devices that add the ability to sense any kind of physical phenomena from the obvious—temperature or strain—to more subtle aspects like chemical and atmospheric changes or even the number of people in a room. The cost of these intelligent sensors will plunge also, and increasingly they will be part of the fabric of construction everywhere.

Another aspect of the telecom revolution will radically increase the utility of these smart sensors, and that is the availability of huge amounts of Internet bandwidth, virtually

anywhere in the world. The comparison I often make is that bandwidth is currently like computer memory was in the Eighties—you never have quite enough of it, and it's expensive to buy more. Nowadays, of course, we buy a computer with a gigabyte of main memory and don't think twice about it. In a similar fashion, over the next decade, the cost will plummet and high-speed, always-on Internet connectivity will be available virtually anywhere.

Several factors will drive that: first, the lighting of all the "dark" fiber that was laid underground during the telecom bubble of the late 90's—there's still a bunch of it, and by now it can be used with orders of magnitude more efficiency. Secondly, we're starting to see a rapid rise in wireless Internet connectivity with the emerging WiMAX standard. That will only accelerate in 2009, as all of the analog television transmitters are turned off and their valuable "beachfront spectrum" is auctioned off and almost certainly redeployed for yet more wireless broadband. And finally, improvements in low Earth orbit satellite Internet service will gradually fill in whatever spaces remain unprovisioned.

Connecting it all together will be the Internet—which sounds like a terribly obvious observation, but here's why it's significant. For the first time in the history of data transmission, the Internet is driving truly global standards. Throughout the latter decades of the last century, attempts to create broad data networks that cut across multiple locales and industries usually foundered on various kinds of incompatibility, either of hardware, software or data structure. (I used to tell a joke when I spoke to personal computer executives, but I stopped telling it because they never laughed. The joke was this: "You people *love* standards. You have so *many* of them." And they'd all nod and congratulate themselves—yes, we have lots of standards—but of course that was what was driving consumers crazy…nothing ever seemed to work with anything else.)

Now, however—while powerful industries or companies may still try to impose their own proprietary standards for competitive advantage—the clear direction of the global Internet is toward open standards. And as we add another billion Internet users over the next decade, as well as who-knows-how-many physical objects with their own IP addresses, the drive for universal standards will be all the more unstoppable. And what that means is that suddenly it will become much easier for very large scale networks to suddenly come together, exchange information and interoperate, as naturally as the standardization of physical construction materials makes large-scale construction projects far easier to manage.

The result over the next twenty years will be the gradual growth of what will literally be a thin film of intelligence and connectivity all across the planet, taking the notion of smart buildings, smart cars, smart infrastructure to an entirely new, interconnected level. In the short term, in fact the big question is how much existing infrastructure can be retrofitted to take advantage of it. The idea, for example, of "smart" highway systems that someone direct and maximize the efficiency of traffic by communicating with smart cars is compelling—but how long will it take to make smart cars even 50% of the vehicle population?

Even with this caveat about retrofitting existing infrastructure, I think literacy about software and data will become part of civil engineering—not just the pluses (and minuses) of using automated design tools, but software and networking as almost literally another kind of building material. Civil engineers may find themselves forced to weigh in on a topic that's currently under discussion in software engineering circles: at what point are software applications so mission-critical that programmers should be licensed to insure public safety?

Is there any potential show-stopper in this vision of a very smart, networked infrastructure busy doing everything from conserving energy and controlling traffic to helping buildings survive hurricanes? Perhaps one, which is the issue of handling complexity in software. The hardware world has managed to stay on the Moore's Law treadmill with consistently astonishing results: when Gordon Moore suggested it in 1965, there were about thirty transistors on a chip. Intel confidently expects to reach ten billion by 2010.

But software has most definitely not kept pace. As software programs reach millions of lines in length, the opportunities for error or unforeseen interactions seem to rise proportionally. In a related development, as the use of the Internet for increasingly sophisticated business transactions increases, so do the level and intensity of security issues. Both of these issues—dependability and security—will need to be carefully addressed in the next decade before software truly becomes an elemental building block of infrastructure.

So we're nearly at the end of my extended metaphor about the automobile's impact on infrastructure in the previous century, and that of information technology in the current. But there is one last vestige of the automobile to address: our on-going and almost certainly accelerating low-grade energy crisis. As Chinese and Indian consumers enter the middle class and their countries begin to dominate the oil market, we are almost certain to experience an increasing number of intermittent energy disruptions. None, I suspect, will be so lengthy or severe that anything more than incremental urgency is added to alternative energy development. That's partly due to increasingly short-term planning by both government and corporations: alternatives are likely to remain less than fully funded, and there will be relatively few structural encouragements to mass commercialization. And the US in particular may not be capable of the massive new capital expenditures that large-scale energy conversion would require, so sticking with a known—even if often painful—economic reality becomes the inevitable choice.

Conservation efforts, such as fuel-efficient hybrid automobiles and smart use of energy conservation techniques in construction will probably provide the greatest technologic impact on energy consumption. Hydrogen will remain stuck in the R&D category due to its initial reliance on hydrocarbons and infrastructure costs. The various forms of solar will continue to proliferate on a piecemeal basis, although advances in material science will particularly drive down photovoltaic costs. And nuclear energy has already begun a resurgence that will accelerate mildly with increasing public concern over energy costs and promotion of safer plant technology.

In short, due to global demand, I believe that energy supplies will be stretched to the maximum for decades to come and for the most part we will learn to live with it. However, there's one big implication: the largest single game-changer in the progress and direction of technology between now and 2025 would be a sudden, major disruption in energy supplies that lasts for several years and appears not to be easily remedied. What could cause this? Consider the possibility of a small-scale nuclear exchange in the Middle East that rendered a portion of that region's oil supply unusable for decades.

After confirmation of the oil-fields' long-term unavailability, we would see a national—and likely global—"Manhattan Project" to remake the world's energy sources. The first beneficiary would be the nuclear industry, via a new generation of "fail-safe," rapidly-deployable compact nuclear plants. At the same time, both hydrogen and fusion research would see a flood of new funding. Photovoltaic, at that point, will be economically manufactured in large and flexible sheets and could become a standard roofing material in the southern portions of the US. Fully retooling the power grid with uniform connectivity and the software support for distributed power generation will be a multi-year project with dozens of vendors. And every aspect of energy efficiency—from new light-weight materials to high-temperature superconductors—will suddenly be shifted to the front burner.

In this scenario the technology climate will resemble a country on war footing, with concentrated government support of relevant research, tax incentives for adoption and benign or active neglect of other sectors. (Commercial television, for example, set to launch in 1941, was frozen until after WWII.) It will likely be a time of remarkable ferment and invention, as so many promising alternative energy concepts have arisen over the years only to be economically overshadowed by the incumbent sources. While the abrupt demise of the world's petrochemical foundations would be a calamity of the first order, it would also produce some remarkable new opportunities and technology breakthroughs.

So now let me transition from that very hypothetical scenario to another—the next generation—that is anything but hypothetical. But before I talk about the characteristics of that generation, let me talk for a moment about their numbers.

We've all heard that the future in most of the developing world portends an older population and a dearth of younger workers. What isn't as often observed is that the United States will continue to be the fastest-growing industrialized country on earth. The forces are already in play for a 46% population increase by 2050, and little in the next three decades will substantially change that. That means nearly 100 million additional bodies by mid-century—with 30 million more before the end of this decade. And the wheels are already in motion: the 2000 census counted more than 52 million kids in elementary and secondary school, the largest number in U.S. history—just beginning their cycle of consumption and family formation.

The United States is a perfect storm for population growth, between increasing life expectancy, a liberal immigration policy and teenagers who continue to dream of families with 2.2 kids. What that means over the next few decades is that all fixed resources will growing increasingly valuable and scarce—especially land. My friends who grew up in New York City marvel at the fact that the little beach cabins that their middle-class parents owned out in the Hamptons now sell for $2 million each. And my friends with Ivy League educations all agree that with current competition, there's no way they could get into their alma maters today. But of course both conditions exist simply because they're not making any more beachfront property or Ivy League institutions—but there are a lot more citizens who want them.

The same is going to prove true of our favorite transportation system as well. We're building more roads—but there's no way we can keep up with the number of people who want to use them. And in fact *must* use them, as increasing land prices force them further and further out into the exurbs to find affordable housing. In the last full study, in 2003, traffic congestion cost Americans 3.7 billion hours of time and 2.3 billion gallons of wasted fuel. I think it's fair to say that when you factor in costs like congestion and pollution, even if you assume some real breakthroughs in efficient vehicles, the total social cost of moving people around is going to continue to rise—while the cost of moving information around is, as we saw early, plummeting.

And this leads me directly to the unique characteristics of the next generation, whom I suggest are already evolving to face the world they will inherit.

The next generation is the first to grow up never knowing a world without the Internet and without interactive media and communications. Some of their adaptations—multi-tasking, for example, or the desire for customized media via iPods and TiVo—are things that most of us can at least partly identify with. But there's one element that I think is truly foreign to many adults.

I have a friend in Silicon Valley, in his forties, who is an engineer for Google—which is about the coolest job in Silicon Valley right now—and who also has an understanding of the Internet that's second to none. But he can't understand his fourteen year old son, who every night finishes dinner and goes upstairs, to play a massively-parallel online game with his best friend—who lives just next door, and is upstairs in his own bedroom, playing right along. Each evening and on weekends the two are "shoulder to shoulder" in the online world, talking to one another through microphones and earpieces. But they go to different schools and actually rarely ever see each other "in real life." Nonetheless, they consider each other best friends.

That to me is one of the remarkable capabilities we will see continue in this generation—the ability to form meaningful virtual relationships and successful virtual collaborations that for most intents and purposes are as substantial as those their parents had in the real world. This generation is about social networks that are held together with constant electronic connectivity. A recent sociological study of teens in Japan and Finland, for example—two countries where teen use of mobile phones and "texting" is almost

universal—shows that the technology has fundamentally changed the way they plan their days. Instead of deciding at the end of the school day that everyone will meet at, say, the pizza parlor at seven PM, they continue to text back and forth the rest of the afternoon and all just more or less converge at the pizza parlor as the plans evolve. And more strikingly, if one of the group doesn't actually get there right at seven, but continues to text, then he's considered to have "arrived" nonetheless.

What this means, I think, is that this next generation will be extremely good in virtual workgroups—but virtual workgroups well beyond the kind of simple online collaboration we think of today. The best example I can think of is an experiment some years ago at Xerox PARC—the fabled birthplace of so much personal computer and network technology. The PARC researchers decided to study what would happen if you were able to fully connect two distant worksites with a high bandwidth connection constantly transmitting audio, video, text, graphics—anything that would fit through a wire.

The result was this: you'd walk into the coffee lounge in Palo Alto and it would look like an ordinary coffee lounge—a table, some chairs—but on one wall was a huge video screen, showing another coffee lounge, only this one was in Portland, Oregon. An infrared body heat detector would ring a bell in the Portland lounge, letting them know someone was "there", and after a moment someone might wander onto the screen, nearly big as life, holding their coffee cup. And so you'd casually chat with your Portland colleague over coffee and after a while you'd both go back to your offices, five hundred miles apart.

This metaphor of constant connectivity was carried out throughout the facilities—cameras and screens and microphones everywhere. What the researchers then did was divide a project into two pieces, have half done in one site and half in the other. A team of work sociologists monitored the progress and at the end determined that basically the work had been done as if all the participants were in the same physical space.

That, to me, is a remarkable finding—but all the more believable now that the next generation is showing its skills at virtual collaboration. And what I think that means is that we'll see an explosion of setups like the Xerox PARC work, only with far more advanced technology. Already places like MIT and the National Institutes of Health are creating very sophisticated virtual conference spaces—some even equipped with software that can automatically sense who at a conference table is speaking and bring their image to the fore onscreen. A Canadian team is using the same technology but adapting it for high-definition video, an inevitable next step as bandwidth costs drop.

This generation's ability for virtual collaboration will lead almost inevitably to a natural embrace of globalization. I learned this early on a few years ago when I was the editor and general manager of *Newsweek.com*. One day we received a request from watchmaker Patek Philipe, for an online banner ad that would show, on five of their watch faces, the time in five world capitals. I wanted to make sure those watches were accurate, so I asked my programmer, who was about twenty-two at the time, if he could write some

code that would go out on the Internet and set the displays to the signals from the atomic clock in Colorado.

"That's a little tricky," he said. "Can I hire a freelancer?" Sure, I said, but don't break the bank.

Two weeks later he came back with the ad and it not only worked beautifully but was done very elegantly, with the bare minimum of code used. I said I'd like to meet the guy who did this. "Well," my programmer hesitated, "I'm not sure that's possible." Why not, I wondered?

"Well, he kind of lives in Moscow."

What my young programmer had done was go out on the Internet to look for a freelancer and simply hired the best and cheapest one he could find. Then it hit me: How did we pay this fellow? "Uh," said my employee, "he wanted American dollars, in cash. So you know that sealed pouch that goes to the *Newsweek* bureau in Moscow? I just put it in there and he came into the office and picked it up."

Who knows what currency laws we might have been violating there, but the point is clear: my young programmer, as he grows up and rises through the ranks, is never going to think twice about employing someone on the other side of the planet.

And there will be plenty of people for him to choose from, because one side-effect of the Internet on the next generation globally is what I call the democratization of information. Two decades ago a friend of mine used to make money by air-freighting the latest American programming manuals to Europe, where the books wouldn't come out for another few months. Now, of course, you can download tutorials on the most advanced kinds of Java programming anywhere from Minneapolis to Mombasa.

As a result, it's not news that first call centers and now programming jobs are increasingly shipped overseas. But the democratization continues: Reuters is outsourcing more and more of its reporters to Bangalore, and it's already possible to have extensive amounts of American legal research done far more cheaply overseas. And some American medical students are already declining to pursue radiology as a specialty, as digital radiography allows the outsourcing of x-ray reading to places like Ireland and Australia. When you consider the nature of civil engineering and its specialties in 2025, I'd suggest as much latitude as possible when considering how elements of the work could end up distributed around the planet.

Finally, let me take a moment to speculate a bit about the impact of this highly interactive environment on the next generation's education and cognition. Of course, in terms of the future of civil engineering, the decline in U.S. math and science skills undoubtedly remains the number one challenge, particularly when youth overseas—newly empowered by the democratization of information—see math and science as the surest stepping stones to lucrative employment. It still baffles me that we remain the only industrialized

nation that lets six graders say, “I don’t really get math,” and proceeds to more or less let them slide—resulting in a mass of college freshmen who find that their entry barred to the many career opportunities whose prerequisite is a comfortable relationship with mathematics. As a result, I’m afraid, we end up with vastly more than our global share of lawyers.

Clearly, the effort required to retool the national attitude toward math and science is something more than merely tweaking the educational system. It has as much to do with cultural expectations, work ethic and the social image of science and engineering. One might hope that the recent media popularity of the “computer geek” would be an impetus to changing the situation, but thus far—even though “geekdom” has managed to create the richest man on earth—it doesn’t seem to have had a commensurate impact on science and engineering enrollment.

More broadly, however, I’m also concerned about how the interactive media that is becoming dominant for the next generation can affect attention span, concentration and reading abilities. The multi-tasking that commentators often admire in young teens—the ability to watch television, instant-message and do their homework simultaneously—has in other contexts now also been dubbed “continual partial attention.” In other words, the electronic environment has created a situation in which no one is fully paying attention to any one thing at a time. It may well be the case that the ability to concentrate fully on one problem or piece of information at a time may be a skill that we’ll need to teach in years to come.

Of greater concern to me is the future of reading. The Internet, as it currently exists, is definitely a text-driven medium, but it’s a medium that’s about short-form reading. Not much exists in longer than fifty or one hundred word bursts of information—nor does instant messaging or email encourage lengthy constructions. (Indeed, write an email longer than one hundred words or so and you can be almost guaranteed that some of the recipients will fail to read the last sentences.)

As a result, I think the ability to read and write long-form text—tracts longer, say, than a few hundred words—may well diminish in the next generation. A decade or two hence, when most text is presented electronically, it will be a simple matter to have everything read aloud. And advances in voice recognition and automatic sentence parsing will ultimately mean that computers will likely be able to turn dictation into better prose than can the speaker him or herself. So the workplace need for long-form reading will decline, and so will those who practice it.

Some lucky subset of the population—those with dedicated parents and (probably) an inborn neural facility with abstract language—will still develop long-form literacy, and thus also inherit the considerable intellectual and organization skills that reading instills. This elite will likely have a considerable strategic advantage over the rest of the population with more limited literacy. One way I think of this is that in a decade or so, probably every kid will graduate from high school knowing how to edit digital video, but only one in twenty will be able to write a 120 page script.

At this point I fear that I'm starting to sound less like a futurist than an old fogy. But if there is anything I learned in twenty years of helping *The Washington Post* and *Newsweek* move into the 21st century, it's that in the end, the fundamentals still apply. A few years ago some technologists thought we could get rid of editors—that smart software would do the work of ranking and sorting and displaying stories, all customized to the reader's personal taste. But it turned out that a bit of that went a long way, and ultimately audiences preferred that an editor's hand remain behind the scenes rather than merely a sophisticated algorithm. More recently some commentators argued that through Weblogs and community journalism, we could get rid of professional reporters, and let the individuals closest to the stories do the reporting. Already it's becoming obvious that it's not so.

The tools and roles of editors and reporters are changing, as is their relationship to the audience, and it would be foolish to pretend otherwise. But the more things change in our field, the more we find that the fundamental skills of the profession still apply.
Thus if over the next two days you find yourselves returning to the fundamental skills and attributes of your profession as you gaze out toward 2025, that's not inappropriate. And if you also find yourselves describing some changes with perhaps just a touch of regret or even sadness, that's not inappropriate either—because in the future, when something is gained, something else is often lost.

The best example I ever saw of that was when I first came to Silicon Valley as a writer. I was there to write a novel, rather than non-fiction: young people changing the world, making vast fortunes, seemed a perfect topic. When you write a novel you do much of the same research as for non-fiction, but you also need to get to know the personalities. So I gave quite a few dinner parties.

At one of these dinner parties the guest of honor was an older gentleman who had already made a tidy fortune in the personal computer industry and was understandably optimistic about the future. Everyone else was from a more liberal arts background—a lawyer, a university professor, a doctor. After dinner my friend from Silicon Valley mentioned that he'd built a new mansion in the hills above Silicon Valley, and had installed audio light switches—"Turn on," and the lights turn on, "turn off," and the lights turn off.

These were quite advanced for their day and my friend was fascinated by them, as was his five-year-old grandson, who came for a visit and understood audio light switches right away. But then he was sent off to the other set of grandparents' house, who did not have audio light switches.

The first night they found the little five-year-old standing in a darkened hallway, shouting up at the light: "Turn on! Turn on!"

My friend finished that story, leaned across the table and said "That is a young man who will grow up believing **anything** is possible!" And there was silence around the table

and I know what everyone else was thinking: **That's a young man who will grow up not knowing how to turn on the lights.**

Somewhere in there, between my friend's great optimism about what the future might bring, and everyone else's real fear of what might be lost in the process, is where I suspect the process of vision-building begins. And with that, I wish you all the best of luck in your endeavor.

Future Think:
Is the Future Any Harder to See Than the Present?

John G. Voeller
Senior Vice President
Chief Knowledge Officer
Chief Technology Officer
Black & Veatch

The future of civil engineering two decades from now is equal parts of four roles, all of which are part of the civil engineering world today, but the elements of which must be very different in many ways. Though the general tendency is to assume a high technology or "Buck Rogers" aspect to such futures that is only a minor part. More importantly, even within the technology elements of the civil engineering future, most of those who predict such things have extremely checkered track records. A way to prevent this problem is to examine some basic precepts and foundation elements that are largely immutable over time and are generally inescapable regardless of the enterprise. These include

Population	Healthcare	Energy-less
Geography	Ubiquity	People-less
Resources	Skilled Labor	Attention-less
Stability	Borderless	Mutant-ful
Access	Scarcity	Omni-talking
Environment	Organic	Lingui-equal
Technology	Autonomous	Micro-value
	Self-repairing	

If we examine these elements, they imply the four roles. These include creator, repair person, integrator and innovator. These roles have some common drivers and some unique, but all the elements listed map into these four roles very well. However, in order to play these roles, the civil engineer of tomorrow will not only have to change their knowledge, skills, teammates, and tools; they will have to be diligent if not aggressive about eliminating the desire to:

- do what they have done in the past;
- accept what is provided by labor and artisans as all that can be done;
- succumb to the limited imaginations of those that provide equipment, materials and service; and

- suffer margins and market methods that prevents re-investment for self-improvement and optimization.

If we look at simple examples like wireless technology which is a mainstay of many future plans, the awareness of limits in capability today and those inherent in how such systems operate causes firms to presume too much and plan too aggressively. The reliance on a dramatic capability over the horizon presumes that those planning such systems are both solving problems and limitations that fit our needs or are even cognizant of the demands we will make on their systems in the far future. Examples like the major CTO's of communications companies not including the billions of inorganic participants we foresee in the next decade alone in communications is classic.

Another area of danger in examining the future of the civil engineering in 2025 is the presumption that those upon which we depend are looking equally hard to embrace the future and provide value to us beyond today's limitations. This is in no way assured and within many elements of civil engineering there is a long and painful history of not pursuing the future because of limited investment funding, inability to attract venture support, unwillingness to embrace the future because the uncertainty suggests greater risk, and inability to integrate new capabilities into the civil engineering enterprise successfully and consistently.

As ASCE and its members plan their individual, group, and profession futures, there are many methods to example the future strategically and build practical plans. However, most of these methods assume much shorter horizons and more specific outcomes that a two decade horizon normally enables. The use of the roles and elements outlined in this presentation allow the kind of leapfrogging of micro-prediction and premature conclusions common in long view thinking. It is critical that ASCE be able to make such leapfrog distances within a structured thought process before they should accept any presumed outcomes of their visioning effort.

Civil Engineering in 2025:
Globalization Issues and Impacts

Ralph R. Peterson
Chairman and CEO
CH2M HILL

Thank you David, and good morning ladies and gentlemen. It is a privilege to be in such distinguished company, and I look forward to our important work over the next couple of days.

Let me begin by commending the leadership of ASCE for having the courage and foresight to convene this ambitious . . . or perhaps audacious . . . Summit on the Future of Civil Engineering. Taking on the challenge of painting a picture of our profession in 2025, and then tackling the task of shaping aspirational visions of that future . . . visions which can enhance the positive impact and the professional excitement of civil engineering and, indeed, of the engineering profession as a whole. . . is not for the faint of heart.

But . . . however ambitious . . . this is in fact a worthwhile and important undertaking. It can . . . and with the talented group ASCE has assembled for this Summit I believe it will . . . provide us with a compass of sorts . . . a compass that can give us important strategic bearings and direction for our profession's journey forward.

The future of our profession is **going** to happen. As David said, we can either react to unfolding events and external influences, or we can get to work on:

-**analyzing** the influences and driving forces that will significantly shape our profession's future,

-**articulating** a realistic and achievable vision of the future we would like to create,

-**shaping** our actions so as to vector our profession toward the future we "choose" instead of the future we simply "get".

ASCE has wisely chosen the latter path, and it starts with this Summit.

My task is to get us started by taking a look at the issues and impacts of **globalization** on civil engineering and the engineering profession in 2025. This is intended to provide ideas and stimulus for the various breakout groups to drill into the implications and aspirations which the topic of Globalization presents.

Let me tackle that assignment by outlining five key and interconnected "global driving forces" that will shape the global context and parameters of our profession in the years ahead. We can then identify a handful of key globalization issues for our profession that emerge from the **aggregate** effect of these five driving forces. Finally, we will seek to extract a few key conclusions for all of this, with which to prime the pump for the more in-depth breakout discussions.

The five global driving forces I present for your consideration are:

- Communication and information technology serving as a profound driver of global business and economic change
- Population and demographic shifts affecting our global civil engineering practice
- Expanding trade and the emergence of democratized market economies, accompanied by heightened security concerns
- Worldwide industry and organization consolidation
- Natural resource and environmental limitations affecting global growth and infrastructure

As we shall see, these forces are interrelated. We will look at them one at a time, and then as noted try to draw some conclusions about their aggregate effect on our professional practices, infrastructure development and what kind of world we create for future generations.

Communication and Information Technology

I must begin my chronicle of global driving forces by addressing Communication and Information Technology, even though John Voeller will provide a much broader and more comprehensive discussion of the topic of "Technology" in his upcoming presentation. I will carefully avoid intruding into John's subject matter, but two aspects of technology: communication information technology and CAD/CAE, have the profound effect of magnifying and/or facilitating virtually all of the other global driving forces I will address.

It is communication IT that makes national boundaries extremely permeable . . . those same national boundaries that have historically insulated nation-states from global change drivers and external influences.

It is communication IT that enables and facilitates an accelerating transformational web of trade and finance relationships.

It is communication IT that lubricates industry consolidation and reshaping of the global corporate landscape.

It is communication IT that has helped to expand and empower Non-Governmental Organizations (NGO's), thereby allowing civil societies across the globe to organize around issues of common concern, and to share the global governance stage with national governments and multi-national corporations.

It is communication IT that allows global sourcing of labor (including engineering), as well as equipment, supplies and material.

When we add the consideration of integrated 3-D/4-D CAD/CAE information technology together with the communication IT aspects, we get an IT impact on our profession in the coming years that is truly a Richter-scale event.

A good illustration of the profound effect of this "integrated IT" catalyst on our profession can be seen in the FIATECH "Capital Projects Technology Roadmap". The vision model for the Technology Roadmap integrates 9 functional elements of the life cycle capital projects . . . ranging from planning through automated design, real-time project management, procurement & supply, integrated information management, and operations. Most of these elements exist today, but their eventual integration…as contemplated in the Technology Roadmap . . . will accelerate transformations in our industry which have already begun in fits and starts.

The trend toward integrated project delivery . . . including design/build, DBO and PPP's . . . is here already but will accelerate as IT tools (such as 3-D and 4-D design tools) are refined and . . . more importantly . . . integrated with a life cycle focus.

Think about what integrated cyber-connectivity will soon mean in terms of shortened cycle times, increased procurement and supply chain synergy, global sourcing, and operations/facility management. We're looking at not just a vastly different playing field; we're looking at a new project delivery ball game.

Value creation through project integration: that's the idea we're talking about here, and it will be a really big deal.

Population and Demographic Shifts Affecting Our Global Civil Engineering Practice

Let me continue this examination of key global driving forces with a look at some population and demographic impacts upon our engineering community.

Over the course of my 40-year engineering career, we always seemed to be asking the same question in one form or another: "Where will tomorrow's engineers come from?" But most of the firms I talk to today—and I'm not talking about just here in the U.S., but

all around the world—are identifying the availability of engineering talent….engineering "human capital" . . . as a rate-limiting factor of truly urgent proportions.

As described in the National Academy's "Gathering Storm" report released last October, and elsewhere, there are plenty of reasons for companies and agencies who are largely dependent on U.S. engineering resources to worry (this is true for all U.S. engineering resources, but especially so for civil engineers): declining numbers of engineering graduates; an aging engineering workforce; under-representation in the profession by women and the minority communities that are the fastest growing segment of the future college-age population; global cost/pricing pressures which drive down the attractiveness of our profession to new entrants; and a disturbing trend toward "commoditization" of A&E services which erodes innovation, creativity, and professional respect.

When we look at this in a global context, we can see an engineering profession (and by inference a civil engineering profession) in 2025 that will be very different from that of today.

Consider the following statistics which focus on just one country: China.

In 1985 the National Bureau of Statistics of China reported 73,000 first (BS) university engineering degrees granted throughout the nation. In the same year, according to the U.S. National Science Foundation, first university engineering degrees granted in the U.S. reached a peak of nearly 78,000, or roughly the same as China.

Ten years later, the number of engineering degrees granted in China had more than doubled to nearly 149,000, while U.S. engineering degrees had declined to 63,000. By 2002, the number of engineering degrees reported in China had more than tripled from 1985-levels to 252,000, while U.S. degrees leveled off to a NSF reported 61,000.

I know there have been questions about the accuracy and comparability of China engineering degrees (the "Gathering Storm" report cited 600,000 engineering degrees in China in 2004. We now know that figure includes many sub-baccalaureate degrees and is not comparable to the U.S. engineering degree statistics with which we are familiar.) In any event, I believe the numbers cited above are in the ballpark and are directionally correct; they clearly indicate that over the next 20 years China alone will add something over 4 times the number of engineers to the global engineering workforce as will the U.S. Now factor in other countries such as South Korea (about 65,000 engineering graduates in 2002, up from 25,000 in 1985) and India (data unclear but **big** numbers . . . and growing), and the rest of the world, and extrapolate to 2025. We're talking about a global workforce that is even more highly interconnected, and **really** different from today.

What is clear is that the historical influence of American (and other developed country) civil engineers on the world stage will diminish as a globalizing engineering workforce is affected by the twin effects of the sheer numbers of developing country engineers, **and** accelerated developing country economic clout.

Another population trend that tilts the engineering leadership scale outside the U.S. is the worldwide movement toward urbanization. Sometime in the coming year, for the first time in history, the world is expected to be made up of more urban dwellers than rural ones. And by the year 2030, more than 60 percent of the world's people, or nearly 5 billion of us, will live in cities.

Where that urban growth will occur is even more significant. Of those 5 billion urban dwellers on Earth in 2030, more than half will reside in Asia. Little wonder that 80 percent of the infrastructure to be developed on the planet over the next 20 years is forecast to occur outside the U.S.

When you add it all up:

- A smaller portion of engineers originating from the U.S. and other industrialized countries
- Urbanized development and infrastructure growth concentrated in the developing world
- Larger more youthful workforces residing in Asia, Africa and Latin America
- All stirred by wealth-generating economies in robust emerging nations

One can see that the U.S./developed country civil engineer in 2025 will be part of a truly global and multi-cultural profession in which there is probably no "dominant" culture of "national standards" influence. Everybody will need to learn from one another's experience because new and exciting projects will be going on everywhere. Adaptability to and respect for different cultures will be valued in a world where global sourcing and multi-disciplinary teams are the norm.

Expanding trade, democratization and heightened security

Let us now shift our focus to the driving force of expanding trade, democratization and their countervailing companion of upholding national and institutional security.

At the close of the 20th century, nearly two out of three people living on the Earth, (3.9 billion of us) lived under some form of democratic rule. Compare that to the start of the 20th century, when only 25 nations or just 12 percent of world population lived under what could be called democratic rule. By mid-century, still less than half the world population (42 percent) lived under some form of democracy. But today, electoral democracies now represent 120 of the 192 existing countries and constitute 63 percent of the world's population.

Clearly, "democracy's century" as some have described the 20th century, has delivered us to a doorstep of hope, freedom and economic promise for the entire world. But meanwhile, lurking at our back door, and occasionally breaking and entering, stands the

threat of global terrorism, nuclear proliferation and those fundamentalist forces opposed to seeing democracy and market economies take root.

As democracy has expanded across the globe, it has been accompanied by robust trade and economic growth. For those of us old enough to experience the past half-century, the transformation we've witnessed of the trade and economic profile of our planet is nothing short of staggering.

- The world population – now some 6.5 billion people – has more than doubled since 1950

- World GDP has increased 8-fold over the same 50-plus years reaching more than $U.S. 40 trillion in 2004

- World trade has increased 14-fold over roughly the same period of time, so trade is a growing part of global GDP

- Foreign direct investment, which reached $1.3 trillion in year 2000, is now more than seven times as large as governmental ("official") fund flows

- Foreign exchange trading…flows of money rather than trade of goods and services . . . is much more than an order of magnitude larger than the cross-border trade of goods and services

So the world, in my lifetime, has clearly moved into a finance-driven web of trade relationships that interconnect national economies. This affects all nations, their people, their businesses and their institutions, because all are part of this web. This, coupled with the emergence of just-in-time global supply chains, has created enormous economic opportunity but also heightened vulnerabilities . . . related to both security issues and natural disasters . . . from this global web.

Worldwide industry and organization consolidation

Closely linked with this global shift in finance and trade activity, and facilitated by the IT cyber connectivity comes the fourth of the driving forces I said I would cover, that being the consolidation and globalization of corporations and industries.

To give you a picture of the force of the economic current toward global, industry consolidation, a look at the 150 largest economic entities (based on value-added, not revenues) on our planet is revealing. As of 2004, the majority of those entities are not nation states, but transnational corporations. A full 63 percent or 95 of those largest economic entities are corporations.

And the trend toward a global-scale, corporate business model is expanding across business sectors and geographies.

The engineering and construction industry is by no means immune to this consolidation trend. E&C industry analyst, Paul Zofnass, did an interesting study of consolidation among firms involved in the civil infrastructure business (mainly water, transportation and environmental firms) a couple of years ago. The Zofnass analysis identified 31 firms that had 1997 revenues of $200 million or more. By 2004, 14 of the 31 had disappeared . . . either through consolidation/takeovers or financial failure.

To see how this E&C industry consolidation is taking shape, take a look at what's happening among the ENR Top 500 Design Firms. A glance at the Top 25 firms shows just how much of the industry is concentrated at the top. The largest 25 firms . . . that's five percent of the firms… accounted for 49 percent of industry revenues in 2005. A decade ago that figure was just over 40 percent of industry revenues, so the concentration is concentrating over time.

The emergence of very large trans-national/multi-national corporations carries some big implications in the context of the driving forces involving democratization and governance. The power, influence, and social significance of these multi-national corporations (MNC's) begins to rival that of nation-states, which means corporations increasingly share the stage with national governments (and NGO's) in the realm of global policy and governance.

Surveys show that public trust in these MNC's is very low, with the result that companies who demonstrate strong ethics and transparency will enjoy a comparative advantage when it comes to working with civil society and government regulators to get the "social licenses" needed for our projects.

This is the world in which we will practice as civil engineers in 2025.

Natural Resource and Environmental Limitations Affecting Global Growth and Infrastructure

Let me now turn to the last of the driving forces which will shape our profession in 2025: natural resource and environmental limitations on global growth and provision of infrastructure.

The global population now tops 6 billion people . . . and is on its way to 8 billion over the next 20 years. Economic growth in the developing countries (where half of the world's population lives on a GDP of $2/day or less) is generally accelerating, with China and India being notable examples where GNP growth rates of 5 - 7% are common. Meanwhile, economic growth in the developed countries continues at a long-term annual rate of about 2.5 - 3%. The effect of the twin pressures of population growth and economic growth will be to require about one new planet's worth of natural resources, energy and environmental carrying capacity in the next 20 years.

In this new century, we have **already** entered an era in which natural resource constraints (raw materials, water, energy, and environmental carrying capacity) begin to show up as

rate-limiting factors for economic growth. And that will have an increasingly significant impact on the way design professionals, and our clients and construction partners, think about and approach projects in the built environment. I remain convinced that the issue of sustainable economic development will become a future competitive factor for the civil engineering profession.

In addition, "sustainable" economic growth ultimately includes not just an environmental dimension but also a social equity dimension. Poverty alleviation and the provision of at least a basic quality of life is a key prerequisite for truly sustainable economic growth. Improving the quality of life for people is also the strongest foundation for global security I can imagine, and basic civil infrastructure is what actually **provides** that improved quality of life.

This situation represents a golden opportunity for civil engineers in 2025 to emerge with two defining attributes which will enhance the positive impact, respect and excitement for our profession:

-civil engineers as effective stewards of the natural resources and environmental assets needed to drive sustainable economic growth

-civil engineers as providers of the basic infrastructure that gives real meaning to idea of improving people's lives and prospects

Let me close with some summary observations about how I believe these change drivers will, in the aggregate, impact our civil engineering profession.

- Notwithstanding the current geopolitical turbulence of military conflict, security concerns, and some anti-globalization backlash, I remain convinced that the next two decades will on balance see a continuation of expanding global trade, expanded democratization, continued "marketization" of economies which are not democratically ruled (such as China), and continued globalization and consolidation of industries. This will occur in a more security-sensitive environment, and in a world of growing resource shortages (including especially water but also a wide array of mineral, natural and energy resources). It will be characterized by cross-border environmental issues (such as climate change and fisheries depletion) that . . . compared to the "point source" pollution issues we are accustomed to thinking about and regulating . . . are more complex in causation and insidious in effect.

- This will yield a marketplace in which both the opportunities and the competition are global. It will be a marketplace with new rules of engagement, in which integrated life cycle project delivery (design, procurement, construction and in some cases project development/finance and operation) will be the norm and where risk transfer and prudent risk management will be of growing importance. Project delivery models will be shaped by increasingly powerful capabilities of integrated IT tools, which will begin to resemble the old "master builder" model.

Civil engineers will have an expanded role in integrating the work of other engineering and design disciplines as well as the increasingly-integrated procurement and construction aspects.

- Global sourcing of both professional talent and material will be a competitive imperative.

  - Flexibility, adaptability and the ability to work in a multi-discipline team environment will be highly valued.

  - Winners will demonstrate respect and acceptance of different cultures and approaches.

  - Licensure will become a contentious issue as national governments use licensure as a kind of non-tariff trade barrier in a futile attempt to maintain "control" over events.

  - Procurement will be of particular importance because of global sourcing and concerns over supply chain stability arising from security and/or natural disaster disruptions.

- The pressing reality of natural resource and environmental constraints on economic growth will become critical to the civil engineering profession. As both the developing and developed worlds strive to improve their economic prospects and quality of life, we will come to grips with the fact that we live in a finite world. The leadership challenge for our profession is to reposition ourselves as effective stewards of natural resources and the environment, and providers of that improved quality of life.

- Civil society will become increasingly demanding in granting the "social license" required for our built projects. **Stakeholder communication** and **collaboration** will be as important as technical content.

- **Ethical expectations** will be high.

As each of these realities comes into focus, there will be a tendency to think of global economic growth as a kind of zero-sum game, in which the gain of one segment of our global society (i.e., one country, or one region) must be a loss for another segment. But the magnificence of engineering and the design professions is that they are capable of creating a **non-zero sum game** for our planet's economic growth . . . making more for all by ingenuity and creative resource utilization and reuse. Engineering is the profession which is most capable of creating "non-zero sumness" . . . of making the pie bigger instead of fighting over who gets smaller pieces, and civil engineering is the natural leader of that endeavor. That fact ought to be a source of pride and inspiration to us all.

I truly do believe this idea of pursuing and creating non-zero sum solutions is a powerful notion both to guide our personal practices, and for the greater good of our clients and society at-large.

As we look to the future we see a world where the global landscape is transforming the distribution of our profession's power and influence in terms of relative economic and cultural clout, the numbers and geographic distribution of engineers, economic interconnectedness, and the big wild card of security. I will leave you with these aspirational thoughts on civil engineering in 2025, which I distill from this globalization chronicle:

1. We are society's master builder. We create value for our clients and society by integrating the life cycle elements of built project delivery.

2. We use ingenuity, creativity and innovation to create **whole** projects that are **more than** the sum of their parts.

   – We thereby ensure that economic growth is not a zero-sum game.

3. We make efficient resources utilization and environmental stewardship an integral part of the built environment.

4. Our high standards for ethical conduct include zero tolerance for bribery or corruption.

Thank you for your time and attention.

Leadership

Henry J. Hatch
Lt. General (Retired)

Good afternoon. I have the privilege of introducing the third discussion topic**, leadership**. When invited to do so I initially assumed that the topic was leadership in the classic sense of civil engineers leading people, individually and organizationally, in the year 2025. As interesting as that would be, we will not discuss leadership in that context, but leadership **by the profession** in a public role in the theme areas of professional practice, infrastructure, and environment. I would point out that to have an effective public role, civil engineers, as a profession, must adopt that role as integral to their profession. We have not done that yet, at least not to the extent other professions have.

For ASCE this is certainly a high priority topic in the current development of ASCE's next strategy. In the current draft environmental scan for professional strategic issues, the top listed issue is this one:

> "Years of deferred infrastructure investment and maintenance, **and the profession's limited effectiveness in communicating with public officials regarding infrastructure needs:**
> a) **Place public safety at risk.**
> b) **Hinder the nation's economic growth and competitiveness."**

That issue focuses on one of out topics, infrastructure. You could add "…and the profession's limited effectiveness in communicating with the public on other issues as well such as professional practice and the environment."

Before getting into the specific topics we should address in our breakouts, I'll like to take a few minutes to set a context for these discussions by taking a critical look at who we are and commenting on the pitfalls in extrapolating basically 20 years into the future based on past data points.

I became an engineer because engineers not only do something—they get things done. Engineers translate dreams, ideas, hopes, and concepts into reality—enduring reality. Engineers are problem solvers, applying science and engineering to provide services or produce products and projects. To quote Herbert Hoover:

> *It is a great profession. There is the fascination of watching a figment of the imagination emerge. . .to a plan on paper. Then it moves to realization in stone or metal or energy. Then it brings jobs and homes. . .*

Then it elevates the standards of living and adds to the comforts of life. That is the engineer's high privilege.

As I progressed through what is now the first 49 years of my career, I became less satisfied with being only an executor of work directed by others and extended my interest into the broader lifecycle of what I, or my organization, or my profession was doing. I saw a need for engineers to reestablish themselves in the public and private processes that decided the what, the why, and the where of what we would do (the context), not just the how. Society needs our involvement.

This is the essential, critical theme in Rich Weingart's book *Forks In The Road*, and I believe is a key ingredient in accomplishing many of our shared objectives such as:

- Increasing public awareness, understanding and recognition of engineers.

- Attracting increasingly diverse youngsters to science and engineering — first schooling, then careers.

- Influencing public and private sectors decisions that promote prudent investment in infrastructure.

- Promoting balance in decision making to insure that development is economically, socially, politically, culturally and environmentally sustainable as well as technically.

But first, who are we? Or what's our image? Not only our image in the public's mind, but perhaps our self-image as well. As a profession, we are generally known to be, and we consider ourselves, ethical. We're honest, serious (at times humorless, or as some might say, dull), committed, more intelligent than the average (excessive humility is **not** one of our weaknesses) and we're client/customer/mission focused. Generally, we're somewhat apolitical, not as individual citizens necessarily, but as practicing professionals.

We're left-brained, unemotional, logical, very prescriptive and very predictable (perhaps that's because we understand and apply the laws of nature, the laws of physics, and we follow laws, codes and regulations precisely). Those are pluses, but what are the impediments to engagement in public issues? We tend to be exclusive, not inclusive, in our organizations and in many of our dealings. We often look down our nose at those we feel are less educated and that lack our innate intelligence and insight. We are often more interested in the individual parts of things than we are the whole in terms of scope and time — "don't bother me with life cycle consequences of that project or development, I'm

only interested in designing the foundation, etc., etc." We are apt to say, "this is not my responsibility, and someone else should do that, particularly if the "something" is beyond the specific scope of the directed task at hand.

On the other hand, some of these impediments are also, at times, our strengths. We're left-brained, unemotional in a very emotional world. We're client/customer/mission focused almost exclusively (perhaps to a fault at times) and because we are apolitical we can have credibility in a partisan political world. Many public issues needing our input, or that impact our profession, are not partisan political issues at all.

OK. So what? Given this hand, how can we possible play it and effectively serve society through engagement in public issues?

I believe, among other things we should celebrate the involvement of those among us who are capable and willing to be involved — we should reward that involvement and we should support it. We should seek out among us those who have the talent, the commitment (and also a high pain threshold at times) to engage in this process and encourage their involvement.

We can contribute our money and time to organizations (such as professional and industry associations) that represent our concerns. We should demonstrate and prove that our input is relevant and value added to the public discourse. We should talk with the public, not at them and directly to decision-makers in ways they understand.

It is important that we listen, speak, and write at the audiences' level of understanding and sophistication recognizing what biases they have, the competing messages, and what paradigms we need to break or cut through to get our points across.

Engineers are normally not known for simplifying the complicated so the average person can easily understand us. The public is deafened by the noise-level of competing messages. Everyone is competing for attention. We are relevant but does the public fully understand to what extent?

Our logic can appeal to theirs and our emotion can appeal to theirs, if we are willing to show it! How many engineers consider it absolutely contrary to their basic values to be openly passionate on an issue? That fact alone takes us off the screen in a compete-for-attention world.

We should apply our innate strengths: integrity, logic, commitment to purpose, and overcome our tendency to be dispassionate so we will be heard and welcomed as valuable participants in the public decision processes.

Most others who take strong positions and are effective advocates begin with emotion to capture attention and then follow with some (perhaps faulty) logic. We normally begin and end with cold facts and logic — all we have to do is find somewhere deep down the passion and carry our messages forward in ways that will capture attention, imagination and support. As Michael Roberts said last night, "be a strong voice."

Larry Roth, ASCE's Deputy Executive Director, gives a great presentation titled "Infrastructure as a Social Issue" that is a refreshing move to include the softer, more emotionally-appealing ramifications of our work beyond, say, technical and economic.

In closing this part, might our vision include engaging in a sufficient level of activism in decision processes to provide balance to the debate? We can and must do this without subverting the basic values or virtues of our profession. If we fail to engage, we will continue to deny society and our clients the benefit of what we can provide them not only for today but also for tomorrow.

I mentioned the dangers of extrapolating to 2025 based on past data points. An example is generational differences among the current and array of "generations." You have all heard the sometimes humorous generalizations about the generations.

There are many definitions of generational groups and I'll use one (by Claire Raines) that divides us into four:

- The Veterans, born before 1939.
- The Baby Boomers, born between '40 and '59.
- Generation X, born between '60 and '79. and
- The Millennium Generation (or Generation Y), born after 1980. (The current or recent entrants into our workforce and those who will be the newer leaders in 2025)

These generational blocks are defined by birth year, not age, hence new ones are added as time moves on. Each has its own personalities based primarily on their times more than their parent's times. That is, what was happening during their most impressionable years? A new generation is taking shape as we speak with the defining events we are now experiencing. I won't try to define their characteristics, but think of the end of the Cold War, 9/11, Iraq, and Afghanistan and how those events are shaping, say, current 10 year olds.

We might compare the personalities of the four I've labeled in such areas as outlook, work ethic, view of authority, how they view leadership, the nature of their relationships and perspective. Time won't allow that, but I'll mention two views of authority and leadership:

- First, view of authority: veteran – respectful, baby boomer – love/hate, generation X – unimpressed (you have to earn it!).
- Second, leadership: veteran – by hierarchy, baby boomer – by consensus, generation X – by competence ("I will be led by whom I respect").

Is it any wonder there are inter-generational challenges in many organizations and in our profession?

There was a very good piece entitled "Steps You Can Take to Hire, Keep, and Inspire Generation X'ers" in the Winter 2001 ASCE's journal *Leadership and Management in Engineering*. That generation is now 27 – 46 years old which brackets the average age in most engineering companies which are run by boomers and veterans.

A list of what the X'ers are saying might include: appreciate us, be flexible, create a team, develop us, involve us, walk your talk, and lighten up.

Why bother with this? By 2025 we will be able to define characteristics of at least one more generation beyond the millennium generation. Because there was no straight line joining these current four, extrapolating to the next one – generation z – is impossible. It would be a worthwhile investment to try to define them, because they are the generation we are talking about in 2025 and we don't know who they are. We won't try to do that today, but that uncertainty does suggest a need for adaptive and multi-scenario planning.

Now to the breakouts – professional practice, infrastructure, and environment. The charge for each group starts with "Paint an aspirational picture of the public role the civil engineering profession in 2025 will play in …(etc.)"

For professional practice it continues "… the definition, selection, and implementation of projects geared towards improving our natural and built environment, with sustainability being a key consideration and opportunity."

Continuing with **professional practice** for a moment, you might consider how can civil engineers take a more prominent role earlier in the life cycle of projects (or we should say, in the life cycle of meeting a need with or without a project). Pre-project life cycle roles might include the development of innovative technologies. How might civil engineers be more involved in the public and private decision processes that affect the practice of civil engineering? The former suggests direct engagement in the political process. Should civil engineers campaign for full understanding by all stakeholders of the life cycle consequences and second and third order effects of short term decisions? Should civil engineers embrace the notion of being the "master integrators?" What are the educational and business model ramifications? Should civil

engineers seek to be leaders among their professional peers in such areas as public policy, public awareness and understanding of engineering, and ethics?

For the **Infrastructure** group the charge reads "Paint an aspirational picture of the public role the civil engineering profession of 2025 will play in considering the tradeoffs between alternative approaches to infrastructure decisions." The charge seems to address three issues: what are the alternative approaches, who makes the decisions and thirdly what is the civil engineers' role? I believe the intent here is to focus on the built component of publicly-funded infrastructure. I say that because the Department of Homeland Security often reminds us that 85% of the nation's critical infrastructure is in private ownership and the current common use of the term infrastructure (beyond civil engineers) is to refer to government infrastructure as systems such as the transportation system which is more than roads, bridges, airfields etc., and includes the rolling stock and trucking companies and aircraft and the aviation industry.

The trade offs among approaches might include privatization vs. public funding. Are there others? What role should stakeholders play? By stakeholders here I refer primarily to the benefiting public and the employed or contracted service provider. What must civil engineers do to be recognized as the best source of technical input to those defining issues, developing options and setting priorities? How do engineers get effectively involved in the political process relating to public sector infrastructure decisions while adhering to their code of professional conduct? Will the "Report Card" approach be enough in 2025? What are the most effective and appropriate avenues for political action – professional societies, or trade and industry associations?

And thirdly, the charge for the environment group is to "Paint an aspirational picture of the public role that the civil engineering profession will play in 2025 in balancing the needs of today and the environmental cost of the future." I will take a little license here and rephrase the charge to say '…the public role that the civil engineering profession will play in meeting the needs of today without compromising the ability of future generations to meet their needs. Of course the reference here is the natural resources base upon which we and those in the future will depend.

This is really the sustainability issue. It focuses on the environmental aspects of sustainability, but must, in my opinion, always be considered in the broader context of the other adverbs in the expression "environmentally sustainable development:" economic, social, cultural, political, and technical. The other adverbs have always been there and have driven decisions. The issue now is how do civil engineers work to insure appropriate weight is given the environmental or natural resources part of the equation? How do we develop a valid multidisciplinary approach to this? What innovative approaches can we take in the developed and developing world? They will certainly be different. Is this another leadership role for civil engineers among our professional colleagues?

I asked David Mongan what my role here was and asked him if it was to "tee-up" the breakout discussions. He thought for a moment and said "you could look at it that way." I later thought that it would be cruel to the golfers here to use a golfing term when some of you would rather be enjoying the beautiful golf course that surrounds us here at Landsdowne!

Thank you… I look forward to our discussions.

APPENDIX J

Breakout Reports: What Will/Could Be Different In 2025?

Globalization Theme

Early in the Summit, and immediately after hearing the globalization keynote presentation by Ralph R. Peterson, CEO and Chairman, CH2M Hill (see Appendix I), six breakout groups focused on globalization. Two groups addressed the professional practice dimension of globalization, two groups addressed the infrastructure dimension, and two groups addressed the environmental dimension.

Immediately after the breakout groups completed their work, the globalization theme team used input from the six breakout groups to prepare the following tabular summary which was immediately presented and discussed at a plenary session. The summary is structured around the following two questions:

- What will be different, with respect to globalization, in the world of 2025?
- What could civil engineers be doing in that different world?

QUESTION	DIMENSION		
	Professional Practice	**Infrastructure**	**Environment**
What will be different in the world of 2025?	• Global staffing • Global communicators • Telecommuting and virtual offices • More multinational organizations • Global engineering standards • Global licensure models • High ethics • Concern with terrorism and security breaches	• Smart and green • Planning and design with blurred professional boundaries • Automated people and goods transportation • Ability to use new materials with life-cycle costing • Virtual and computational design, construction, and operation • Equitable access to basic infrastructure service	• Burgeoning population • Balance between economic and environmental demands • Macro global trends across national borders • Move to global standards • Need to earn "social license" • Conflict between government and non-government organizations (NGOs) • Sustainability dominates and standards govern

QUESTION	DIMENSION		
	Professional Practice	**Infrastructure**	**Environment**
What could civil engineers be doing in that different world?	• Attracting leaders into the profession • Rapid adaptation and innovation • New forms of risk management • Greater investment in research and development • New methods of financing projects	• Master managers • Master connectors • Master professional integrators • Master holistic visionaries • Master communicators • Master leaders • Master at integrity and ethics	• Global civil engineering practice and professional societies • Leading and managing cross-cultural and cross-discipline teams • Sustainability – design standard operating procedure • Niche/boutique firms connect globally

Technology Theme

After hearing a technology keynote presentation by John Voeller (see Appendix I), all participants went into one of six breakout groups. Two probed the professional practice dimension of technology, two the infrastructure dimension, and two the environmental dimension. The technology theme team then synthesized input from the six breakout groups and presented the results to a plenary session. That presentation, which was organized around the two questions noted above, is summarized in the following table.

QUESTION	DIMENSION		
	Professional Practice	**Infrastructure**	**Environment**
What will be different in the world of 2025?	• Standards and codes become increasingly international and default to the most stringent and are performance-based • Innovative financing models permit the have-nots to participate in basic infrastructure projects • More interdisciplinary (silo busting) incorporating technology from nanotechnology, bioengineering, remote sensing, etc. • More symbiotic relationships between academia and industry • Research and development are more proactive and more applied	• Boundaries (political, geographical, cultural, etc.) cease to exist • Technological literacy of the world population continues to decrease as the poverty numbers increase; concern finding technology workers • Technological divide between the haves and have-nots widens • Competition for limited resources (natural, money, technologically-trained people) • Rate of technology innovation results in the inability of technology users to efficiently assimilate it	• Sustainable, eco-friendly design is a necessity • Alternate energy sources are the norm • Natural hazard incidents are more costly in terms of human lives lost and property damage, with or without global warming, especially in Asia

QUESTION	DIMENSION		
	Professional Practice	**Infrastructure**	**Environment**
What could civil engineers be doing in that different world?	• More agile and adventurous in adopting new technologies • Increasing ability to understand and incorporate risk management • Greater bandwidth accelerating the use of information technology • Increasing need to become a decision maker in determining the needs, that is, the drivers of technology • Engineering judgment increasingly important • Technology creates a "smarter" public • Technology is the major catalyst in becoming the "master integrator" to lead and manage projects	• New technologies for: o Disaster reduction and response o Protection of natural and built environment o Increased resiliency and capacity o Inspection and maintenance o Infrastructure delivery o New energy sources and uses o Design and internal work processes o Paperless, connected 4-D design • Design and construct modular offsite elements for quick installation • Supervise larger numbers of less specialized staffs • More effective, compelling communicators to influence change • Apply lessons learned from the developed world to prevent deployment of obsolete systems	• Better understanding of the environment using real-time monitoring and modeling • Outlaw countries ignoring environmental impacts • New approaches to protection of coastal areas • Engineering being a catalyst for building a better world • Involved in setting national research agenda • Litigation free zones to support new ideas: o Risky applications to advance the state of the art o Tort reform • More sophisticated public infrastructure asset management and accountability • Cheaper and less intrusive ways of solving environmental problems (e.g., microbugs)

		in the developing world • Work in permeable (borderless) environments • Work in more interdisciplinary, multi-cultural integrated supply chain with cradle-to-grave teams • Think and work more holistically about: o Big picture systems o Higher-value creative systems o Life cycle costs o Asset management • Rapidly recognizing, trying, and applying new research • Modeling existing environments and systems: o With more robust data o To detect defects and deterioration o To learn from performance • Creating and deploying modular, site-specific, closed-loop infrastructure systems • Involved in project ownership and management enterprises • Working into later	• Biotech agents used wherever possible • Workplace more automated and "humanless:" more decentralized/ technology reduces human challenges • Informing the public and governments about risk management • Taking a systems/holistic view • Prepared for global impact of rapidly spreading environmental problem with incidents anywhere and impacts everywhere • New engineering applications for resource exploration and extraction • Addition of a social ethic to the codes

		age with better capacity and vitality • Creating more transparent infrastructure systems (physically and socially) • Decommissioning, recycling, reusing, and reprogramming existing systems	

Leadership Theme

Lt. General (Retired) Henry J. Hatch presented the leadership keynote presentation (see Appendix I) which was immediately followed by the previously-described breakout group–theme team process. The results are summarized in the following table.

QUESTION	DIMENSION		
	Professional Practice	**Infrastructure**	**Environment**
What will be different in the world of 2025?	• Social motivators will be different as a result of new generational demographics • Better appreciation for global impact of local decisions • Conservation and/or sustainability are requirements, not simply morally desirable • Middle size firms may be challenged. Small and large firms may be the future. • Life-long learning	• Infrastructure is a social issue • Infrastructure is significant to making economics competitive • Unified licensure or designation process • Formation of a national infrastructure trust	• Profession engaged in advance of project with balanced approach for environmental and sustainability challenges • International governance of sustainability and environmental processes and standards • Clean coal the new technology • Alternative sources of environmentally-sound fuel • Private sector

	needed to keep up with knowledge changes • Client may not be end user – but the integrator or privatization leader • Diverse workforce • Universal global standards for design and professional practice and ethics • Public a more influential partner in major civil projects		firm's social transparency is recognized for their commitment • New forms of "doing my job" decreases the projected urban center population increase • Substitute materials have significantly reduced the need to harvest and mine natural resources

QUESTION	DIMENSION		
	Professional Practice	**Infrastructure**	**Environment**
What could civil engineers be doing in that different world?	• Public has seat at the table for major infrastructure decisions • High level of ethics, engineers are viewed as trustworthy • Providing integration of all disciplines having bearings on project development • Make-up of engineering firms mirrors demographics of populations they serve • Keeping public safe from major threats, terror, natural disasters, etc.	• Content experts, ethical conduct, honest brokers, culturally aware • Listeners, system-thinkers, and communicators with public, interacting with politicians, and building coalitions • Involved at all levels – local, state, federal • Actively participating in formulating public policy • Profession, viewed by the public as attractive, diverse, visible, and relevant	• Environmental system is a normal part of infrastructure decision process • Profession has clear leadership role including environmental and sustainability challenges with other project elements • Invited early to the table prior to project identification • Environmental sensitivity not limited to regulatory issues • Profession approaches developing countries balancing environmental and sustainability

			with public health and economic needs • Advocacy beyond submitting documented opinions • Profession leading the emerging “World Life Quality Society” • Coalition of engineering professions, with trans-disciplinary stakeholders, is the go-to source of knowledge for decision process • Public routinely comments on the skill of the engineering profession to relate sensitively to their concerns

APPENDIX K

Breakout Reports: Vision Ideas

Near the end of the Summit, each of six breakout groups were asked to draft an aspirational vision drawing heavily on ideas and information shared during the Summit. These vision statements would be used later by the Summit organizers to create a single vision. Presented here are the visions developed by the breakout groups, edited for consistency, clarity, and brevity.

Vision 1

When civil engineers talk, people listen, because civil engineers are professionals:

- trusted by global society to bring technology and people together to build a better world and
- recognized as competent decision-makers and advisors for creating and maintaining a superior quality of life
- seen as the designers and constructors of the built environment, protectors of the natural environment, shapers of public policy, and leaders in the global quest toward the imagined future.

Vision 2

Civil engineers create a sustainable global community by:

- **being** ethical, compassionate, sensitive, apolitical, diverse, inclusive, flexible, respected, and visionary;
- **knowing** the body of knowledge needed to enter the profession and the role of life-long learning; and
- **doing,** that is, by leading, collaborating, partnering, communicating, teaming, managing, adapting, persuading, inspiring, developing, and articulating.

Vision 3

Civil engineers create, utilize, and share appropriate technology that improves the quality of life, meets the needs of diverse populations and cultures, preserves and enhances the natural and built environments, inspires optimism, and establishes them as the partner of choice and collaborative integrator for sustainable progress. Civil engineers have become sustainability engineers viewed as the Number 1 resource for technical leadership in

creating a safer, cleaner, equitable, and sustainable civilization. Civil engineers facilitate appropriate technology transfer that improves the quality of life while being sensitive to and respectful of diverse cultures and social needs.

Vision 4

Civil engineers, as a result of their:

- passionate commitment to public health, safety, and welfare,
- ethics,
- technical knowledge and skills,
- environmental conscientiousness, and
- innovative and creative outlook

lead, collaborate, and advise to contribute significantly to enhancing the quality of life and creating a better world as the master steward of the natural and built environments.

Vision 5

Civil engineers are the people's engineers who have earned the public's trust for the care and enhancement of the natural and built environments in which society lives and interacts. Civil engineers are the public's trusted counselor for delivering infrastructure solutions that improve lives in a sustainable manner.

Vision 6

Civil engineers harmonize and shape the natural and built environment to create a better world.

APPENDIX L

Notes

1. Ron Dubois, Pulitzer Prize-winning biologist suggested the value of vision when he said “In human affairs, the willed future will always prevail over the logical future.” In a humorous fashion, U.S. Hall of Fame baseball player Yogi Berra pointed to the need for vision, or at least direction, when he said “If you don’t know where you are going, you’ll end up somewhere else.”

2. From Burt Nanus, management consultant as quoted on http://www.heavypen.com/vision/index.html, 5 April ’06.

3. From management researchers Peg Thomas and David Greenberger as quoted on http://www.heavypen.com/vision/index.html, 5 April ’06.

4. http://www.thefreedictionary.com/vision, 11 April ’06.

5. http://www.iastate.edu/~vision2020/Phase1/b5b/B5aPeter.html, 11 April ’06.

6. Hensey, M. 1995. *Continuous Excellence: Building Effective Organizations,* ASCE Press.

7. Besides the U.S., Summit participants came from Australia, Canada, China, England, Japan, Mexico, South Africa, and Tunisia.

8. As used here, intra-disciplinary means within civil engineering, cross-disciplinary means among engineering disciplines, and multi-disciplinary means involving engineering and other disciplines such as planning, economics, and law.

9. “Pre-preg,” short for pre-impregnated, is a term used to describe a material system that is comprised of a fiber mass or other means of reinforcement that is then impregnated with a resin, slurry, or some other type of matrix, to which heat, pressure, etc. are applied to achieve desired final properties (e.g., stiffness).

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