

# **AC 2007-1233: CIVIL ENGINEERING IN 2025: THE VISION AND HOW IT WAS DEVELOPED**

**Stuart Walesh, S. G. Walesh Consulting**

**Michael Chajes, University of Delaware**

**David Mongan, Whitney, Bailey, Cox & Magnani**

# **Civil Engineering in 2025: The Vision and How It Was Developed**

## **Abstract**

In June 2006, a diverse group of civil engineering and other leaders, including international participants, gathered to articulate an aspirational global vision for the future of civil engineering. Summit participants saw a very different world for civil engineers in 2025. An ever-increasing global population that is shifting even more to urban areas will require widespread adoption of sustainability. Demands for energy, transportation, drinking water, clean air, and safe waste disposal will drive environmental protection and infrastructure development. Society will face increased threats from natural events, accidents, and perhaps other causes such as terrorism.

Informed by the preceding, an aspirational global vision was developed that sees civil engineers entrusted by society to create a sustainable world and enhance the quality of life. Civil engineers will do this competently, collaboratively, and ethically as master builders, environmental stewards, innovators and integrators, managers of risk and uncertainty, and leaders in shaping public policy.

Summit organizers and participants intend that the vision will guide policies, plans, processes, and progress within the civil engineering community and beyond including around the globe. Individual civil engineers and leaders of civil engineering organizations should act to move the civil engineering toward the vision.

Keywords – change, civil engineering, global, leadership, summit, vision

## **Introduction**

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.

Civil engineers know they cannot rest on their laurels. 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.

## **The Summit and Its Purpose**

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. 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 in addition to the U.S. (Australia, Canada, China, England, Japan, Mexico, South Africa, and Tunisia) 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." 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.

## **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) representing various elements of industry, government, academia, age, and gender 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.

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 an invited presentation on a specific topic and a concluding Summit activity would focus on crafting a series of visions.

Stephen Bechtel, Jr. and Patricia Galloway were invited to serve as honorary co-chairs of the Summit. Parallel to the Task Committee's activities, the ASCE Foundation began an effort to raise the necessary funds to conduct the Summit. Supporters of the Summit on the Future of Civil Engineering, without whom this gathering would not have been possible, were: 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; and Whitney, Bailey, Cox & Magnani, LLC

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 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 in planning for the Summit.

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. This includes an annotated bibliography, a refined version of which is Appendix A.

The TC 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.”<sup>1</sup>
- “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.”<sup>2</sup>
- “A mental image of something that is not perceived as real and is not present to the senses” “...produced by the imagination.”<sup>3</sup>
- “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.”<sup>4</sup>
- “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?”<sup>5</sup>

Based on input like the preceding, “vision” as used at the Summit and 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, a 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. This understanding of vision was shared with Summit participants.

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 a report 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, 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. A final draft<sup>6</sup> was reviewed by a wider audience, both within and outside of ASCE. A final report, reflecting the results of that wide review, will be issued in 2007.

## **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:

**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**

The Summit addressed this question: What could civil engineers be doing in 2025? Addressing this second 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
- **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:

- **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
- **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 **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.

### **Student Response**

Forty-four University of Delaware first-year engineering students in the Introduction to Engineering class were asked to read a draft of the Summit report and write a one to two-page essay. Topics to be addressed in the essay were the aspirational vision, the portrayal of the civil engineer's world of 2025, and the report as a whole. A sampling of comments from different students follow:

“I commend the selected civil engineers for trying to be prepared and ahead of the game.”

“This vision seems to make civil engineers out to be one of the most important professions in society.”

“It amazes me that civil engineers can come together... to create goals that will benefit the entire community.”

“I personally would like to be a part of this field because I know I will get the chance to make an impact on society and help people.”

“The civil engineer is a truly amazing person... intelligent, charismatic, and powerful.”

“I had no idea how important civil engineering was, and from what I have heard, seen, and read from this class and this report, I am definitely leaning towards this specific area of engineering.”

Professor Michael Chajes, who taught the course, reported that “the students were virtually unanimous in liking the report.” Chajes stated that “we have developed a document that captures the imagination of young engineers.”

Perhaps the final report, or summaries of it, can be used to more fully inform prospective and current civil engineering students, parents and counselors of pre-college students, and others about the civil engineering profession of today, and more importantly, tomorrow.

### **What Next?**

The aspirational vision presented in the vision 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.

The vision gives leaders a target to guide their policies, plans, processes, and progress on a broad and diverse front, within and outside the engineering community. 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.

In addition to technical and professional organizations, client-related organizations must also be engaged. Finally, civil engineers must also engage 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 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 use its abilities to improve the quality of lives in more areas of world. 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.

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. 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 relate to the future civil engineer so advancement toward the vision can be realized. Similarly, experienced engineers should coach and mentor younger engineers, especially during the pre-licensure period, with the goal of enhancing knowledge, skills, and attitudes acquired during formal education.

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 the brightest to the profession.

Summit organizers hope that these first sketches of possible action will cause individual members of the civil engineering community to contemplate how they, their organizations, and their 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**

The authors gratefully acknowledge the many and varied efforts of members of the Task Committee, Summit participants, ASCE staff, and report reviewers.

## **Appendix A**

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](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, Straus 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.”)
- Silbergliitt, 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).)

Note: 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. Welsh, Consultant.

## Bibliography

1. From Burt Nanus, management consultant as quoted on <http://www.heavypen.com/vision/index.html>, April 5, 2006.
2. From management researchers Peg Thomas and David Greenberger as quoted on <http://www.heavypen.com/vision/index.html>, April 5, 2006.
3. <http://www.thefreedictionary.com/vision>, April 11, 2006.
4. <http://www.iastate.edu/~vision2020/Phase1/b5b/B5aPeter.html>, April 11, 2006.
5. Hensey, M., *Continuous Excellence: Building Effective Organizations*, Reston, VA: ASCE Press, 1995.
6. ASCE Task Committee to Plan a Summit on the Future of the Civil Engineering Profession, *The Vision for Civil Engineering in 2025*, Final draft, Reston, VA: ASCE, January 12, 2007 (For the current draft, contact Editor S. G. Walesh, [Stuwalesh@comcast.net](mailto:Stuwalesh@comcast.net))