

# ACEC INSIGHTS

American Council of Engineering Companies of Massachusetts

June 2008

## The Future of Engineering: Thoughts about Engineering and Engineering Education

By Charles M. Vest, President, National Academy of Engineering



The engineering workforce of tomorrow will face profound new challenges. Each day engineers face the stress of competing in the fast-paced world of change we call the knowledge-based global economy of the 21st century. They will face even larger challenges because the nation and world will need to call on them to both seize new opportunities and solve global problems of unprecedented scope and scale.

The United States has long been King of the Hill in engineering education, especially at the graduate level, and certainly in the quality and accomplishment of our research universities overall. We have been the most technologically innovative nation on the planet. But things are changing rapidly in the 21st century.

The last half of the 20th century was dominated by physics, electronics, high-speed communications and high-speed long-distance transportation. It was an age of speed and power. The 21st century appears to be quite different, dominated by biology and information, but also by macro-scale issues like energy, water and sustainability. These are things that should be strengths of US engineers, but the context is rapidly evolving.

We once dominated all other countries in terms of expenditures on research and development, but today North America, Europe and Asia each account for about a third of the world's R&D expenditures. Although the US is still on top, we are losing "market share" in every category used to evaluate R&D. From 1986 to 2003, the U.S. share of R&D spending dropped 9 percent. The US dropped 8 percent in share of scientific publications, dropped 10 percent in share of new of science and engineering bachelors degrees, dropped 2 percent in share of U.S. patents, and dropped 30 percent in share of new science and engineering PhDs. Now this is not all bad because it largely reflects growth in other parts of the world, and we should celebrate the advance of other countries. Nonetheless, because we must depend on our thinking and our innovating others, these trends must be watched carefully.

The rise of production of engineers in China is unprecedented. China now educates about 250,000 bachelor-level engineers per year while the US graduates about 60,000. Yes, there are still large quality differences, and numbers are not everything, but Floyd Kvamme, a highly experienced high-tech venture capitalist with Kleiner-Perkins, says that, "Venture capital is the search for smart engineers." So we do have to worry about numbers, and must note

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with deep consternation that fewer than 15 percent of US high school graduates have sufficient math and science background to even have the option of entering engineering school.

Our engineers must work and innovate at ever accelerating rates. When the

automobile was introduced into the market it took 55 years, essentially a lifetime, until a fourth of US households owned one. It took about 22 years until 25 percent of US households owned a radio. The World Wide Web achieved this penetration in about eight years. Such acceleration drives an inexhaustible thirst for innovation and produces competitive pressures. The spread of education and technology around the world magnifies these competitive pressures many fold.

Globalization is changing the way in which engineering work is organized and in which companies acquire innovation. Today the service sector employs more than 70 percent of the US workforce. The development and execution of IT-based service projects is usually accomplished by dividing the functions into a dozen or so components, each of which is carried out by a different group of engineers and managers. These groups are likely to be in several different locations around the world. In the manufacturing sector this new distribution of work is even more dramatic. For example, the new Boeing 787 reportedly has 132,500 engineered parts that are

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## ACEC/MA Government Affairs Committee: The 2007/2008 Year In Review

By James A. Pappas, PE, Senior Principal, Stantec Consulting Services Inc.



The Government Affairs Committee has been extremely active over the past year meeting on the first Wednesday of every month to discuss the status of existing and pending legislation. We pay particular attention to legislation that is of importance to our member firms and our clients. This year's emphasis has been focused on the following items:

- Senate Bill 2292, relating to the creation of a special commission charged with evaluating the public health and public safety problem, and recommending ways to increase the Commonwealth's investment in water and wastewater. This Water Infrastructure Finance Commission would be similar to the Transportation Finance Commission. The Senate has passed this legislation and we are working for passage in the House. Representative Jeffrey Sanchez and Senator Pamela Resor sponsored the bill.
- House Bill 3182 to standardize the use of Qualification Based Selection (QBS) for public projects. This bill is sponsored by Representative Joseph R. Driscoll, and received favorable action from the Committee on State Administration. We are working to move this bill positively from the House Committee on Ways and Means.
- House Bill 4609, which relates to the second part of the Transportation Bond Bill, and includes a number of reforms that will help to streamline the delivery of critical projects throughout the Commonwealth.
- House Bill 4743, an act financing an accelerated structurally deficient bridge improvement program that includes a \$3 billion, eight year proposal to address the State's structurally deficit bridges.
- House Bill 4339 to give the Professional Engineers and Land Surveyors Board of Registration authority equivalent to other registration boards that are part of the Division of Licensure. This bill would also correct a drafting error that was intended to permanently add two more land surveyors to the Board. This legislation is sponsored by Representative Harold P. Naughton and is currently awaiting passage by the Senate.

- Senate Bill 2404 requiring Massachusetts homeowner insurers to provide coverage, with specific limits and deductibles, for the costs of investigating and cleaning up home heating oil releases while providing incentives and requirements to homeowners to upgrade their above ground liquid fuel tanks. This legislation has lead sponsorship from Senator Pamela Resor and Representative Patricia A. Walrath. At this time it has passed in the Senate and we are working for passage by the House.
- ACEC/MA has also been following numerous pieces of legislation focused on sustainable environmental issues.

ACEC/MA is working with our political advocates at Rasky Baerlein Strategic Communications to oppose any amendments or attempts to prevent state agencies and municipalities from contracting out for design services.

ACEC/MA, through Government Affairs, meets with State Senators and State Representatives as well as government officials periodically at The Engineering Center. In addition to meetings at the State House, this year we had in-depth discussions with the following public leaders:

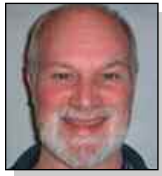
- ACEC/MA supported fundraising events for Lieutenant Governor Timothy Murray, Senate President Therese Murray and Senator Steven Baddour;
- EOT Deputy Secretary Bob Rooney attended the December ACEC/MA Board Meeting;
- Senator Steven Panagiotakos, Chair of the Senate Committee on Ways and Means met with the ACEC/MA Government Affairs Committee in February;
- Leslie Kirwan, Secretary of Administration and Finance met with the ACEC/MA Board in February.

On Tuesday, April 29th ACEC (national) held its annual Consulting Congress Day in Washington, DC. ACEC/MA leaders met face-to-face with US Representatives Tierney, McGovern and Capuano along with aides for Representatives Olver, Neal, Frank, Tsongas and Delahunt and

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# Building a Better World Through Engineers Without Borders: A Mentor's Perspective

By Michael Weyand, PE, Shaw Environmental & Infrastructure, Inc.



Engineers Without Borders (EWB) is a non-profit humanitarian organization with a service-directed objective. EWB strives to improve the quality of life in developing communities through implementation of environmentally and economically sustainable engineering projects, while developing responsible engineering students internationally.

I first became involved in EWB through student recruitment when I was asked to be a mentor for the University at Buffalo (UB; The State University of New York) EWB Student Chapter. The EWB Professional Chapter in Longmont, Colorado establishes student chapter guidelines including the requirement to have a licensed Professional Engineer on board as a volunteer/mentor. I am grateful to be one of those mentors.

The EWB-UB is currently working on the design and construction of a primary school for war orphans in the Kigoma region of Tanzania on the shores of Lake Tanganyika in East Africa. War, poverty, and especially AIDS have brought approximately 4,000 orphans and street children to the city seeking refuge. Unfortunately, these children currently have no opportunity for growth or integration into the local society, and the result is the systematic marginalization and criminalization of the great majority of them.



The project also includes solutions for clean drinking water and irrigation for farming. The project will be accomplished in several phases and from now until mid 2009, the first phase will focus on providing clean drinking water and irrigation.

The primary school will provide clean drinking water, food, shelter, and basic education. The overall goal of the school is to serve as a vehicle

for the children so they can integrate into society using their education, and by practicing the social and practical skills they have learned, they will enter into society with skills to support and give back to the local community. The primary school will be operated by a non-governmental organization (NGO) and the International Good Samaritan Mission (MIBOS).

EWB strives to improve the quality of life in developing communities through implementation of environmentally and economically sustainable engineering projects,

My role is not only to oversee the project, but to act as a teacher so students can learn "real-world" design and construction. Most importantly, I monitor and contribute to the design

and construction of the project in such a way that it is safe and economically feasible. For example, when digging a well, having OSHA 40-hour training is valuable in understanding soil conditions, shoring methods, and confined space entry issues, all of which is required to safely perform an excavating task.

EWB requires that an assessment trip must take place prior to the actual construction of the project. As mentor, I had the choice of going on the assessment trip or the trip for actual construction of the project. The students and I agreed that having me on the Kigoma assessment trip was more critical to get the project off the ground. I also traveled with Masamichi Ikeda, the President of the UB Student Chapter. Masamichi had previously been to Kigoma two times. While there, we met with members of the community, local NGO's, the children, and the local and regional government, which has generously provided land for the school. Our assessment trip accomplished several goals and provided us with information needed to design the project. First and foremost, we were able to assess the site and determine the layout of the land and depth of the water table. During the trip, we also tested the water for bacteria, collected Health and Education census data using an EWB standard form, and researched local materials, equipment and costs to perform the construction. Another one of EWB's requirements is that sustainable local materials be used. In conjunction with the site assessment, we used this information when designing the drinking water and irrigation systems.

I would imagine that for most volunteers with EWB, the trips are the first opportunity to travel to a developing country. My case was exactly this and — as the adage says "a life changing experience". Living, even if only for a short time, in a developing country within a foreign culture and speaking an equally foreign language is a challenge both mentally and physically. Masamichi and I were fortunate in that local contacts from MIBOS were working with us. They arranged our lodging and acted as guides and interpreters. The local language is Swahili, which I found to be relatively easy to learn the basics. If you ever find yourself with 24 hours of flying time, get a pocket book and learn Swahili!

It is customary in Africa to meet formally with local authorities before conducting business and so we spent one full day and parts of others in meetings. This was quite impressive, giving one a heady—if temporary—status of celebrity. The Kigoma District Commissioner, whom we met, would be considered the equivalent of a Governor in the United States.

During one of Masamichi's previous trips, he was able to manufacture a boring tool out of pipe with a cutting edge and internal valve. This tool is tied to rope and dropped through a pulley connected to a tripod. The location of the hole is saturated with water and the impact of the dropped pipe penetrates into the soft silty soil. When the pipe is pulled, the valve closes, thus bringing up about 6 inches of soil each time. Because of the silty soil conditions and the addition of water, the soil becomes slurry. Fortunately the soil conditions were conducive to using this tool or we would not have been able to bore or dig a test well.

Our trip started out using this tool to bore a test well and determine the water table depth, soil stratifications, and ultimately collect water

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# Greening Our Profession Now!

By Richard P. Kosian, PE, LEED, Beals And Thomas, Inc.



On May 21st design and construction professionals from the Boston area gathered at the LEED Certified “Meeting Room at Two Arrow Street” in Cambridge for a symposium entitled, “How Can We Green Our Profession Now?” The symposium was presented by the ACEC/MA Private Sector Committee and featured moderator Doug Kot, LEED AP, of The Green Roundtable and panelists Noah Maslan, Director of Real Estate, Urban Edge; Paul Chamberlin, Assistant Vice President for Energy and Campus Development, University of New Hampshire; Chris Schaffner, PE, LEED AP, Principal, The Green Engineer LLP; Arlen Li, AIA, LEED AP, Associate Principal, Payette; Anthony Consigli, President, Consigli Construction; and Willa Small Kuh, Senior Associate, Sasaki Associates.

Doug Kot opened the discussion by identifying that buildings account for 39% of carbon dioxide emissions, 12% of water use, 65% of generated waste and 71% of electricity consumption. He stated that the American Institute of Architects (AIA) and American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) have established a goal of designing net-carbon-neutral buildings by 2030. He also stated “The projects on your desks today will need to meet this goal in their intended life span. Are you designing for this eventuality now?”

Willa Small Kuh referred to the “Presidents Climate Commitment” that has been signed by the presidents of over 500 American colleges and universities. Each president has committed his or her institution to, “...exercise leadership in their communities and throughout society by modeling ways to minimize global warming emissions, and by providing the knowledge and the educated graduates to achieve climate neutrality.” Kuh remarked that, there is an enormous challenge for engineers and architects to provide the necessary expertise to colleges and universities so that their institutions may satisfy this commitment. Engineers, planners and architects must take a holistic approach to sustainability to include the campus-wide impacts of non-building issues like parking lots and manicured landscapes. Even the day-to-day impacts of student lifestyle must be examined.

Arlen Li reflected upon his firm’s recent experiences with two building projects for a single university. The same A/E team was used for both projects. The first building project was tasked to obtain LEED silver or gold certification, and it utilized a sustainability consultant and visioning workshops to engage the design team to meet the owner’s

goals. Eventually, Li commented, “...the budget reality set in,” and this meant that the Green-design of the building was not as successful as originally envisioned by the team. For the second project the team reduced the formal process and approached the challenge with a changed mindset. “The success was the learning that had been achieved on the first building.” Li also commented on the need to integrate a contractor into the early planning stages. If a contractor has not been selected the A/E team has to fill the void or the owner should consider hiring a contractor for advice during the planning process.

Noah Maslan commented that engineers must be involved at the beginning of the planning process if a sustainable project is to succeed. Comprehensive and accurate life cycle cost data is the fundamental driver for decisions to be made by the owner. Owners must engage energy consultants and modelers as well as HVAC engineers in order to obtain this information. “Innovative solutions occur when everyone is in the room together,” Noah offered.

Paul Chamberlin expressed skepticism that adequate data about HVAC performance is available to enable owners to make good decisions. He commented that the energy forecasts for the last two buildings built at UNH were inaccurate. Chamberlin added that “Ironically, these buildings are performing better than expected, which may mean that the engineering was too conservative.” There is a great deal of tuition pressure at UNH which translates into a need for efficient buildings. Operational and capital costs must be scrutinized. He stressed the need for durable buildings and maintainable systems. Systems that require ‘knife-edge precision’ to operate properly won’t succeed. Chamberlin also acknowledged the need to bring engineers into the project planning process at an earlier stage, and recognized that typical A/E fee arrangements don’t usually allow for this.

Chris Schaffner agreed that more fees will be needed to involve engineers earlier in the building design process and that a more integrated process is needed. “Engineers must go from performing their strict job definition to providing what is really needed,” he stated. We have to meet the ‘triple bottom line’ to satisfy occupant comfort requirements, satisfy the owner’s economic requirements and to protect the planet. “Instead of getting more oil to power what we have, we need to figure out how to reduce what we use, and we must do it cost effectively.”

Anthony Consigli spoke of a recent successful school science building project that was constructed by his firm. The project was designed to meet LEED platinum certification, but the owner did not seek certification. The school’s objective was to build a sustainable building that would serve as a teaching tool for the school. “This objective drove the design and construction team, and changed the internal mindset of our organization.” Although the initial project construction cost estimate was 10% higher than the owner’s budget, the owner instructed the design and construction team not to cut sustainable elements. This forced the design and construction team to engage in a collaborative effort to cut costs. The project succeeded because, as Consigli identified, “...the owner said that sustainability is sacred.” This meant the involvement of everyone early in the process, including the contractor, and forced face-to-face collaboration. Consigli acknowledged that contractors, subcontractors and estimators have to better understand life-cycle cost impacts when making value engineering evaluations.

The panel’s comments were followed by a collaborative exercise. The audience was divided into mock design teams, and each team was given 30 minutes to evaluate the pros and cons of developing a fictitious school building program on each of two potential urban sites in Boston, based on the owner’s goals for sustainable design. The teams evaluated and reported on the opportunities and constraints presented by each site with respect to site demographics and economics, solar orientation, wind energy, public transportation, outdoor air quality, ambient temperature variations, ambient noise, geotechnical and environmental issues and storm water management.

Key take-away points:

- Owners should establish clear project expectations early-on in the planning process;
- The engineer’s voice is valuable and must be heard sooner. This may have fee implications;
- Design professionals must fill the gaps that exist between our disciplines;
- Climate change is not somebody else’s problem. Engineers must accept the challenge and provide the leadership to work toward a solution.

*Richard Kosian, PE, LEED AP is a Principal and Vice President of Beals and Thomas, Inc. and a member of the ACEC/MA Private Sector Committee. He has more than 30 years experience in design and construction services for civil engineering projects, 23 of which he has accomplished at Beals and Thomas. The firm provides integrated civil engineering, landscape architecture, land surveying, planning, and wetlands consulting services throughout New England. Rich can be reached at 508/366-0560 or rkosian@btriweb.com.*

## A SEAT AT THE TABLE

“A Seat at the Table” is designed to provide our ACEC/MA membership with direct insight into the wide range of endeavors, accomplishments and special activities undertaken by the many committees and task forces of ACEC/MA on its behalf. Remember, ACEC focuses on advocating laws, policies and regulations that improve the business environment and on helping member firms improve their business acumen, and can only be successful in this regard through an active membership. So come take “A Seat at the Table!”

### The Program Committee

By Erik J. Stoothoff, PE, Structural Engineer, Jacobs



Last year, Lisa Gove (Program Committee co-chair) presented our plan to improve the Program Committee’s focus on consistency and efficiency, as well as our determination to

develop a strong menu of readily recognized programs. Those past efforts have produced marquee annual programs like the March State Market Event, September Social Event and May LEED/Sustainability Events. In addition, every year the Program Committee brings our ACEC membership topical programs that provide an update on specific discipline related topics. Recently we brought our membership programs that give a legal perspective on electronic communication retention, industry trends of incorporating renewable energy sources in modern building construction, and the new DEP Storm water discharge elimination systems provisions.

The Program Committee has implemented an online survey program to receive real-time feedback on the quality and expectations of our programs so that we can continuously evolve and adjust these within future programs. Often times the survey results are encouraging and support our efforts; however when your

comments indicate that we missed the mark we have adjusted our programs accordingly.

Recently we began looking for our next staple of programs and how we can continue to bring programs with better content targeting the pulse of our industry. In doing this we have looked for inspiration inside and outside of our industry, asking ourselves:

- How does our Committee connect with our membership;
- How does our Membership connect with our community; and
- Does the program produce new curriculum and insight to the industry?

Additionally, we have looked to this magazine, *Insights*, to bring together programs that will have a quality that can inspire a continuation in this quarterly publication.

For example, we looked at everyday life for the inspiration of our November “Future of Energy” program. With gas prices and home heating costs continuing to escalate we sought a program to address technological improvements we can adopt into our personal lives to lessen our burdens. The result of that introspection was a not-too-far leap towards our building construction industry, and this led to our very successful program. The program was born out of the uncertainty of sources of

energy for our society. Following that notion we examined the industry forecast to support business interests in energy.

We have also worked successfully with the Private Sector Committee to keep our membership, whose business lines are primarily in the private market, interested in programming relevant to their goals. That collaboration brought together a terrific sustainability program spotlighting the Two Arrow Street Theater in Cambridge.

The Program Committee is preparing our 2008–2009 schedule, and we welcome any and all recommendations for program topics including industry trends, government legislation or regulations. Please send your recommendations to me at erik.stoothoff@jacobs.com.

*Erik Stoothoff has been a Structural Engineer with Jacobs Engineering Group for the past eight years, designing bridges and related infrastructure structures. A graduate of Northeastern University, Erik has also completed the ACEC/MA “Emerging Leaders” program. Erik has been Co-Chair of ACEC/MA Programs Committee for the past three years, and he offered to the Insights Board of Editors that his favorite movie is “Ghostbusters.” Perhaps ACEC/MA can look forward to a program on Green vs. the Marshmallow Man! Erik can be reached at erik.stoothoff@jacobs.com.*

## 2008 ACEC/MA Engineering Excellence Awards

An evening gala banquet marked the ACEC/MA Engineering Excellence Awards presentation on April 9th at the Boston Marriott Copley Place. ACEC/MA President Robin Greenleaf, president of Architectural Engineers Inc., presided over this annual event, and Jon Beekman, a Principal with SEA Consultants Inc., continued in his role as Master of Ceremonies. Gray, Gray & Gray LLP, Certified Public Accountants provided Diamond Sponsorship.

This year’s Silver Award recipients include:

- BSC Group, Inc.—Cambridge Discovery Park
- Parsons Brinkerhoff—Massport Central Parking Garage—Repairs and Expansion
- Pennoni Associates—Brownfields Redevelopment Project, Home Depot Site, Chelsea, MA
- SEA Consultants Inc.—Yankee Gas Liquefied Natural Gas (LNG) Facility

- Simpson Gumpertz & Heger, Inc.—The Macallen Building Condominiums
- Symmes Maini & McKee Associates, Inc.—Milton Landing
- Tighe & Bond, Inc.—Wastewater Treatment Plant Upgrades and Expansion, East Greenwich, RI
- Wright-Pierce—Callahan Wells Water Treatment Plant

Gold Award winners are:

- Garcia, Galuska & DeSousa, Inc.—Dedham Middle School
- Nitsch Engineering, Inc.—Rainwater Harvesting Using Rain™ USE Software
- Weston & Sampson Engineers, Inc.—The MBTA Cabot Yard Remediation System—Innovation Design in a Complex Urban Environment

The 2008 Platinum winner is Vanderweil Engineers, LLP for their work on the WGBH Corporate Headquarters.

And the ACEC/MA Engineering Excellence Grand Conceptor Award recipient is CDM for their exceptional work on the Cobble Mountain Dam Outlet Works Rehabilitation.



# Transportation Strategies for Massachusetts—III

By: David Chappell, PE, President of Chappell Engineering Associates, LLC



In 2007, the Massachusetts Transportation Finance Commission issued a two-volume report evaluating the present state of our transportation assets and offering recommendations on financing and reform. Commission recommendations included raising revenue to close the 'funding gap' of \$15 billion to \$19 billion required, over and above current levels of expenditures, to maintain the existing highway and transit systems over the next 20 years. The Commission also recommended a series of reform measures focusing on how the Commonwealth can more effectively deliver transportation services.

Several key legislative initiatives filed by Governor Patrick this year reveal how the governor, legislature and federal and State transportation officials plan to reverse the decline of the transportation infrastructure. These are a \$3.5 Billion Transportation Bond Bill enacted in April, House 4743, "An Act Financing an Accelerated Structurally Deficient bridge Program," and House 4562, the second part of the Transportation Bond Bill, which passed in the House on June 11 and now moves to the Senate for action.

The \$3.5 billion Transportation Bond Bill is roughly consistent with the Capital Investment Plan for FY 08 to FY 12 proposed by Governor Patrick in 2007 that recommended \$5.7 billion in capital spending on transportation over five years. The bond bill consists of a \$1.6 billion investment to leverage \$1.8 billion in federal funds. Approximately \$2.6 million is for Federal and Non-Federal Aid highway and bridge projects, \$150 million for Chapter 90 local aid to cities and towns for roads and bridges, and \$750 million for transit. Although the projected level of investment in FY 08 is increased by about 20 percent over FY 07, by the Administration's own admission this level of spending falls far short of what is needed to start closing the infrastructure funding gap.

To supplement the issuance of bonds for the highway and bridge program, the Transportation Finance Commission recommendations included such revenue enhancement measures as raising the gas tax and indexing it with inflation and investigating other means of increased revenue. The Commission also proposed a series of reform measures to reduce costs and improve the delivery of transportation services. Raising the gas tax is not likely at this time because of rising fuel prices and the current economic and political climate, and borrowing is limited by the

administrative bond cap. With these fiscal realities in mind, the governor, legislature and federal and state transportation officials are concentrating on implementing reforms to stretch the transportation dollar further.

As approximately 75 percent of the expenditures in the Transportation Bond Bill are for highways and bridges, many of the reform measures focus on the concept of accelerating project delivery for highway projects. MassHighway has reported the average road project takes ten years from concept to completion. The intent is to cut this time to six years through streamlining and an increased level of accountability and transparency saving about 44 percent in escalation and deferred maintenance costs for the typical project

Included in the Transportation Bond Bill are such reform measures as:

- Use life-cycle cost modeling for all project selection and planning;
- Establishment of a dedicated Transportation Deferred Maintenance Trust Fund;
- Development of a reporting system designed to track and reduce the time it takes to pay Contractors;
- Reducing the time between advertisement to notice to proceed for construction contracts to less than 120 days;
- Reviewing existing procedures and establishing best management practices for procurement, design and construction of transportation projects;
- Undertaking five plus design-build highway/bridge projects to be completed no later than June 30, 2011 utilizing economic benefit as a selection criterion;
- Completion of construction of at least ten highway projects within one year of advertisement;
- Enhancing MassHighway's project information system and making this data available on the internet.

MassHighway is already making progress on several of these reforms. Their 'Scorecard' documenting measurable performance standards in project delivery, congestion, travel time, safety and the condition of roads and bridges is now available on their website at [www.mhd.state.ma.us](http://www.mhd.state.ma.us). The effectiveness of delivery of transportation services can now be monitored by the consumers of those services—the general public. MassHighway established an Asset Management Division to develop systems which better track the condition of assets and facilitate decision making. In addition, they have added

key management staff, hired additional personnel and streamlined some of their processes.

Due to public safety concerns and the potential economic cost of emergency shutdowns, the emphasis in the coming years will be to accelerate bridge repairs. To supplement the Transportation Bond Bill, House 4743 "An Act Financing an Accelerated Structurally Deficient Bridge Program," filed by Governor Patrick, would dedicate \$3 billion over an eight year period to repair MassHighway and Department of Conservation and Recreation (DCR) bridges. This bill is still pending, but is said to have the support of the legislative leadership.

The Administration has projected that at current funding levels, the backlog of the over 500 structurally deficient MassHighway and DCR bridges would actually increase by 30 percent over the next eight years. According to the Administration, implementation of H. 4743 would reduce the number of structurally deficient bridges by 15 percent over the same eight year period. The plan would be financed with \$1.9 billion in gas tax bonds to be repaid with gas tax revenues and \$1.1 billion in grant anticipation notes borrowed against future federal funding. The legislation specifies a goal of 20 percent of annual expenditures be transferred to the Transportation Deferred Maintenance Trust Fund. It also allows for design-build procurement, performance based design and bonus payments for accelerated project delivery. The legislation is also seen as a means for job creation, which will stimulate the economy.

The governor, legislature and federal and state transportation officials have taken the first steps required to address the state of our transportation infrastructure. They clearly believe that more funding alone will not solve the problem and that institutional reforms are necessary. They also understand that an accelerated program offsets some of the need for new revenue sources by saving on escalation and deferred maintenance costs. Now comes the difficult task of implementing reforms, successfully managing the program and winning the confidence of a skeptical public.

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# The Future of Engineering

*continued from cover*

produced in 545 global locations. Indeed, IBM CEO Sam Palmisano says that we have now moved beyond multinational corporations to globally integrated enterprises. An emerging element of this evolving engineering context is 'open innovation.' Companies no longer look just within themselves for innovation, nor do they just purchase it by acquiring small companies. Today they obtain innovation wherever it is found—in other companies, in other countries or even through arrangements with competitors. Working in this evolving context requires a nimble new kind of engineer and engineering organization.

Perhaps even more dramatic than the changes brought about by globalization and competition in the Knowledge Age are the new engineering frontiers and grand challenges. I think of two frontiers of engineering, Tiny Systems and Macro Systems. Tiny Systems are those developed in the 'Bio/Nano/Info' domain where things get increasingly smaller, faster and more complex. Here there is little distinction between engineering and natural science. Research and product development are done by teams of men and women from various scientific and engineering disciplines who rapidly move from reductionist science to synthesis and system building.

Macro Systems are of ever increasing size and complexity. Work at this frontier may be associated with systems of great societal importance: energy, water, environment, health care, manufacturing, communications, logistics, etc. Research, development and the design and deployment of projects frequently require teams of engineers and people with backgrounds in social science, management, and communications.

We also must think about what projects should engage the best of engineering talent and knowledge in the years ahead.

Much of what will be exciting and valuable in the 21st century will be the work of engineers who will move Tiny Systems technology into Macro Systems applications. Here I have in mind the application of bio-based materials design and production, biomimetics, personalized predictive medicine, biofuels, nano-technology based energy production and storage devices, etc.

We also must think about what projects should engage the best of engineering talent and knowledge in the years ahead. The National Academy of Engineering formed a committee of 17 amazingly creative and accomplished engineers and related scientists and medical experts and asked them to define several Engineering Grand Challenges for the decades ahead. The challenges needed to meet two criteria, 1) accomplishing them would advance the human condition, and 2) they could actually be accomplished in the next few decades. The committee proposed 14 unranked Engineering Grand Challenges:

- Make Solar Energy Economical
- Provide Energy from Fusion
- Develop Carbon Sequestration Methods
- Manage the Nitrogen Cycle
- Provide Access to Clean Water
- Engineer Better Medicines
- Advance Health Informatics
- Secure Cyberspace
- Prevent Nuclear Terror
- Restore and Improve Urban Infrastructure

- Reverse Engineer the Brain
- Enhance Virtual Reality
- Advance Personalized Learning
- Engineer the Tools of Scientific Discovery

These challenges, which are detailed at the website [www.engineeringchallenges.org](http://www.engineeringchallenges.org), involve energy and sustainability, medicine and health-care, reducing our vulnerability to natural and human threats and advancing our human capabilities and understanding of our world and ourselves. Meeting some of these challenges is imperative for human survival. Meeting some will make us more secure, and all will improve quality of life.

The message here is that the 21st century will be very different from the 20th. Engineering will be enormously exciting, but also increasingly rich and complex in its context and importance. As we think about the challenges ahead, it is important to remember that students are driven by passion, curiosity, engagement, and dreams. Although we cannot know exactly what they should be taught, we can focus on the environment in which they learn and the forces, ideas, inspirations, and empowering situations to which they are exposed. Despite our best efforts to plan their education, however, to a large extent we simply wind them up, step back, and watch the amazing things they do.

In the long run, making universities and engineering schools exciting, creative, adventurous, rigorous, demanding and empowering milieus is more important than specifying curricular details. Nonetheless, I hope that those who design curricula, pedagogy, and student experiences will profitably contemplate the new context, competition, content, and challenges of engineering described here.

*Charles M. Vest is President of the National Academy of Engineering and President Emeritus of the Massachusetts Institute of Technology.*

*Dr. Vest earned his B.S. in mechanical engineering from West Virginia University in 1963, and M.S.E. and PhD degrees in mechanical engineering from the University of Michigan. He was a member of the faculty and the administration of the University of Michigan before becoming provost and vice president for academic affairs. In 1990 Dr. Vest was appointed president of the Massachusetts Institute of Technology (MIT) where he was active in science, technology, and innovation policy; building partnerships among academia, government*

*and industry; and championing the importance of open, global scientific communication, travel, and sharing of intellectual resources.*

*Charles Vest was vice chair of the U.S. Council on Competitiveness, served as a director at both DuPont and IBM; and with various federal committees and commissions including the President's Committee of Advisors on Science and Technology (PCAST) during the Clinton and Bush administrations, the Secretary of Education's Commission on the Future of Higher Education, the Secretary of State's Advisory Committee on Transformational Diplomacy and the Rice-Chertoff Secure Borders and Open Doors Advisory Committee.*

*He serves on the boards of several non-profit organizations and foundations devoted to education, science and technology.*

*In July 2007 Dr. Vest was elected to serve as president of the U.S. National Academy of Engineering (NAE) for six years and was awarded the 2006 National Medal of Technology by President Bush. This article is based on a talk delivered at the National Engineers Week luncheon in Boston and derived from an editorial by C.M. Vest in "Educating Future Engineers: Who, What, and How?" Journal of Engineering Education, July 2008.*

*Photo of Dr. Vest is courtesy of Donna Coveny.*

## The 2007/2008 Year In Review *continued from page 2*

aids of Senators Kennedy and Kerry. The focus of these meetings was to discuss:

- Repealing of legislation enacting a 3 percent withholding mandate on government contracts scheduled to take effect in 2011;
- Finding a long term solution to the Transportation Funding shortfall, as well as opposing the repeal of the gas tax, and;
- Greater federal investment in our state's water and wastewater needs.

On Tuesday, May 13th ACEC/MA conducted Design Professionals Day at the State House in conjunction with the Boston Society of Civil Engineers Section, the Licensed Site Professional Association and the Massachusetts Association of Land Surveyors and Civil Engineers.

The Government Affairs Committee has also been coordinating with the Massachusetts Infrastructure Investment Coalition (MIIC) on

some regional Transportation Forums, a project initiated by TEC several years ago. MIIC held its first "Transportation in My Backyard (TIMBY)" forum on March 28th in Holyoke, and on May 30th MIIC held its second TIMBY forum at Merrimack College in North Andover.

Finally, the ACEC (national) Political Action Committee (PAC) contributed to the campaign committees of Congressmen John Olver, Jim McGovern and Michael Capuano, who all serve in key Congressional leadership positions affecting infrastructure funding. Supporting the ACEC PAC is a very important way to reinforce our government affairs activities. This greatly enhances the image and visibility of engineers, engineering firms and ACEC/MA on the national level, and it positions the industry to positively influence federal regulations and legislation. During calendar year 2007 we met our ACEC PAC goal for the second year in a

roll, which is evident by the contributions we provided to these key leaders of the Massachusetts Congressional delegation.

All of the activities of the Government Affairs Committee were more successful because of the advice and counsel of Abbie Goodman of TEC, with Jeffrey Terry and Dee Dee Edmondson of Rasky Baerlein Strategic Communications. Without their on-going assistance and guidance we could not have recognized such success. In addition, our Government Affairs Committee members should be commended for their participation and support for our activities. Thanks to everyone for the hard work!

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*James Pappas is the Regional Leader for Stantec's New England Region. He currently serves on the ACEC/MA Board of Directors as President-Elect and Chair of the Government Affairs Committee. Jim can be reached at jim.pappas@stantec.com.*

## Engineers Without Borders *continued from page 3*

samples to test for bacteria. The land given to us was on a hill and unfortunately when we bored a test well we bottomed out on clay at 7.5 feet without finding water. However, we persisted and, looking elsewhere, found another location in the valley where we found several existing shallow wells. Because of the existing availability of water, MIBOS and the local community agreed to exchange the land in the valley for the original land up on the hill. In addition, the local community requested that we include them in our project by providing sand filtration for their local wells. Originally we were going to provide clean drinking water through sand filtration in the second phase of the project. But as in many designs, field conditions and politics often change things.

After returning from the trip, we were required to submit a report to EWB, Colorado, much like in industry. I found it handy to keep a daily log similar to what our Quality Control people do on our projects where I currently work. I passed this information onto Masamichi for him to complete the report. The report is included as an appendix to the fundraising proposal.

Since returning from the trip, my role is to aid the students as they use the information gathered on the trip to develop a design. Much of the work in this phase of the project is related to infrastructure: size, depth and number of wells and sizing of pumps and irrigation piping. For example, with sizing the pump and not knowing



the recharge volume of a particular well we were unable to get an accurate count on the number of people using the well and how often. I then suggested to the students, knowing the flow rate of the pump we are proposing, to assume a worst case scenario and determine how long it will take to run the well dry based on the known volume of the well. Once this is determined you can then calculate the number of people the well will supply water. In addition to this, the students need to realize that the pump will not be the controlling factor here because the sand filter flow rate is less than the pump

In addition to the assessment trip and initial design, a third and critical undertaking during this pre-construction phase of the project is fundraising. As a non-profit organization, EWB is required to raise money for travel, food and accommodations, as well as materials and possibly local labor to support the construction. The information gained on the trip was used to

compile our fundraising proposal, the vehicle with which we will request money from corporations, agencies, non-profit groups etc. The students prepared the proposal and then I, along with the students' Faculty Advisor reviewed the proposal.

At this point we have submitted our proposal for review by EWB, Colorado. Once complete, the proposal will be sent out to solicit donations to allow us to return to Kigoma during the 2009 winter break to construct the clean drinking water and irrigation system.

Being a mentor to EWB is a satisfying role for me because it allows both for an opportunity to give back, and also "do good" with my accumulated knowledge base. This knowledge I have to share includes not only engineering but "real-world", hands-on experience. I, in turn, am forever changed by my involvement in this project. If not for EWB-UB and this project, I would have missed out on an opportunity of a lifetime.

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*Mike Weyand is an engineer with Shaw Environmental & Infrastructure, Inc. Shaw provides technology, engineering, procurement, construction, maintenance, fabrication, manufacturing, consulting, remediation and facilities management services for government and private sector clients in the energy, chemicals, environmental, infrastructure and emergency response markets. Mike can be reached at 716/504-8607 or michael.weyand@shawgrp.com.*

## ACEC/MA's Ninth Annual Emerging Leaders Graduates

The ACEC/MA Emerging Leaders program, designed for professionals committed to developing their leadership abilities, has completed its ninth successful year. This highly rated six-session program imparts specific skills and competencies identified by top ACEC/MA CEOs as critical for leadership success. Experts in the fields of business administration and people management for professional services firms instruct each interactive four-hour session.

The program is moderately priced and provides an effective, high impact for future leaders through a carefully crafted curriculum that addresses the specific needs of Massachusetts engineering firms. It is ideally suited for engineers, architects, land surveyors, LSPs, geologists and other emerging leaders with approximately 8–15 years of prior engineering consulting experience.

In addition to gaining *secrets of success* from local industry leaders, program participants learn to:

- Understand and differentiate management from leadership;
- Understand basic financial metrics and why they are important;
- Identify and handle contracts and risk management issues;
- Understand business development strategies;
- Understand principles of strategic planning;
- Develop techniques for motivating/coaching in a professional services firm;
- Develop an understanding of how government works and how government affairs activities affect our industry;

Our 2008 Emerging Leaders graduates include: Robert B. Adams, PE, Metcalf & Eddy, Inc.

Joshua J. Alston, PE, Nitsch Engineering, Inc.

Mark Balfe, Haley & Aldrich, Inc.

Marc Bergeron, BSC Group, Inc.

William D. Casey, Jr., PE, Malcolm Pirnie, Inc.

Michael R. Cunningham, PE, S E A Consultants Inc.

James M. Danila, Howard/Stein-Hudson Associates

Christina FitzGerald, Nitsch Engineering  
Scott Havey, Architectural Engineers, Inc.

Michael Hall, Tetra Tech Rizzo

Wayne A. Keefner, PE, Symmes Maini & McKee Associates, Inc.

Karen E. Kelley, CDM

Robert McCoy, S E A Consultants Inc.

Timothy B. McIntosh, PE, VHB/Vanasse Hangen Brustlin, Inc.

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Jenna Rzasa, Tata & Howard, Inc.

Jennifer A. Shemowat, PE, Fay, Spofford & Thorndike

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Please watch your email this fall for the Spring 2009 Emerging Leaders program announcement.

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### UPCOMING EVENTS

**16th Annual Golf Tournament**  
Shaker Hills Golf Club, Harvard, MA  
June 20, 2008

**ACEC National 2008 Fall Conference**  
The Fairmont—The Queen Elizabeth  
Montreal, Quebec, Canada  
October 19–22, 2008

**ACEC/MA and CIM Dinner Program**  
Sheraton Needham  
October 29, 2008

### NEW MEMBER

**McCluskey Consulting  
& Management, LLC**

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