

Leaders Survey 2008

Charles Vest¹ and Diran Apelian² are among today's engineering and scientific leaders stressing the need for engagement in the challenges facing the 21st century. In short, the engineering and scientific community needs to address the "real problems facing mankind". Global climate changes, energy security, environmental stewardship, green manufacturing and resource sustainability are a few of the critical needs requiring scientific and engineering solutions.

As engineers and scientists, our future leaders must understand the societal impact of their professions, be well-versed in technology and function in global enterprises. They must also **motivate people and organizations to improve the quality of life around the world.**

To set the stage for tomorrow, leaders of today's engineering and scientific community were asked for their opinions on the following critical questions facing our profession:

- What do you see as the role of engineers in the 21st Century?
- With the impending societal issues we face regarding energy, transportation, health, housing, resource scarcity, climate change, etc., what are the opportunities you see for the engineering profession?
- What critical leadership skills will our next generation of engineering leaders need to possess?

Here is what they had to say.....

What do you see as the role of engineers in the 21st Century?

Arthur Coury, Vice-President, Genzyme Corporation: Engineers are the practical people. They are the ones who convert concepts to reality, and there is a growing need in the field of biomedical engineering to combine value with technology. The main source of the growth of health care costs is the increasing use of technology. But if health care costs advance in proportion to the quality and the adoption of technology, we are going to have an unsustainable situation. Engineers have to look in terms of value. Does a new technology mean fewer days in the hospital? Does it mean less morbidity down the

¹ President, U. S. National Academy of Engineering. (see C. Vest, "[The Future of Engineering Education: Context and Musings](#)", presented at the ABET Annual Meeting, Incline Village, NV, November 2, 2007.

² 2008 TMS President (see D. Apelian, "[The Engineering Profession in the 21st Century—Educational Needs and Societal Challenges Facing the Profession](#)," *International Journal of Metalcasting*, Fall 2007, pp. 21–30

road? The cost effectiveness of health care has to be considered and engineers are really good at that sort of thing.

Tomas Diaz de la Rubia, Associate Director, Chemistry, Materials, Earth, and Life Sciences Directorate, Lawrence Livermore National Laboratory: Energy is the grand challenge of the 21st century, and the kind of energy we consume is going to be important. For that reason, it is incumbent on the engineering profession to find solutions to the energy and climate problems the planet faces. In order to provide enough energy to allow the standard of living in the developing world to approach the United States and Western Europe by the middle of the century, we would have to increase our energy supply by 2 percent per year for next 100 years. If we do that with the current mix of energy sources—fossil fuels and oil—the amount of carbon dioxide in the atmosphere will be such that the probability of massive climate change is very high. We must find a way of providing the needed energy, however, because people in the developing world want to come out of poverty. That is the challenge for the engineering profession. We have to be able to design, build, and operate new sources of energy that allow us to provide that power without a further increase of CO₂ in the atmosphere. We have to replace fossil fuels and oil with renewable energy such as nuclear energy, fusion energy, and hydrogen for transportation. This will be a massive transformation; it will be a 21st century revolution.

John Moavenzadeh, Senior Director, Sustainable Mobility and Strategy

World Economic Forum: I see engineers continuing to play an important role as drivers of technological innovation, but I see other forms of innovation becoming increasingly important, such as business model innovation and artistic creativity.

David Spencer, President, WTE Corporation: A key role of engineers is extremely critical in society because engineers are unique. That key role is in the area of inventions and innovations. This is so essential to our way of life and progress and no one is better equipped than an engineer for invention and innovation. I hate to think of the profession having some sort of “special role” or special obligation to society any more than any other profession. What I do think will happen is that those who pursue engineering will have a vision of themselves and how they can make the world a better place. In the past, this has extended from making nuclear bombs to making nuclear power plants, from new medical devices to improving the biological capacity of plants and the quality of fruits and vegetables on our table, and the list goes on. I hope that engineers will maintain a high standard of personal integrity and values. In the future, as in the past, I hope engineers will distinguish the profession by doing the things that illuminate their internal “light bulb” and excite their senses. As a consequence they will inevitably create a better vision of the future.

Jaleel Al-Khalifa, CEO, Dragon Oil Limited and 2007 SPE President: I think there is room for engineers to improve energy technology much further in the future. If we reflect on what happened 200 years ago, and then in the last 100 years, I think we can see a bright future in the coming years. Engineers are the ones who actually take technology and translate it into day-to-day products that humanity can enjoy in their daily lives. I expect engineers to continue to provide oil and gas supplies for 40, 50, hopefully 100 years to keep up with the demand for energy. That is not an easy task because by then we will have run out of our easy resources and will have to go, for example, into deep

water or harsh environments. We will need ingenuity and new technology and engineers who can make it happen.

Thomas Barlow, ASME Fellow and 2008-9 ASME President: The engineers of the future will be very much concerned with the issue of sustainability as developing nations require a greater share of resources and contribute, to a greater extent, to competing global issues. The focus on collaboration, new business models, and staying competitive will create a very independent, decentralized workforce that relies on connecting through professional networks.

Nikhil Trivedi, Senior Partner, IDEKIN International: In the 21st century, engineers have as great a role to play (if not greater than) as they have ever played. Extracting raw materials from the ground or from forests with an eye on protecting the ecosystems, processing those hard to replace natural products to ensure exacting quality specifications and then utilizing them for the use of mankind is as relevant today as it was back when the industrial revolution began. I visualize engineers of the 21st century to be externally oriented and internally focused. That is, they will be seeking and integrating all the input from the world around them and their output will be in sync with the global expectations of multiple stakeholders.

J. Steven Gardner, President/CEO, Engineering Consulting Services, Inc: Engineers will continue to be in the lead both in emerging technologies and in the business world.

Tim Arnold, General Manager, General Moly Inc: Engineers will continue to be the bridge between ideas and action. In the past, because engineers were the people that “created” the buildings, roads, mines, infrastructure, and products that man needed, they were often in the management of these companies. I see engineers becoming less important in the management of companies due to the ever increasing complexity of financial and legal aspects of running companies. I.E., the lawyers and accountants will eventually be the majority of CEO’s in America. Too bad. But these companies will still need engineers to apply science to problems.

Arlie M. Skov, P.E., Trustee, American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc.: Very important. In one sense it is unchanged: Its primary value remains in the use of scientific principles and knowledge for the economic benefit of mankind, but the burgeoning pool of scientific knowledge, coupled with ever more complex societal problems, creates an ever expanding and important role for engineering.

Ray D. Peterson, Director of Technology, Aleris, International and 2009 TMS President: Historically engineers have always been problem solvers: How do you build a bigger pyramid? How do you build a bridge across a river? How do you get a man to the moon? Engineers will continue to be problem solvers, but the problems will be different in the 21st Century. How do we provide clean water and food to rural inhabitants? How can we provide sufficient power to everyone so they can lead a healthy and comfortable life?

With the impending societal issues we face regarding energy, transportation, health, housing, resource scarcity, climate change, etc., what are the opportunities you see for the engineering profession?

Diaz de la Rubia: Energy and sustainability are the challenges in the 21st century. The 19th century was notable for the industrial revolution, and the 20th century for electronics and communication. This century, the challenge will be energy. That is where engineers need to be trained and taught about the planet as a system. We need to think in terms of planetary engineering. Engineering is not just about machines or circuits, but concerns the entire planet as a very intimately coupled system.

Moavenzadeh: Each of these great challenges will require capable engineers, and this in itself is good news for the engineering profession. However, engineers who don't understand the broader social, political, and cultural dimensions to these challenges will be less effective. Technology is part of the solution—but technology alone will certainly not address the challenges of transportation. Engineers have a great opportunity to lend clear but critical thinking to the process of working toward solutions for these challenges— provided they do not operate in a technology-focused vacuum.

Spencer: These societal issues and challenges are all engineering opportunities for the future. What I find so frustrating is that the hard work and investments of our engineers are often undermined by a horrible political process or short-term thinking. In my own career I have seen the value of an important socially responsible recycling project fall victim to a limited budget in a community where a new sports stadium was the highest priority. All that was built went to waste, and all the waste is now going into landfills rather than going to a waste-to-energy plant and recycling facility. The challenge is not so much the technical engineering but the “sociopolitical engineering” that must go with it to move our society into doing the right things. This is a challenge for all, but engineers have a special knowledge and responsibility to communicate these issues and advocate for them for the good of our society. I would love to see not only good projects, but an enrichment of society through beauty and substantive buildings.

Al Khalifa: Although there is great intent by engineers and professionals to help the community and humanity in these societal issues, I feel that what is lacking are the vehicles through which engineers and individuals can meet these objectives. It's nice that we talk about them, and it's nice that we publish papers about them, but unless we provide the structure, the vehicles through which we can achieve solutions, we will not proceed further.

Barlow: The engineering profession will face both challenges and opportunities, requiring greater technical knowledge and more in-depth management skills to provide creative solutions. Engineers will be called upon to develop efficient and sustainable energy resources, to address transportation and food production, and to develop cost-effective systems for providing clean drinking water for the world's population. True innovation will be tested by the underserved markets marked by poverty.

Trivedi: Each societal issue listed above offers a great deal of opportunities for the engineering professional of the future. What is underlined here is the need for engineering education to be a lot more interdisciplinary than it is today. A mining engineer cannot afford not to be keenly aware of motivational principles for his workforce, for example. With the global implications of even the smallest local actions, a narrowly focused engineer is doomed to failure. Another important opportunity is CONTINUING EDUCATION. With rapid changes in technologies, engineers can readily fall in the trap of obsolescence; unless they are in constant and continual mode of educating themselves. An engineer of the 21st century is clearly blessed with the most effective communication tools, but he must use those tools to reinvent himself. These are the opportunities presented by the societal issues listed above.

Gardner: One opportunity where engineers have been underrepresented is in the public arena, i.e. elected public offices.

Arnold: As has been in the past, engineers will be called upon to help find the solutions to many of these social issues. Engineers will need to be the ones that use science to make sure that we are addressing and prioritizing the issues. Today, these issues are driven by hysteria and marketing campaigns. For instance; in your question you list several "social issues"; health being one, and resource scarcity as another. With less than 10% of the globe explored for resources, I don't believe that it is as big of an "issue" as AIDS in Africa (health). But if you listen to the rhetoric in America and world wide today, you would believe that many of the lesser important issues were more urgent than AIDS or poverty.

Skov: Engineers are remarkably well positioned, by nature and training, to take advantage of rapidly increasing scientific knowledge and adapting it to the economic solution of mankind's problems. So long as engineers remain focused on these opportunities, there is immense potential for engineering to solve our most pressing needs.

Peterson: There will be a huge number of opportunities for engineers. There will continue to be the large infrastructural change and improvement projects, but also more projects that will be of a more modest scale and applied to certain locales or groups. Additionally materials will continue to be important as we try to "do more with less." Engineering will also continue to grow in the life sciences area as this becomes one of the next big human endeavors.

What critical leadership skills will our next generation of engineering leaders need to possess?

Barlow: Engineering leaders will be called upon to foresee developing threats to our environment and sustainability, and they will need to bring their messages effectively to political leaders. They will have to understand and cross multidisciplinary boundaries, because solving the most difficult problems will involve multiple, interacting and conflicting causes and effects. Language skills, cultural competency, and other soft skills will be brought into a comprehensive systems analysis of their work.

Trivedi: By definition, a leader is someone who can get others to do things that they would not otherwise do. One of the most useful skills for a successful leader is "communication". Communication of ideas, goals, expectations, obstacles and concerns and of challenges and solutions in clear articulation for a global audience is soon becoming an absolute necessity for leaders of this and future generations. Another skill set of equal importance is "VISION". A leader must have a vision of what it is that he and his team should be striving for. What defines success? At which crossroad should his troops justifiably cry out, "eureka"? Having a vision that is realistic and measurable when attained is an absolute must leadership skill for our next generation of leaders. A leader with exemplary work ethic is destined to succeed. There is no better leader than one who leads by his own example. That is a historical fact and it has yet to be disproven. So, in summary, a leader of the future is a hard worker, a visionary and an effective communicator.

Gardner: Communication skills are one important area where engineers need improvement.

Arnold: Somehow engineers will need to figure out how to gain the respect of the public, and **communicate** science in a way that our "sound bite" society will listen to. We can build roads, log, mine, drill, and develop resources AND protect our environment. The fastest growing business in America is the one that is trying to stop all development. Society will eventually need to be informed of the truth. Engineers must find a way to be that spokesman.

Skov: Early in every engineer's career, first class technical skills are a must. As engineers mature, and particularly for those destined for leadership roles, they must accumulate a much broader understanding of human factors, such as interrelationships, environmental impacts, and broad societal goals and objectives.

Peterson: Engineers will still require the core engineering competencies that they always have, but additional emphasis will be needed in various "soft skills" for dealing with people of all types. It is critical that engineers be able to effectively communicate with people at all levels of business and society, as well as being able to interact with people from other cultures as our globe becomes smaller and more intertwined. Leadership is more than "telling someone what to do." We need vision, effective communications, efficient planning and follow through.

Acknowledgement

Responses from John Moavenzadeh, David Spencer, Jaleel Al-Khalifa, Tomas Diaz de la Rubia and Arthur Coury reproduced with permission from TMS (ref. "The Role of Engineers in Meeting 21st Century Societal Challenges – Part 1", [JOM](#), February 2008, p. 28.)