

## CENTENNIAL READER SURVEY

# Where Do You Think We Are Headed



As we contemplated AIChE's 100th anniversary, we wondered what our readers foresee for the future of chemical engineers and the chemical engineering profession. We invited members to participate in an online survey composed of multiple-choice questions and an open-ended discussion forum. We asked what technical, business, and professional factors will have the largest impacts on chemical engineering, as well as what areas will see the most significant advances over the next 25 years.

Almost 1,300 people responded to the online questionnaire. In addition to answering the multiple-choice questions, many took the time to add comments explaining their choices or mention additional factors. Here is what they told us.

**JOANNA ZIEMLEWSKI**  
SENIOR EDITOR



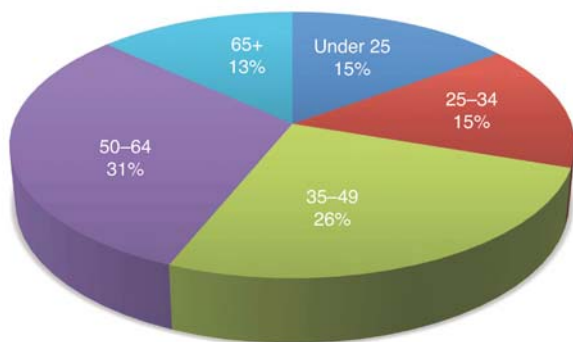
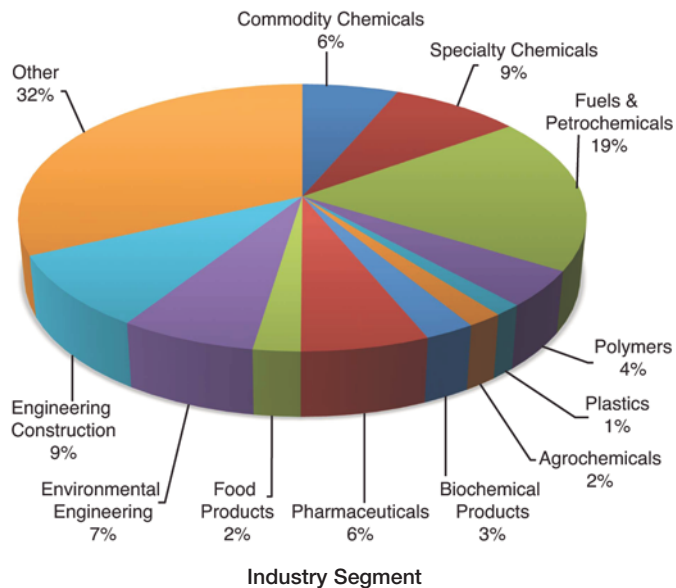
### The Respondents

The intent of our centennial reader survey is to tell an interesting story about where members see the chemical engineering profession heading over the next 25 years. While we report specific numbers and results, they are neither statistics nor scientific results, but rather the opinions and responses of those readers who chose to participate.

Most of the respondents are male (83%) and 17% are female. This is reasonably consistent with AIChE's overall membership. The largest age group are those in their fifties and early sixties (31%), followed by those in their late thirties and forties (26%).

Almost 40% work for companies having over 5,000 employees, while 24% work for firms of less than 100 employees; 11% are in organizations of 101–500 people, 7% in 501–1,000-person organizations, and 19% in 1,001–5,000-person organizations.

The most popular chemical engineering fields are fuels and petrochemicals (19%) followed by specialty chemicals, environmental engineering, and engineering construction at 9% each.



Age



Employer Size

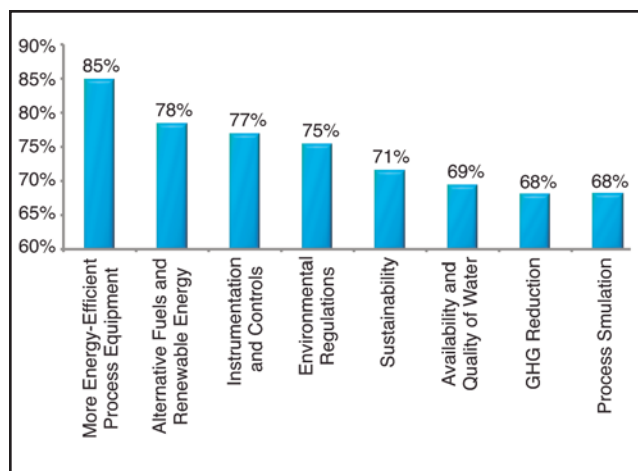
### Technical factors affecting ChE careers

More-energy-efficient process equipment is the technical factor likely to have the most significant impact over the next 25 years, according to *CEP* readers. More than 85% of respondents rate it significant (giving it a 4 or 5 rating on a scale of 1 = little or no impact to 5 = most significant impact), with a weighted average rating of 4.32.

Figure 1 shows the eight factors chosen as most likely to have a significant impact and the percentage of respondents who selected each. Most are related to environmental issues, with the second-highest factor being alternative and renewable energy. This is not surprising, considering the impact energy has had on the economy recently (the survey was conducted in the summer, when oil prices were almost double what they are at press time) and the attention energy is receiving in the U.S. presidential campaign.

One reader states that “the main requirement will be to minimize the use of petroleum as a fuel, and instead focus on its value as a source for petrochemicals. This will lead to massive new efforts in developing synfuels (clean coal), nuclear power, and alternative sources for energy.”

Another reader writes, “In my opinion, a clear energy policy will be key to the future success of the U.S. A strong move to renewable resources is important, but in the next 25 years oil will still maintain a prominent place in our economy. The ‘Nuclear Super Highway’ is, in my opinion, a key way to change the energy paradigm — using nuclear to generate electricity and hydrogen; using liquid hydrogen to create supercooled conductors to transmit the power; and tapping off the hydrogen at points to serve as fuel for vehicles. Endless fuel and power — this should have the same priority as did the Manhattan Project.”

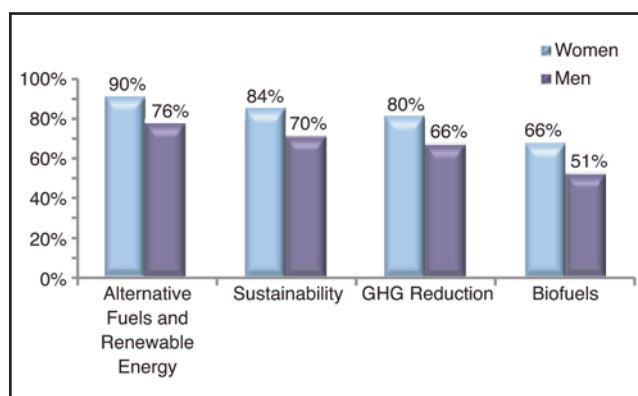


▲ Figure 1. Top eight technical factors expected to have a significant impact on chemical engineering careers.

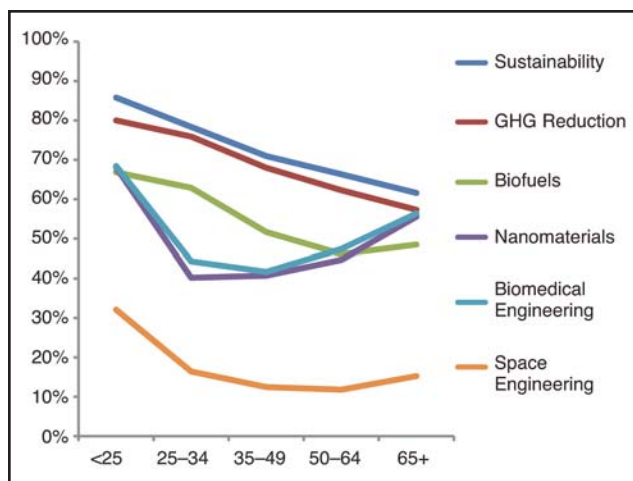
Environmental factors, such as regulations, a move toward sustainability, availability and quality of water, and the need to reduce greenhouse gases (GHGs), are also expected to significantly impact chemical engineering.

One reason given is that “energy and water will become increasingly scarce and will require a large amount of engineering effort to meet the public’s demand.” Thus, there will be a need for “more ‘nut-and-bolt’ chemical engineering than anything else.”

Another reader says, “The need for water is destined to become a stressor between nations. The need for advanced water treatment and distribution will be a major challenge (*e.g.*, trace organic contaminants, water shortages in the U.S. both inter- and intra- states). As chemical engineers, we should be positioned to answer the advanced water treatment call and work with other engineering disciplines to maintain quality during distribution and at the end of the pipe.”



▲ Figure 2. Larger fractions of women than men think alternative energy, sustainability, GHG reduction and biofuels will impact their careers.



▲ Figure 3. Respondents of different ages have differing opinions about which technical factors will significantly affect chemical engineering careers.

A topic of continuous debate is global warming and greenhouse gases. One respondent states, “We are unfortunately being driven by the fiction that human activity is primarily responsible for greenhouse gas emissions, even though the climate record shows that the world has been much colder with higher atmospheric CO<sub>2</sub> concentrations and much warmer with lower CO<sub>2</sub>, and despite the fact that nature produces 24,000 times as much water vapor as we produce CO<sub>2</sub>. Water vapor is a much more significant greenhouse gas. Nonetheless, the need for sustainable energy is paramount.”

Regardless of where one stands on global warming, it is clear the issue will impact the chemical engineering profession. “The upcoming mandated GHG reductions will necessitate improved energy efficiency and conservation in all aspects of our careers and society,” says one respondent.

More-advanced instrumentation and controls and process simulation are also expected to have a significant impact. This is similar to the findings of an earlier *CEP* survey, “Engineering the Next Millenium” (Oct. 1999, pp. 102–112). Then, readers said that computer-related developments would have the most significant positive impact on their careers.

The differences between the opinions of men and women are shown in Figure 2. The percentages of women who think alternative and renewable energy, a move toward sustainability, the need to reduce GHGs, and biofuels will have significant impacts are approximately 14 points higher than the corresponding percentages of men.

The largest differences among age groups can be seen in Figure 3. An interesting trend is that the expected sig-

## “Whatever happens, it will be an interesting ride!”

nificance of sustainability, the need to reduce greenhouse gases, and biofuels declines with reader age. Environmental factors seem to be more important to younger respondents than to older ones.

Another noteworthy observation is the apparent optimism of those under the age of 25, and this optimism seems to decline in the older age groups. Interestingly, those over about 50 appear to be more optimistic about nanomaterials and biomedical engineering. Experimentation and manufacturing in space is more significant to those under 25. This could be because the younger generation has experienced many of the commercial products resulting from technologies created for the space program, whereas the older generations have a more traditional view of space exploration.

Other important factors to readers include nanotechnology, globalization, and materials. One reader adds, “You have left particle technology off the list — again. This continues to be an area of design challenge for new engineers, since only a handful of U.S. chemical engineering departments give any treatment at all to the third phase of matter, *e.g.*, solids handling.”

Some respondents take a bigger-picture view:

“I see many engineers, chemical and others, focusing on problem-solving in the developing world. There is so much room for engineers to have an impact on people’s lives, especially the people who most need help,” comments one reader.

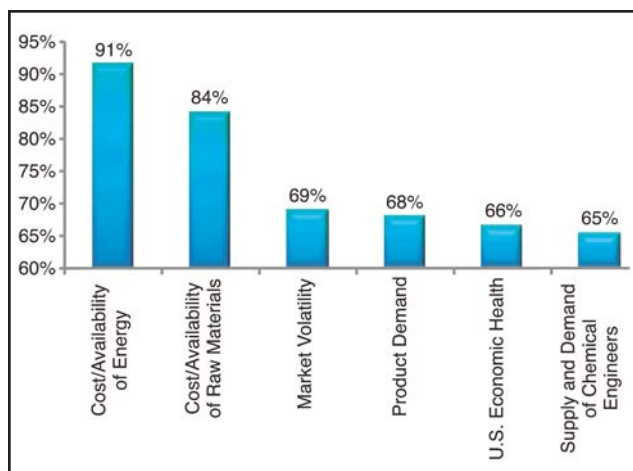
And another believes, “Whatever happens, it will be an interesting ride!”

### Business factors affecting ChE careers

Of various business factors, respondents think the cost and availability of energy and raw materials will have the biggest impacts on their careers. The top six business factors most likely to have a significant impact are shown in Figure 4. The cost of energy tops the list, with a weighted-average rating of 4.54 and more than 90% of the respondents giving it a significant rating.

In second place is the cost of raw materials, with a weighted-average rating of 4.28 and 84% of respondents rating it significant. Market volatility ranks third (3.94, 69% significant), product demand fourth (3.89, 68% significant), the economic health of the U.S. fifth (3.83, 66% significant), and supply and demand of chemical engineers sixth (3.77, 65% significant).

Readers have various beliefs regarding the business of



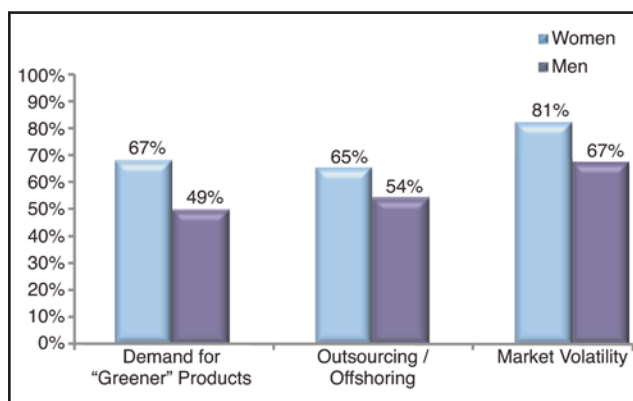
▲ Figure 4. Top six business factors that readers feel will have a significant impact on chemical engineering careers.

chemical engineering in the U.S. “Business will continue to follow cheap labor until a worldwide economic steady state is achieved. U.S. chemical engineers must diversify away from the traditional petrochemical roles that they have played,” writes one respondent.

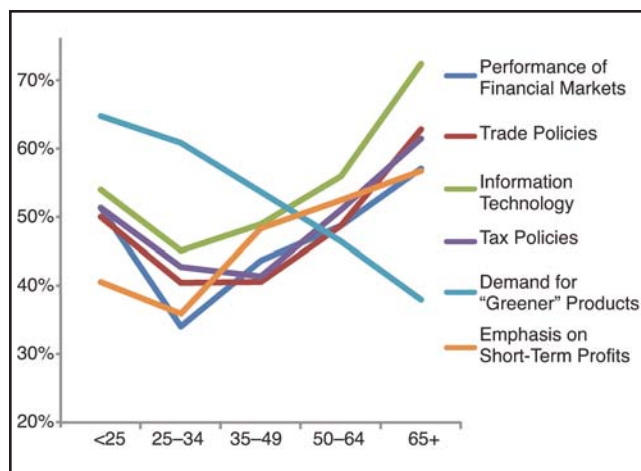
Others agree. “U.S. engineers in particular are going to suffer to the extent they allow themselves to feel entitled. There is talent all around the world, and we are not insulated from it. We need to wade in and be part of it.”

Furthermore, “India and China will either become equal or surpass the United States in economic influence. Brazil will also exert significant economic influence. The United States is headed the way of the British Empire.”

There is also debate as to how to deal with some of these challenges. “I think in 25 years, there will be no chemical engineers working outside of academia. It is going offshore pretty fast now, and I do not think any government policy (tax or trade) will change things



▲ Figure 5. Larger fractions of women than men think the demand for “greener” products, offshoring and market volatility will impact their careers.



▲ Figure 6. Respondents' opinions about how significantly various business factors will affect their careers vary with age.

much," says one reader.

Another gives a possible reason for this: "The growing technology gap in the United States is a growing concern, as there is a diminishing supply of talented and capable individuals pursuing scientific and engineering career paths."

One member believes, "Outsourcing and moving engineering jobs offshore should be subject to severe tax penalties, amounting to a reverse tariff on intellectual properties."

Although outsourcing "does reduce production costs, I believe we have reached a point that unless manufacturing is returned to the U.S., we are destined for significant failures in the future," explains another respondent.

"Without wise tax, trade, and financial policies in place, companies, regardless of how good they are, will continue to struggle to have the resources necessary to stay competitive and in business," says another.

Many respondents share one reader's belief that "the competitiveness of U.S. manufacturers is negatively impacted by the pressure for short-term profits versus long-term investments in research and development and by the strong tendency to view the technical work force as a cost center rather than as a source of competitive advantage."

Another reader explains, "Corporations will march to the bottom line and sacrifice long-term investments. The desire for instant gratification has hit the stockholders, and the companies will bend to their demand."

There are some disagreements between men and women (Figure 5) and among different age groups (Figure 6). The younger respondents and about two-thirds of the women think the demand for "greener" products will have a significant impact; less than half of

the men agree. Interestingly, the significance also declines almost linearly with age, from 65% of the respondents under the age of 25 to less than 40% over the age of 65.

In addition, larger percentages of women than men believe offshoring and market volatility will have a significant impact on their careers.

Other factors that increase almost linearly in importance after the age of 35 include the performance of financial markets, trade and tax policies, information technology, and emphasis on short-term profits.

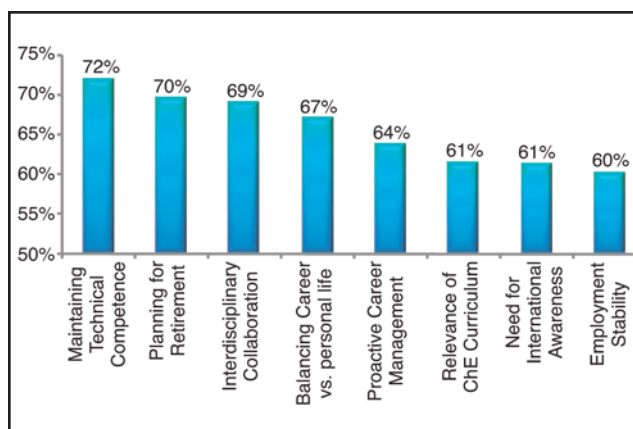
### Professional factors affecting ChE careers

The professional factors that chemical engineers believe will have a significant impact on their careers are shown in Figure 7. The most important factors on engineers' minds are maintaining technical competence and planning for retirement, both of which have a weighted-average rating of 3.9 with approximately 70% of respondents selecting them as significant.

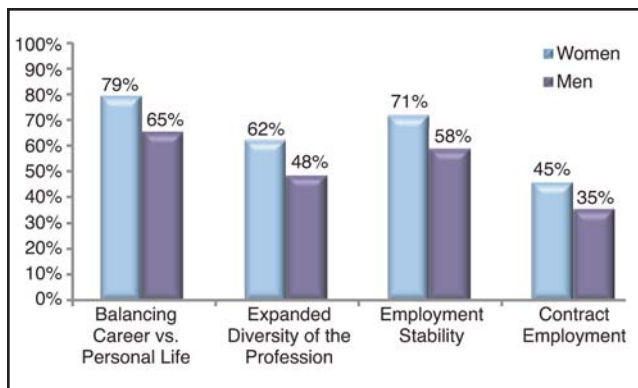
One reader discusses concerns about planning for retirement: "The next generation will be faced with a lot more uncertainty concerning retirement, employment, and balance between personal and career goals. Social Security cannot afford its current promises. Medicaid is worse off. Defined-benefit plans are a thing of the past. Competition is intensifying. Retirement age will increase and benefits will decrease. This will make it much more difficult to plan for retirement."

Also important are interdisciplinary collaboration (3.87, 69% significant) and balancing career versus personal life (3.87, 67%).

One reader shares, "The key for success for any chemical engineer during the next 25 years will be maintaining



▲ Figure 7. Professional factors expected to have the most significant impacts on chemical engineering careers.



▲ Figure 8. Larger percentages of women than men believe balancing career and personal life, expanded diversity of the profession, employment stability, and contract employment will impact their careers.

his/her technical competency and ability to collaborate with other engineers. During the next 25 years, most chemical engineering jobs will be outside of the U.S. (Middle East, Africa, Asia). Therefore, diversity, knowledge and understanding of these cultures will be very important factors for a successful chemical engineering career.”

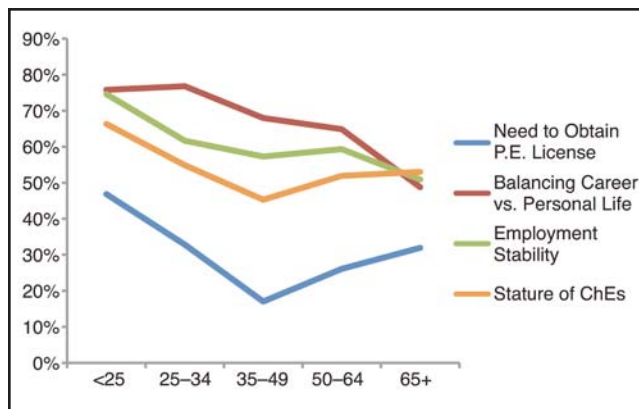
However, an area of challenge and concern is the balance of career and personal life. One reader states, “In a 24/7 world, balancing career and personal life will become harder and more important — we can’t always be on duty!”

Another reader agrees and goes one step further, explaining the effects on the industry: “The balance of work/life is almost nonexistent in the industry that I work in. The company wants and demands complete contact and responsibility even when we are ‘on vacation.’ There is no down time. This will have to change, or people will not stay in this industry.”

This is reflected in the responses of the women and those under the age of 35. Table 1 shows that women rated balancing career and personal life the number-one factor affecting their careers. Although the men agree that it is important, they rate it fourth. Most important to

**Table 1. Men and women agree on the four most important professional factors, but not on their relative importance.**

Men	Women
Maintaining technical competence	Balancing career vs. personal life
Planning for retirement	Maintaining technical competence
Interdisciplinary collaboration	Interdisciplinary collaboration
Balancing career vs. personal life	Planning for retirement



▲ Figure 9. Respondents have different opinions about how significantly certain professional factors will affect their careers.

men is maintaining technical competence, which women rank second.

Other key differences between the choices of the men and the women are their ratings of expanded diversity of the profession, employment stability, and contract employment. Figure 8 shows that the percentages of the women who rated these factors significant are larger, by 10–14 percentage points, than those of the men.

Figure 9 shows that balancing career and personal life is also ranked significant by more than 75% of the respondents under the age of 35. This balance appears to grow less important with age. Likewise, younger respondents are more likely to think employment stability will have a significant career impact than their more-experienced counterparts.

Almost half of those under 25 years of age feel that a professional engineer’s license can have a significant career impact. Among 35–49-year-old respondents, the number who share this view drops to 17%, but it rises to 32% in the over-65 age group.

Readers’ feelings about the stature of chemical engineers in the eyes of employers are represented by a similarly shaped curve. The younger (66%) and older (53%) respondents consider it a more significant influence on their careers than those in the 35–49-year-old bracket (45%).

One member believes, “So far, engineers rank pretty low among the learned professions. In my opinion, this is because we don’t mandate professional licensing and continuing education.” Another simply states that “there is a clear need to encourage licensing in chemical engineering.”

Another professional factor of importance is proactive career management. Almost two-thirds of the respondents believe it will have a significant impact on their careers, with a weighted average of 3.74.

Several respondents point out that networking is a key

“If you want to be treated as a professional, act like one. Participate in AIChE.”

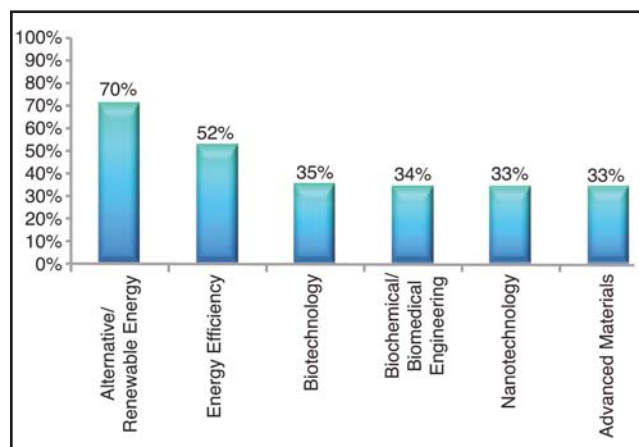
element of proactive career management, one saying simply “network, network, network forever.” Another adds that “participation in AIChE activities will become more important due to networking possibilities.”

We couldn’t have said it any better ourselves than the respondent who advises: “If you want to be treated as a professional, act like one. Participate in AIChE.”

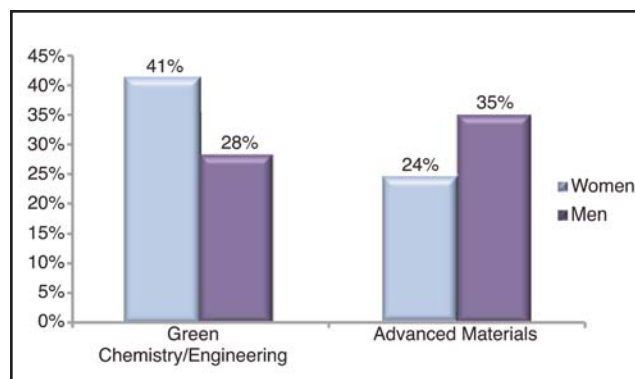
Another member explains why this is important: “Unfortunately, in today’s business there is very little loyalty from a company to individual employees. This has filtered down to very little loyalty, as far as sticking with a company, from employees to their companies. Because of this, proactive career management is vital to move up the career ladder. It is no longer a matter of ‘how high up the ladder can I go and add benefit to my current company?’, but ‘what path do I take to achieve my career and personal goals?’, with little or no thought to the current company. This is unfortunate — but after seeing valuable people with high loyalty to a company escorted out by security because of cost reductions or restructuring, it makes one reevaluate their position.”

### Significant chemical engineering advances

The areas of chemical engineering in which readers think the most significant advances will be made over the next 25 years are shown in Figure 10.



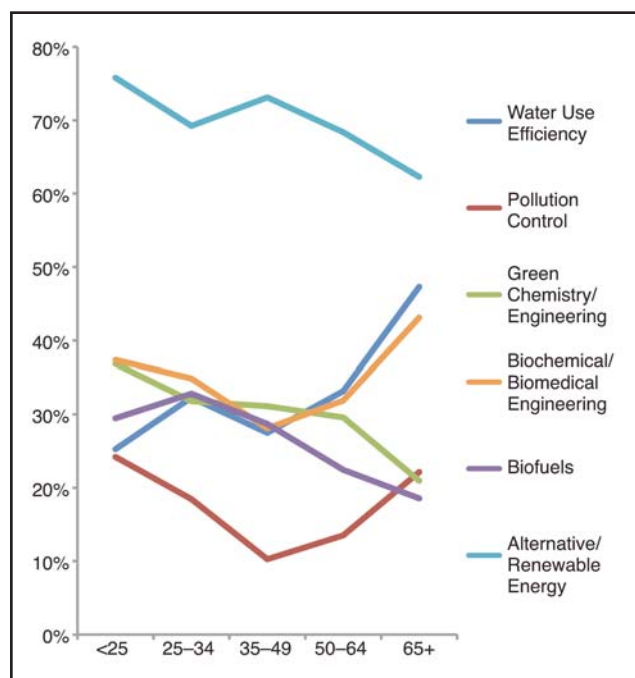
▲ Figure 10. The most significant advances over the next 25 years are expected to be made in alternative and renewable energy and energy efficiency.



▲ Figure 11. A larger percentage of women believe green chemistry/engineering will see significant advances, while more men believe advanced materials will.

More than half of the respondents believe the greatest advances will be related to energy, with 70% choosing alternative or renewable energy and 52% choosing energy efficiency. In particular, numerous respondents express hope for nuclear energy, and some feel that we should have included it as a separate item on the list.

“You barely skirted around of the edges of what I believe will have the largest effect, and that is nuclear energy. Anything related to efficiency and waste reduction will also be big. I predict that the global warming hysteria will die out in the wake of ‘global cooling’ — both of



▲ Figure 12. Respondents’ opinions about where the most significant engineering advances will occur vary with age.

which are natural phenomena,” writes a respondent.

Another says, “The price of energy is a fundamental driving factor in the world’s economy. Yet, just two of the areas mention energy. Your list should include nuclear energy. It should also include power generation. And it should include crude oil and natural gas recovery.”

One reader is enthusiastic about the potential of solar energy, stating “I see leaps in efficiency for solar panels on house roofs as a huge part of our future. I’m ready and waiting for Dow Corning to make the next big leaps in conversion efficiency for solar panels, and I think I will be able to generate more electricity than I use. Getting a small check from the utility company every month is an exciting thought.”

Another member believes that “petroleum-based energy must co-exist with alternative sources over this period, or at least until the alternatives develop significantly. Our country needs to support both.”

In addition to energy, biotechnology and biomedical engineering received votes from about 35% of the respondents. Nanotechnology and advanced materials were also rated similarly.

Green chemistry and engineering was chosen by 41% of women, shown in Figure 11, as well as over 30% of respondents under the age of 65, shown in Figure 12.

One reader states, “The movement to be ‘green’ is going to become an increasingly large driving force from our various customers. We need to embrace this movement and adjust our thinking to work toward sustainable operations while still maintaining profitability and a competitive advantage. There is no reason we cannot be ethical and responsible manufacturers.”

Another reader points out that “going green seems to be more of a result of rising energy prices versus a true concern for the environment. Therefore, things like energy efficiency that affect the dollar will be at the forefront of people’s focus.”

Another reader sums it up with, “Go see Wall-E and then tell me that waste reduction/minimization is not extremely important.”

Advancements in pollution control are rated highly by respondents under age 25 (24%) and over age 65

“If it involves reactions or separations, we will be involved, and it will be improved.”

(22%), but less highly by those in other age groups. “I think the pollution control industry will parallel the future initiatives in energy development, as well as both the public and the industry become increasingly aware of both energy needs and environmental quality requirements,” says one member.

Additionally, while about a third of the respondents under the age of 35 believe there will be significant advancements in biofuels, the optimism is less among respondents over the age of 35, dropping to under 20% among the over-65 group. Alternative energy fares similarly: almost three-quarters of the respondents believe it will have a significant impact, but the number declines 14 percentage points for those over the age of 65.

Conversely, more of the 65+ members, approximately 45%, believe biomedical engineering and water use efficiency will have a significant impact.

Some members’ comments relate to the overall picture rather than specific areas that will experience advancements. “I see most of these as incremental changes that add up to a lot over 25 years. I have been out of college 25 years and I am amazed at how much incremental improvement has occurred in everyday items. For example, the least efficient appliances today are more efficient than the ‘super efficient’ models sold during the oil crisis of 1979. All the changes add up in a very quiet way.”

Another member reminds us that “if it involves reactions or separations, we will be involved, and it will be improved.”

Social concerns were also mentioned. “I selected areas that are going to be driven by the problems we are facing today — health care costs, energy costs, alternative materials due to scarcity of raw resources, and provision of good potable water throughout the developing world.”

Another member agrees and further explains, “Chemical engineers will become increasingly concerned with social considerations, such as health care, child-care leave, retirement financing, etc., for themselves and for all employees in the chemical and related industries. In devising new products and processes, chemical engineers will become increasingly involved in satisfying the material needs and desires of society, and also with advancing the humanistic quality of life.”

### Acknowledgements

CEP would like to thank AIChE’s Marketing Team, Tim McCreight, Jeanne Chan, and Roza Konopacka, for their help in conducting the survey and developing the statistics, Dov Harrington, web administrator, for setting up the online forum discussion, and Diane Capiella, for assistance in organizing the online forum participants’ comments.

Thanks to all of you who participated in the survey. Three lucky respondents, selected at random, will each receive a \$100 gift card.



Part 2 of our reader survey asked you to share your thoughts on where we've been, where we're going, and what we'll be leaving for the next generation.

For the first time, advances in technology have allowed us to give you, our readers, the ability to speak with each other directly. When we started the online discussion forum as the second part of our survey, we had no idea what to expect. We weren't sure who (if anyone) would respond, what the responses would be, or how this survey would take place. Not only did you respond to our questions, you even added one of your own and started your own discussion.

We're pleased to say the results not only exceeded our expectations, but really moved us as well. From the key technological breakthroughs we've produced, to the next noteworthy advancements we're creating, to the inspiring stories and motivating reasons you have for doing what you do — by sharing what drives you to be a chemical engineer, we became even more excited, inspired, and proud to be a part of this great field of chemical engineering with you.



## How would you like to see chemical engineering affect society and/or humanity?

MANY CHEMICAL ENGINEERS GO INTO THE PROFESSION WITH THE HOPE OF GIVING BACK TO SOCIETY AND CONTRIBUTING AT A GREATER LEVEL. WHO KNEW THAT WE COULD NOT ONLY PRODUCE SOLUTIONS FOR THE WORLD'S PROBLEMS, BUT BE SO INSPIRATIONAL AS WELL! AS ONE READER SAYS, "WE ROCK!"

"I would like to see chemical engineering (continue to) make contributions to pharmaceuticals and finding alternatives to oil. Chemical engineering can be the leader in discovering new ways to reduce pollution and developing energy-efficient processes."

*Rosanna Ayala*

**"Chemical engineering has incredible potential to improve the quality of life and to help people live longer and more rewarding lives. With our involvement in everything from medicines, fuels, and foods, our profession touches all of our daily lives and has a global impact. That is an incredible amount of influence — which places a considerable responsibility on all of us to perform our jobs safely and effectively. I have no doubt that as a profession, we will continue to make life better for billions of people across the globe."**

*Michael J. Asher*

"Make the world more equitable now, and more sustainable in the future."

*Hak Koon Yeoh*

"Chemical engineering will affect society in a big way by generating alternative sources of energy. In addition, chemical and biomolecular engineering are already working to eliminate diseases by studying the root causes, *i.e.*, bacteria and viruses, and developing cures. I hope breakthroughs will one day be attained in this field."

*Tarrun*

"Change the way people think to a more productive and focused one: many voices, one vision."

*Akay*

"I would like the chemical engineering profession — and the chemical engineers in the profession — to be seen as the 'voice of reason' and the place to come for solutions to many of society's technical problems. Global warming, energy, food production and clean air and water are just a few of the many areas for which chemical engineering has the solutions."

*Anthony Fregosi*

**"I think chemical engineers rock. They have the capacity to work in any field — like combining their studies with biology, or with mechanical, electrical engineering ... They make an impact through whatever they do. Their work in pharmaceuticals is doing miracles, similarly for finding better alternatives to oil and in finding ways to reduce pollution and increase the energy efficiency of processes."**

*Ramani Gidugu*

"I think engineers should educate society about practical matters. It seems to me that the public in general gets caught up in media hype, and misses the science or practicality of the issue. Engineers can help."

"In addition, we need to educate the public about what chemical engineers do. Many people think it's mysterious or too difficult. Kids in school need to know that what we do is important and feasible (with hard work, of course), as well as rewarding."

*Rachel*

**"Engineers have the ability to recognize, analyze and logically attack a problem. We need to help society to do the same, so that the general public can be guided thoughtfully rather than through emotions or the latest trend."**

*Darrell Schmidt*

“I would like to see more prominent chemical engineers in high-profile jobs, like analysis/news shows and government positions, to get the needed exposure to sustain the career field.”

*LT*

“Chemical engineers could have the biggest impact by helping to develop and commercialize alternative forms of energy — as well as by improving the energy efficiency of existing energy users — in order to make existing energy supplies last longer. We need a paradigm shift and chemical engineers are good at that sort of thinking!”

*Laura L. Chutny, P.E.*

**“I would like to see chemical engineers take a larger part in medicine and government management. The government has been run by attorneys for many lifetimes and they do not seem to be solutions-oriented.”**

*Etsco*

“Chemical engineers have skills that are required to shape the future of the world. There are complex interactions at work between societies, governments and the environment. We must be a voice of reason.

“Government’s role in shaping things such as energy policy cannot be overlooked or underestimated ... Are there standards for measuring the societal benefit of new technologies? Chemical engineers must actively participate in shaping the future ... through communication with governments, other professionals, environmentalists, and average people everywhere.”

*Jody Smith*

**What do you think have been the most significant chemical engineering breakthroughs in the past decade?**

**CHEMICAL ENGINEERS HAVE PRODUCED BREAKTHROUGHS IN A WIDE VARIETY OF AREAS. THE GENERAL CONSENSUS INCLUDES IMPROVEMENT IN CATALYSTS, PROCESS INSTRUMENTATION, NANOTECHNOLOGY AND ITS USE IN THE MEDICAL FIELD, STEM CELL USE TO CURE ILLNESSES AND GROW BODY COMPONENTS, SURFACE CHEMISTRY, ALTERNATIVE ENERGY AND BIOFUELS, MEMBRANE PROCESSES, AND COMPUTER-AIDED DESIGN.**

“Catalytic materials, particularly new photocatalysts, and new methods of precise catalyst characterization.”

*Gregory*

“The biggest opportunities for the profession are things like global climate change. By enabling the modern economy to exist, based as it is on the efficient production and processing of fossil fuels, we have contributed to the problem. However, we are also uniquely equipped to help the public understand the issue and to marshal support for the steps needed to deal with it.

“Probably the first thing I ever learned in chemical engineering classes is the simplest and most powerful idea — an idea the public can easily grasp. ‘What goes in must come out or accumulate.’ We have spent lifetimes transforming that abstract concept into useful knowledge. To make ourselves relevant we certainly must communicate the complex ramifications of this simple idea amongst ourselves, but we must also keep the focus of the general public on the simplest, most basic things that all of us learned in school. If we lose the public’s attention, the entire solution to the problem suffers. If we can learn to speak to our neighbors in terms they understand, we will be the key players in the solutions.”

*John G. Tiessen*



**“I think the greatest improvement has been in instrumentation and process control, which has been driven by the boom in computer technology.”**

*Darrell Schmidt*

“Some of the most important breakthroughs have been in the area of medical advances brought about by the collaboration between the medical and engineering professions. Major advances have also been made in material science research, nanotechnology and alternative fuels. I do not believe there are any areas of our society that have not been touched in some way by the chemical engineering profession.”

*Anthony Fregosi*

**“Materials, including catalysts. New materials, ultra-pure materials (allowing things like electronic circuits to be made smaller, better pharmaceuticals, tighter tolerances, etc.) and related developments have been at the heart of most major advances I’ve seen.**

“‘Green’ and ‘sustainable’ are similar to what we saw in the 1970s, but new materials and higher (likely permanent) relative prices of energy drive somewhat different decisions. Often, energy costs are still relatively minor. There is a temporary blip in excitement over greenhouse gases and global warming, but they will soon receive less attention, as the data do not support the excitement and publicity.”

*Bruce D. Bullough*

**“Nanotechnology. The use of nanoparticles to solve various kinds of problems is one of the best things happening presently.”**

*Akay*

“I believe that most important developments have taken place in the fields of bioremediation and green chemistry. We are trying to find new ways to eliminate waste, and bacteria are being developed to degrade toxic wastes. Also, green chemistry has received a lot of attention for reducing our toxic footprint.

“‘Alternate’ sources of energy have also gained importance in the minds of the research community, and new avenues are being sought.”

*Tarrun*

“If we are talking about breakthroughs in the practice of chemical engineering, then it has to be the dominance of computers — both in plant design and in process control. This change has occurred over more than a decade, but certainly the change is quite radical when you consider how things were, say, 30 years ago and how they are now.

“If we are talking about breakthrough products, it seems to me that new materials for electronic applications and lightweight materials for transportation applications are probably among the most important advances over the past decade or two.”

*Alan Rossiter*

## Where do you anticipate the next big breakthrough coming?

### COULD THE NEXT BIG BREAKTHROUGH COME IN THE AREA OF ENERGY? IF WE HAVE OUR WAY ...

**“With energy costs impacting every facet of society — I would expect the next major breakthrough to come in the energy sector. Fuel cells, alternative fuels and enhanced oil recovery are just a few of the areas in which I think major breakthroughs will occur.”**

*Anthony Fregosi*

“Nanotechnology, biotechnology and nonconventional energy.”

*Mandyam Badari, PhD*

“I would watch for a major push over the next few years to resurrect the alternative fuels projects shelved in the early 1980s, since now they’ve become more economically attractive. Expect coal-to-synfuels, for example, to come to the forefront.”

*John D. Barry, P.E.*

“I think the next big thing will focus on alternative sources of energy. I work for a plant where there is more push to utilize the clean energy we already make. There are plans to expand that so we no longer have to rely on the power company, but can make and possibly sell our own power.”

*Rosanna Ayala*

**“Catalysis is one of main driving forces of our industry. Design of new catalysts and improvement of catalytic processes, particularly photocatalytic processes, will be key areas of the future technological revolution. I am working in this science and anticipating a big breakthrough.”**

*Gregory Yablonsky*

“The next biggest breakthrough could be in the field of bacterial infection studies. I am a chemical engineering student using microfluidic devices to study how pathogens infect humans. These devices mimic the human intestinal environment and give us the luxury of observation under a microscope. We observe bacteria-host interactions in these devices, and we decipher how the process takes place. We also study the genetic response of both bacteria and human cells through DNA microarrays and test new chemicals that can inhibit infection. One day I hope I will be able to develop something that stops bad bacteria, for good.”

*Tarrun*



“Energy is on a lot of minds right now. Energy has transformed our society and will continue to do so. Increasing petroleum costs will drive energy diversification to everyone’s benefit. Technology advances will continue to drive productivity gains in manufacturing.”

*Jody Smith*

“The biggest breakthrough is going to be in nanotechnology, which will eventually change everything on the globe. I believe nanotechnology, together with new advanced super-materials, are going to create a totally new scenario.”

*Asim Ali*

**“Energy, Energy, or —  
please let it be — Energy.”**  
*Etscot*

“Progress happens on the margins of established technologies. It is almost always enabled by advances in properties of materials. Thus, I believe that advances in materials processing will enable the ‘next big thing.’ I work in the area of radiation curing. I hope it has a role to play. The order-of-magnitude increases in chemical reactivity seen with nanoparticles has a role to play. Bioengineering has a role to play. Just like when Jobs and Wozniak built the first Apple computer in their garage, the pieces for the ‘next big thing’ have probably all existed for some time already. What is missing is the process to put them all together. That’s where we come in — uniquely qualified to do the process engineering.

“Humans have built containers for their belongings for thousands of years. Wheels are prehistoric. Suitcases with built-in wheels have existed for about 25 years.”

*John G. Tiessen*

**“Solar is the next breakthrough area — with the price of oil rising, the use of solar is becoming more cost effective.”**

*Patrick*

“In general, alternative fuels of all kinds. Specifically, though ... in fuel cells, which can have a huge impact.”

*Michael*

“The next big area is alternative fuels, and I am fortunate to have some involvement in this area. I think new materials, especially for electronic applications, will continue to be important. As far as I can tell, nanotechnology and biotechnology are not really living up to their billing as ‘the new paradigms,’ but I would be happy to be proved wrong.”

*Alan Rossiter*

## What other fields of life do you think most chemical engineers divert to and why?

CHEMICAL ENGINEERS ARE SUCH WELL-BALANCED, OUT-OF-THE-BOX THINKERS THAT THE PROFESSIONAL OPTIONS ARE ENDLESS — DOCTORS, LAWYERS, MANAGERS, EVEN DOMESTIC EXECUTIVES.

“I have seen many colleagues get their MBA with the attitude that somehow an MBA is ‘better’ than a ChE degree. They then move out of the technical positions into management and finance positions. Many other chemical engineers go into alternative careers, such as venture capital firms, sales and marketing, or training firms. It is a testament to the broad educational background a chemical engineer obtains that we are able to enter so many varied workplaces.”

*Anthony Fregosi*

“In my nearly 30 years, the two new fields I have seen chemical engineers go to most are sales/marketing, and women deciding to stay at home and be moms. Both of those groups are small, but they are the most common. A very high percentage of the really good women engineers I have worked with have taken that stay-at-home route (maybe 20%). Some left from mid-manager jobs, some from labs, some from project management, process design ... essentially the whole spectrum. Some come back, some don't. I exclude management, environmental, health/hygiene, chemical development, and safety, because I see them only as specialties within the ChE umbrella.”

*Bruce D. Bullough*

“I know of engineers who have become veterinarians, lawyers, teachers (non-engineering), doctors, business managers, salesmen (outside the industry), and homemakers. I think many are drawn by the practical question of how much money is made against the hours required. (The exceptions, such as homemakers and teachers, have to be considered on a case-by-case basis.)”

*David*

“Environment and safety ... chemical engineering is very close to these areas. Also, chemical engineers can effectively work in bioengineering and civil engineering, and in mechanical engineering as well.”

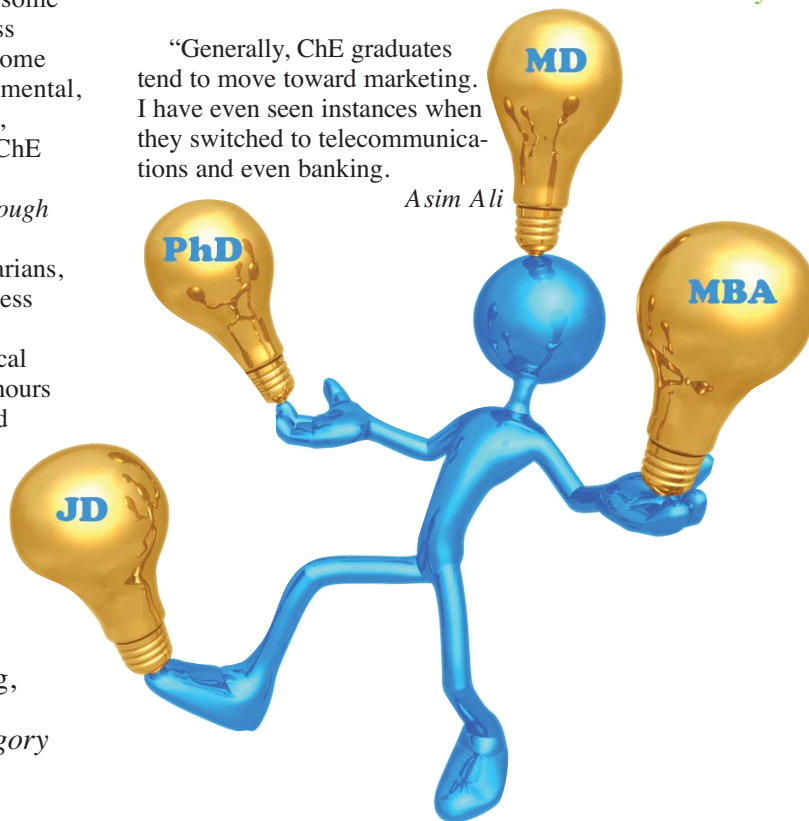
*Gregory*

“I feel that the chemical engineering field provides individuals with a whole new thought process. Our mentality may sometimes be far beyond general knowledge and it's what makes us stand out. I think that most chemical engineers end up going into the business field, and this is clearly because of the way we think. When you study business as a major, you think along the lines of businessmen. But when you are a chemical engineer in the business field, you think outside the box of a businessman. Chemical engineering provides us alternative views to various issues and a large number of us make it in life when we do something different.”

*Akay*

“Generally, ChE graduates tend to move toward marketing. I have even seen instances when they switched to telecommunications and even banking.”

*Asim Ali*



## What do you hope your chemical engineering legacy will be?

FROM IMPACTS ON SOCIETY, TO ADVANCEMENTS IN TECHNOLOGY,  
TO TEACHING THE NEXT GENERATION'S WORKFORCE —  
THE CHEMICAL ENGINEERING LEGACY IS ONE OF GREAT PRIDE.

"I hope that one day society will know me as a chemical engineer/scientist who ventured outside of traditional chemical engineering to develop a cure for bacterial infections through the application of chemical engineering knowledge, as well as genetics."

*Tarrun*

**"I hope to be remembered as an engineer who strived to always make things better and whose recommendations could be trusted."**

*Darrell Schmidt*

"I did the right things, for the right reasons (based on data or whatever information was available) and successfully used the basics to get there. I can't tell you how many times I've had to fix things by going back to the basics because the first person/people apparently thought a guess was as good as some calculations and analysis of the data using the basics!"

*Bruce D. Bullough*

**"I want to get people to think for themselves, and leave a legacy of challenging others to act for the benefit of others and society, not just themselves."**

*Etscot*

"One day I hope society will know me as a chemical engineer who did something to benefit our economy or environment. Times are calling for an innovative mind who will look beyond what currently exists. Improvements need to be made and new possibilities need to be discovered. It would be great to be able to do that."

*Rosanna Ayala*

"Advocacy and some contribution towards sustainability, and acceptability of chemicals and the chemical industry."

*Mandyam Badari, PhD*

"I am hoping to bring some change to society ... My major concern is global warming. I am hoping to be a major contributor toward reducing it."

*Ramani Gidugu*

**"Why restrict it to chemical engineering legacy? Many chemical engineers end up on entirely different career paths, then their 'ChE legacy' will be minimal. I am an educator in a small developing country. I hope my legacy is that I have a deep impact on the education of chemical engineers who eventually contribute significantly to global well-being, despite the not-so-glamorous origins."**

*Hak Koon Yeoh*

"I have abandoned thoughts of great change, accomplishments or recognition. I hope my legacy is the influence on my coworkers of steady, reliable, consistent work, always giving my employer, the client and society, my best efforts."

*David*

**"I hope that the recognition of the need for a diverse workforce and the advantages it provides for a company will be an accepted fact."**

*Henry Brown*

"I hope to be seen as one who promoted the ethics and vision of what being a chemical engineer is all about — whether I am working in a traditional ChE role or one of the many alternative roles chemical engineers find themselves."

*Anthony Fregosi*

"The importance of common sense to the engineering field."

*LT*

**"I derive some satisfaction from the process improvements I have made over the years at facilities in various places. However, I find greater satisfaction in helping other people to develop their skills and grow in their profession."**

*Alan Rossiter*

