





## Engineering brain drain?

As the aerospace business picks up, a shortage of engineers throughout the industry is looming. **by Louise Wilkinson**

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**A**s the aerospace industry grows and the engineering population shrinks, top aerospace companies such as Boeing are looking at how they can address a potential shortage of aerospace engineers in the coming years.

Several factors are contributing to this potential shortage.

First, there has been a steady decline in the number of engineering graduates in the United States since its peak in the mid-1980s.

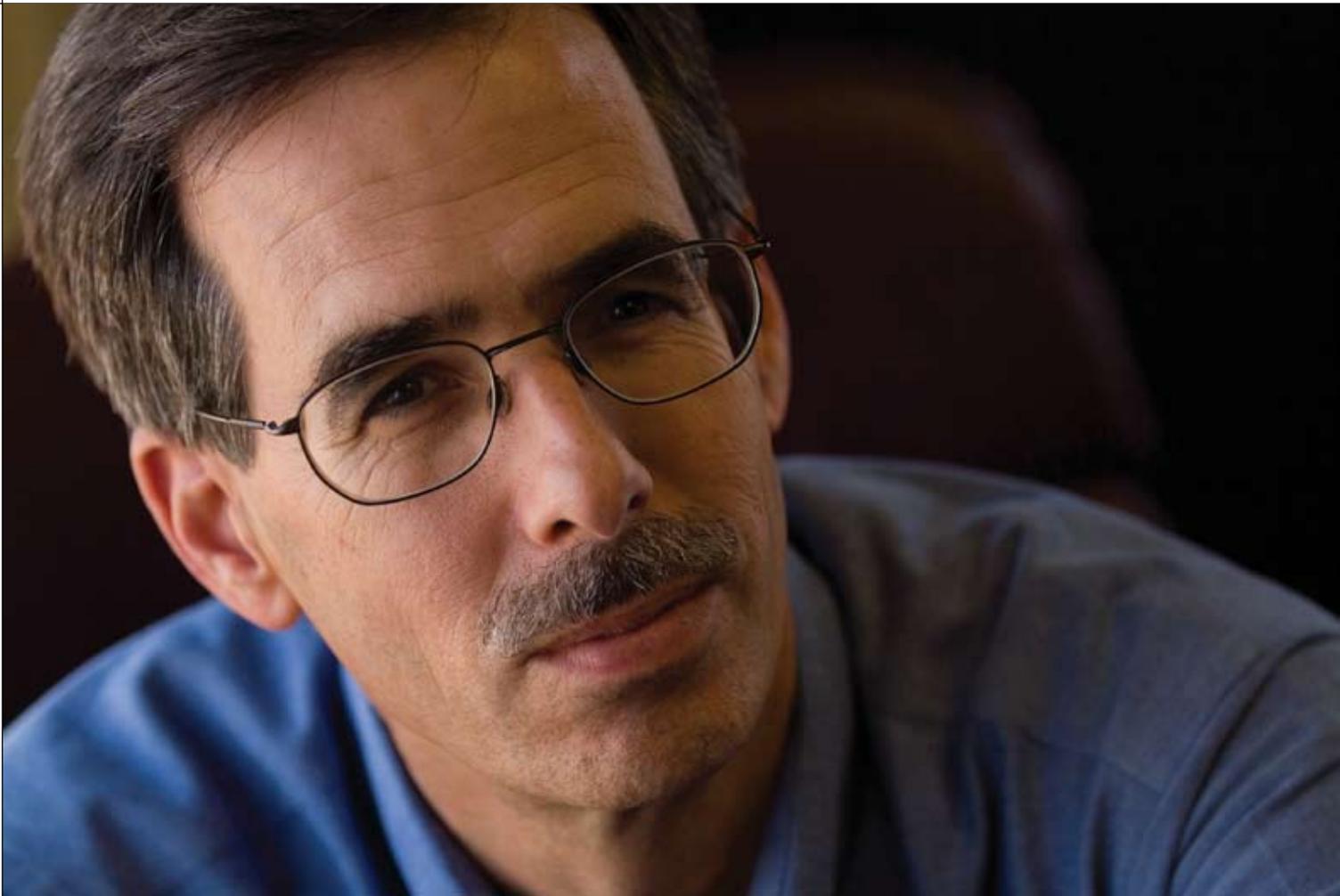
According to a recent study by *Aviation Week & Space Technology* magazine, the United States is turning out only about 110,000 engineers a year compared with China's 600,000 a year and India's 350,000 a year.

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**Deborah Limb, director of Payloads and Structures Engineering for Boeing Commercial Airplanes, says engineering derives strength from diversity. "It should be dynamic teamwork," she says, "bringing people from different cultures and backgrounds and achieving something more than any one of them could do alone."**

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**John Tracy, senior vice president of Engineering, Operations & Technology and Chief Technology Officer.**

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**– John Tracy**

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In addition, fewer students at engineering schools are opting for aerospace careers, favoring high-paying high-tech careers in other fields instead.

According to the *Aviation Week* study, just seven percent of the students interviewed at 15 top engineering schools expect to pursue a career in aerospace and defense.

And finally, a large number of baby boomers that comprise the current engineering work force are expected to retire during the next few years, reducing the ranks by about 25 percent. At Boeing, the percentage of the engineering work force that is eligible for retirement today is expected to double over the next five years.

John Tracy, senior vice president of Engineering, Operations & Technology (EO&T) and Chief Technology Officer, says,

“Engineering is our lifeblood.

It is at the heart of everything we do. We need to find ways to fill the engineering pipeline and then draw from the best of the best.”

And the aerospace industry is not the only one concerned. Recognizing the critical role that aerospace engineers play in the U.S. economy and national security, Congress in 2005 passed a bill creating a federal task force to work with state governments and the private sector to identify and promote ways to revitalize the aerospace work force.

For its part, Boeing is encouraging more segments of the population to enter technical disciplines and urging those people to enter aerospace engineering.



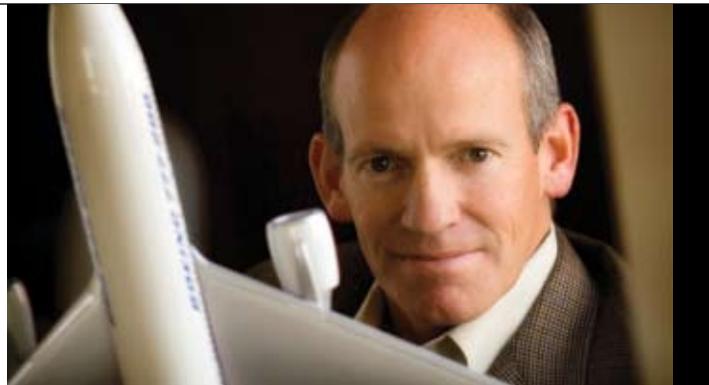
**Nan Bouchard, vice president of Engineering & Mission Assurance for IDS and team leader with Mike Denton of the Enterprise Engineering function within EO&T.**

“At Boeing, women are increasingly taking on key engineering roles with major management and technical responsibilities. Boeing is working hard to hire new engineers – men and women – and to retain those eligible for retirement.”

– Nan Bouchard

### Finding a way

“We have got to find ways to inspire students at all levels and from all backgrounds and cultures to become more interested in math and science and to pursue degrees in engineering,” Tracy says. “By increasing the diversity of our work force, we can better meet our growth requirements and also meet them in a way that enhances our ability to provide more creative and competitive solutions.”



**Mike Denton, vice president of Engineering for Boeing Commercial Airplanes and who leads the Enterprise Engineering function of EO&T with Nan Bouchard.**

“Women represent 50 percent of the population but only 11 percent of engineers in the aerospace industry.”

– Mike Denton

Boeing has been involved in a number of activities to meet these challenges. These include:

- Diversity councils
- Affinity groups (see article page 50)
- External technical affiliations focused on diversity
- The university executive focal program
- University scholarship programs
- Primary & secondary school outreach programs

While Boeing is working hard to increase engineering representation among all minority and non-minority groups, women represent a particularly large under-represented population.

“Women comprise 50 percent of the population, yet they represent only 11 percent of the engineering population in the industry,” says Mike Denton, vice president of Engineering for BCA and head of the Enterprise Engineering function within EO&T. “If we can interest more women in engineering as well as more minorities, we would be making a big step forward. We know we can do better, because about 18 percent of today’s engineering graduates are women. Similarly, the graduation rate of minorities is also higher than our current representation rate.”

“At Boeing, women are increasingly taking on key engineering roles with major management and technical responsibilities,” says Nan Bouchard, vice president of Engineering & Mission Assurance for IDS and team leader with Mike Denton of the Enterprise Engineering function within EO&T.

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**Julie-Ellen Acosta: “It doesn’t hurt to be passionate about engineering in front of your children. We must be role models.”**  
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Deborah Limb, now director of Payloads and Structures Engineering for Boeing Commercial Airplanes, also enjoyed taking things apart as a child. She was recently the director of the Fuselage and Interiors team for the 787 and led the international team responsible for the design, build and support of the 787 fuselage. “Wired to be an engineer,” she took the whole family’s bikes apart and rebuilt them so they would perform better. And hers was a family of five. Limb’s father was an engineer at Boeing for 29 years, and he “talked about science and math at the dinner table – asking the equation for this or that, or making you recite laws of physics.” Limb has another unusual entrée to the world of mechanics and mathematics: “I play the drums, and they are very mathematical in a way. When you play drums, you use all four of your limbs with beats that are linked and yet separate.” Structures have always fascinated her, and when she walks into a building, she looks at how things are connected, the load paths and what holds it up.

Helene Michael is the vice president of 737 Manufacturing for BCA. She grew up in Sweden in a rural environment “tied to nature and the outdoors and to the physical things of building, designing and seeing how things work.” Involved in many team sports, she found it “almost identical to doing business – defining what you want to accomplish and knowing that you can’t do it yourself. Defeats and victories also apply to work on a daily basis.”

Michael spent her first two years in agricultural engineering in Montana before she switched to mechanical engineering. She always kept a hands-on relationship with her work; she learned to weld and machine anything she designed – to understand what was possible and what the limitations were.

Nan Bouchard did not take things apart or put them together. “I’m not a naturally handy person – I don’t build my own com-

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In interviewing Bouchard and several other woman engineers at Boeing, *Challenge* learned that there are abundant opportunities for women who choose a technical career. The women also discuss what inspired them to become engineers, how they are doing in their careers, and what advice they have for other women just starting out.

## Early interest

All of these engineers recognized their passion for science early, and many had strong family influences that made mechanical and mathematical curiosity a part of everyday life.

Julie-Ellen Acosta, now vice president of Leadership Development for Boeing and before that vice president of AeroStructures, Manufacturing and Support Technologies for Phantom Works, grew up wanting to know how things worked. Engineering flowed in her blood and filled her young days. “My grandfather designed machinery in his basement. The kids would clean the parts as he made them. Our tiny fingers were perfect for winding the armatures on motors. I was only four or five, but I was fearless about tearing things apart and trying to put them together again.” Acosta felt totally comfortable in the grimy environment of a machine shop, and dirt never dampened her fascination with her summer job installing telephones, crawling under and over the roofs of houses.

PHOTO BY MARIAN LOCKHART



**Dianne Chong: “Things are changing for men as well. Now there is an opportunity for us all to be included and our ideas heard and valued.”**



**Helene Michael:** “Young girls have a very traditional view of what it is to be an engineer, they don’t see the variety and breadth.” She suggests two-week shadowing internships when girls are 13 and 14, the age “when interest in math and science seems to diminish.”

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puters or fix things,” she says. “My degree is in chemical engineering.” Bouchard turned to engineering because she enjoyed math and science and was looking for a stable career. Today, she has functional management responsibility for the IDS engineering processes, engineering tools, and the 32,000-person engineering team, as well as co-leading the enterprise engineering function for Boeing.

Pam Drew’s father was an engineer with the space program, and Drew says she was hugely inspired by the technical feats of Apollo and Skylab, accomplished in NASA’s heyday. She remembers watching the first man walk on the moon: “It was an enormous deal. My mother made me a special white dress with blue polka dots, and a cape – just for that event.”

Now Drew is vice president and general manager of Integrated Defense and Security Solutions, part of the Advanced Systems group in IDS. She looks at markets for Boeing technologies and helped to land the contract for SBInet, a huge Homeland Security program for securing all 6,000 miles of the United States’ northern and southern borders through a virtual sensor network.

Drew has never forgotten her roots. While her mother was a secretary, her aunt was a nurse named Nancy Drew (she thought

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Through mentoring.”

– Helene Michael

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her aunt had written “all of those wonderful books”). Drew aspired to be a nurse until one day her father asked why she couldn’t be a doctor. She went on to study biology and chemistry. She later discovered her fascination with computer science, when the field was still in its early stages.

All eight women described families particularly supportive of their scientific interests.

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## The critical teen and college years

During adolescence, many girls lose interest in science and math. While these women maintained their interests in math and science, their lives were not without challenges. All described grueling academic curriculums and long hours of study.

Shelley Lavender is the program manager for the F/A-18E/F Navy aircraft and is responsible for all aspects of development, production and performance of the Super Hornet. During her freshman year at the University of Illinois, she called home complaining about missing all the campus parties because she had to study so much more than her sorority sisters. Her mom said, “Think long term. If you sacrifice now, you will be able to do what you love.” Lavender says it was well worth it; she not only learned “this technical stuff,” she learned how to study.

Dianne Chong, director of Material & Process Technology for BCA, started out in pre-med but moved into bioengineering and then materials engineering. Her family was supportive of her career aspirations from childhood, and she mulled over the possibility that Asian families tend to have clearer expectations for daughters’ success in math and science. She had a passion and confidence that prevented her from becoming discouraged despite the hard work. However, in her role as executive focal for the University of Illinois, Chong observed a much higher attrition rate for women in engineering than for men.

Mary Jayne Adriaans, head of the test program and the chief flight-test engineer on the A160 Hummingbird, an autonomous helicopter being developed by Advanced Systems at Integrated Defense Systems, said that only 10 percent of her physics class in college was female, and in graduate school the percentage dropped even further.

She has a Ph.D. in physics but loves the engineering side of “building, testing, and getting something to work.” In her doctoral program, she was the only woman in a class of 15. It was a bit like having a class full of brothers, she says now.

## Current Boeing experience

All eight women – confident and successful – spoke about Boeing’s current commitment to a culture of inclusion. They feel the company values their perspectives and their contributions.

All of these women love the work they do at Boeing. Bouchard finds lots of opportunities to work with great people who share a common mission. “It’s an environment where you continue learning and help solve technical challenges on important programs,” she says. Limb travels all over the world and meets people from different cultures. She gets great satisfaction out of seeing a team complete a project successfully, “something far more than any individual could achieve.” Her 787 team designed a new way of making commercial jetliners for the future – one-piece composite fuselage barrels. They’ve overcome an old paradigm, and they used a global-partner model, involving men and women from all over the world. Adriaans loves the excitement of solving problems on things that fly. The excitement of flight-testing a new-configuration helicopter is “hard to beat,” she says. She has the freedom to do a job that she enjoys doing. “To me, that is a luxury. Not everyone gets that opportunity.” Drew says “Boeing is one of the most inspirational companies on the planet. One of the reasons I chose Boeing is that it is the intersection of three major transformational forces: transportation, communications and computing. We have done some

of the most advanced computing to create advanced products.” Lavender talked of “being able to do something that is really important.”

Why, then, aren’t more women clamoring to become engineers?



**Pam Drew: “Boeing is one of the most inspirational companies on the planet. One of the reasons I chose Boeing is that it is the intersection of three transformational forces – transportation, communications and computing.”**

## What can we do?

The problem, according to most of the women interviewed, has to do with perception. Bouchard suggests that many forms of engineering are seen as “uncool and unfriendly,” and many women who are good at math and science tend to gravitate to other fields such as medicine, finance or architecture. Bouchard supports efforts to reach out to students and teachers to “put math and science on their radar screen as a possibility for the future – that ‘engineering is something I can do, and make a good living doing it.’”

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## The one and only Helen Holcombe



**Above: Helen Holcombe, hard at work at the old Boeing headquarters now preserved as the Red Barn at the Seattle Museum of Flight.**

**Right: Helen Holcombe in later years.**

Helen Holcombe, born in Kalamazoo, Mich., Dec. 5, 1892, made Boeing history – she became the first woman member of the company's engineering division. She started as a draftsman in September, 1917, working on Model C trainers for the Navy.

She was the only woman working in the attic of a building at Boeing's Plant 1, later known as the Red Barn, now restored and on view at The Museum of Flight in Seattle. Her job was to copy blueprints and hand the drawings to a carpenter who built the specified parts. James C. Foley, Boeing directing engineer, hired her after asking her to duplicate a blueprint he sent her in response to her application for work.

"We will be in a position to have you come with us when our new office building is completed, which will be in three or four weeks," Foley wrote on Aug. 8, 1917.



Holcombe represented contradictions apparent in 1917. That year, Jeanette Pickering Rankin of Montana became the first woman elected to Congress, serving as women picketing the White House for the right to vote were being thrown in jail. Women would not get to vote until after Aug. 26, 1920, when the 19th amendment to the Constitution took effect.

Holcombe graduated from the University of Wisconsin, having studied mathematics and music, and later moved to Seattle. By the middle of 1918, she was among 335 people on the Boeing payroll building the trainers for service in World War I. When the war ended, most were laid off. By the end of 1919, payroll was down to 67.

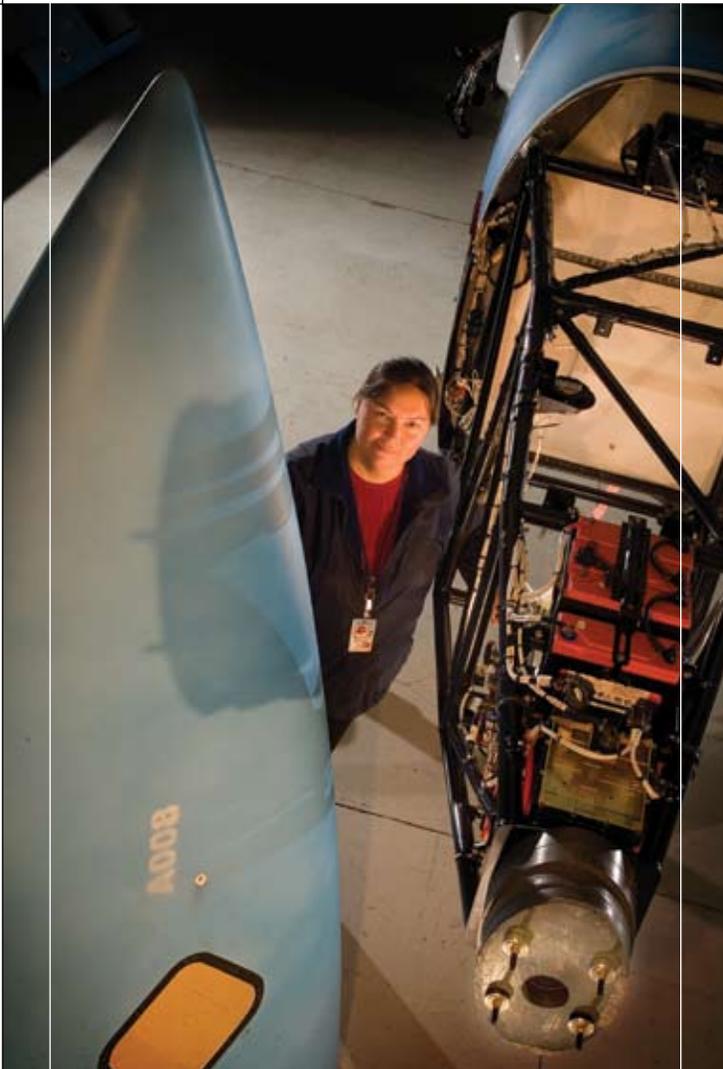
Holcombe escaped the layoff and by 1920 was still the only woman in a group of 20 in the engineering division, working on DH-4B observation planes and the BB-L6 passenger plane. There is a record of her riding as a passenger with pilot Claude Berlin for a 35-minute flight in an unspecified Boeing biplane on May 1, 1919.

She left Boeing for a couple of years to study architecture at the University of Washington, but was back at the drafting table by 1922, when she served as secretary of the Boeing Aircraft Club. The club sponsored soccer matches and social events and sent notes to families in times of crisis and triumph. In a way, it was a forerunner of today's Employee Services.

Holcombe left the company in 1925 to begin her career as an architect, returning to drafting only during World War II at a Seattle shipyard. According to her sister-in-law, Ellie Holcombe, Helen designed a dozen or more buildings in the Seattle area. One was her own home in West Seattle. In 1975, her health required that she move to her nephew's home in Oregon.

Holcombe died Sept. 21, 1984, at the age of 92.

*by Eve Dumovich*



**Mary Jayne Adriaans: During her doctoral program, she was the only woman in a class of 15. But it was worth it. “I have the freedom to do a job I enjoy doing,” she says. “To me, that is a luxury. Not everyone gets that opportunity.”**

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Lavender examined role models and how girls play as children. “How often as a child do you play engineering?” Lavender says girls need to relate engineering to their lives, and women engineers can be role models who can say, “Here’s what life could be like if you do this. I’ve done it, and it is fun and very rewarding.”

Limb agrees. “Young women need to see that engineering isn’t calculating equations all day. It is dynamic teamwork, bringing together people from different cultures and backgrounds and achieving something more than any of those individuals could do alone.”

Michael says some women have a very traditional view of what it is to be an engineer. “They don’t see the variety and breadth.” She suggests two-week shadowing internships when girls are 13 and 14, the age “when interest in math and science seems to diminish.”

Acosta suggests parents start early: “Get your children to play with toys that promote mechanical skills. Involve children at an early age in activities that help promote creativity, puzzle solving and learning. It doesn’t hurt to be passionate about engineering in front of your kids. Two of Acosta’s four children have graduated with Aeronautical Engineering degrees, and she speculates that the other two will end up going down the engineering path. She participated in career fairs in Wichita, Kan., where she once worked as an engineer, helping grade- and middle-school students build bridges and rockets to get them excited about engineering. “We have to see this as part of our community effort. We must be role models.”

Chong mentors and counsels young women. She suggests working with school counselors to make sure they have the information and materials to help girls make wise choices. Chong speaks at Historically Black Colleges and Universities, noting that her being a woman of color helps young African American, Hispanic and Asian women see themselves in engineering roles.

## **Attracting and retaining women engineers at Boeing**

All eight engineers agree that Boeing is going in the right direction. Limb says we should “keep progressing by doing what we are doing. As we grow the company, and new blood comes in, we are transforming.”

Lavender notes that “if you look at the Leadership Model and the Boeing values, it’s all about a culture of inclusion. Women want to be included, want their thoughts and ideas heard and valued – just like male engineers. So what we’re doing now – valuing diversity, engaging and valuing everyone – will retain everyone.”

Communication is the key for Michael. “If we want to retain these women engineers, we have to understand what makes them tick, what interests them. How do we best do that? Through mentoring.” Michael also notes that “providing better work-life balance would help. Young people today put a greater priority on their personal life, and what will this mean for us as a business as we move forward?”

Bouchard says there are perceptions about the nature of the aerospace industry that must be overcome: “People think defense companies have a command-and-control culture, and that they’re male-dominated. We need to overcome that perception.” Bouchard encourages “continuing conversation between managers and teams to make sure people are engaged, have an opportunity to grow, and change assignments when they need to.” She concludes: “The products we make are tremendous. They are a great entry card” that inspires people to work at Boeing. “Then we strive to give our employees opportunities to work on challenging programs and develop their careers.”

The face of engineering has changed dramatically at Boeing in the last 20 years. There are more women in prominent leadership positions. And they are helping to make the company more creative, more diverse, more inclusive of all perspectives and ideas, and more in tune with a healthy balance of work and family.



**Shelley Lavender: When she called her mom from college to complain about having to study so much, her mom said, “Think long-term. If you sacrifice now, you will be able to do what you love.”**

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Not only are women benefiting and enjoying their work as engineers more, but so, too, are men.

Mike Denton agrees with Bouchard that stereotypes about engineering being a job for men only should be dispelled. “In

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**– Shelley Lavender**

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the future, white males will be a minority in the work force. We have to attract and retain women and minority engineers to get the talent we need to succeed,” he says.

Bouchard and Denton say that Boeing is working hard to hire new engineers and retain those who are eligible for retirement. In order to retain potential retirees, Boeing is trying to do what it does with new hires – give them challenging, interesting work to keep them engaged and working for Boeing.

Dianne Easley, vice president of Human Resources for EO&T, says: “All of us here know that Boeing is a great place to work. We have to take that message to the universities, educational and cultural institutions across the globe. We have to convince students that this company offers them tremendous opportunity and that this is where they can build a strong future. And once we succeed in hiring the best engineers, we have to make sure that there is sufficient challenge and opportunity available to keep them at Boeing.”

Now the challenge is to spread the word that Boeing is a great place to work – for all employees. ■