

THE YEAR IN DEFENSE

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**AEROSPACE
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**UNMANNED AND INDISPENSABLE:
UAVS TODAY**

EXCLUSIVE INTERVIEW

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MILITARY SPACE

PRECISION GUIDED MUNITIONS

INTERVIEW

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“The worldwide competition of overall national strength is actually a competition for talents, especially for innovative talent.”

That statement by Chinese President Hu Jintao describes a 21st century in which the United States is fast losing its 20th century ranking as the world leader in science and technology. It is a loss spurred by the continuing decline of U.S. students working toward bachelor’s, master’s, and Ph.D. degrees in science, technology, engineering, and mathematics (STEM).

The United States has dropped from third to 13th in the world since 1975 in the proportion of 24-year-olds with engineering degrees. From 1991 to 2000 alone, the number of aerospace engineering degrees awarded by U.S. colleges and universities fell 47 percent. Even worse, more than one-third of the 122,450 U.S. engineering and science graduates in 2007 were not citizens and so ineligible for high-level security clearances. Of engineering Ph.D.s awarded in the United States that year, 60 percent went to foreign nationals.

That massive decline in American STEM degree-holders runs counter to a steadily increasing need for scientists and engineers, a need heightened as retirements outpace replacements; 26 percent of all STEM degree-holders in the United States are 50 or older – 40 percent of those with doctorates.

China and India are each said to have more students with genius IQs than America has students. And as the number and quality of foreign scientists and engineers grows against dwindling U.S. counterparts, the nation’s economic and national security are at increasing risk.

Delores Etter, Ph.D., a former Assistant Secretary of the Navy for Research, Development, and Acquisition and current director of the Caruth Institute at Southern Methodist University’s Lyle School of Engineering, is an outspoken advocate for greater emphasis on STEM education. She is using her new position at the Institute – as well as her appointment as the first holder of the Texas Instruments Distinguished Chair in Engineering Education – to push for a greater emphasis on STEM education in the United States, from kindergarten through graduate school.

The Year in Defense: What is the current problem with engineering and science education in the United States?

There are lots of challenges. Young people have so many options they tend to not think of engineering as one of those careers that will be as satisfying as others, which is where those of us in the profession of engineering education haven’t done a good enough job explaining what engineers do.

What about the cultural impressions and stereotypes, often negative, youngsters see on TV and in the movies?

One part of what I want to do is change those stereotypes, getting kids into things related to science or engineering, many of them team activities, where they can interact with engineers and scientists and see they are not the kind of people often portrayed. We have to find ways to help people understand what engineers and scientists really do.

At what age do you start?

You have to start very early. As director of the Caruth Institute, my role is to develop programs to really help encourage students to stay in engineering, but also to help encourage younger people to think

about engineering. There are four key programs I’m working on, the first of which is K-5, so I think you have to start very early to get kids interested in science and activities that relate to engineering.

How do you do that?

One way is through local activities. There are lots of things going on wherever we live that can get kids involved, from going to the zoo to soapbox derbies to scouting, which has badges that relate to engineering-type problems. But you also want to introduce them to things going on at a national level, which typically means getting them involved in activities on the Internet.

The 1960s and ’70s produced a record number of U.S. scientists and engineers, all influenced by the culture of their youth – the race to the moon, computerization, medical advances, consumer electronics, and, most commonly cited, *Star Trek*. But that era is dwarfed by the speed and quantity of developments in science and technology today, so why this generation’s apparent indifference?

Ironically, the new *Star Trek* is just coming out and maybe that will help get a new generation interested in that area again. And I think there is more going on than we may recognize. Today’s kids



How well is that effort doing?

I'm afraid it's treading water, at best. The statistics are frightening if you predict where we are going to be. You look at the economic health and defense of our country and I'm convinced they depend on the innovation and creativity of our engineering and science workforce, yet fewer and fewer young people are choosing those. I think that very directly says we are in a crisis situation. Unless we can get more young people interested in engineering and science, it will have a direct impact not only on our economic health but also on our national security.

Is it too late?

You have to be doing things simultaneously in kindergarten as well as middle and high school. The biggest program I have right now is focused on undergraduate students and trying to help them be more innovative, more creative, which I believe is putting the fun back into some of the things we're doing. But this is not a problem we have decades to solve. We have to come up with solutions that will make a difference, starting now, even while we work on the youngest.

It is a very serious position we're in and if we're not careful we will lose our edge on innovation – and once we lose it, I don't know that we will ever get it back.

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are heavily involved in games and I think that is one area where we can work to get them more interested in technology. For middle and high school kids, the program I'm involved with is looking at how to develop more games and regional competitions to get their computer interests channeled into areas that will build skills related to engineering and computers. If you play games centered on robotics, they will help you to start thinking about those things.

When you think back to the engineers at NASA who developed the moon landing, most were in their 20s. It's hard for kids today to see a similar kind of excitement, but there are things out there today that are a challenge. And kids want to do things that make a difference, so we need to help them see how engineers and scientists really make a difference in the world.

What about the attitudes of parents and teachers?

That is extremely important and there are a lot of things we can do there. One thing I feel very positive about is the strong interest in people who are retiring from the military and industry to give back. A lot of those people are interested in teaching and mentoring and being role models and that is a real opportunity for us.

But if we are going to turn around this decline we're in, it will take everyone working together. While on one hand I'm very frustrated with the trends I see, there are lots of opportunities for all of us.

One of the things I wanted to do early on when I came to SMU about a year ago was to figure out how to get more innovation into our undergraduate curriculum. As I thought about what was the most innovative program in the country today, I came to the conclusion it

was the Lockheed Martin Skunk Works, which has been around for decades but continues to be among the most innovative people in the country. So SMU and the Skunk Works have formed a partnership to bring a lot of their philosophy on innovation into our undergraduate community at SMU. I'm also trying to figure out how to expand and share this with other universities.

One of the things I've incorporated with our Skunk Works program is a lecture series, where every semester we bring in people from Skunk Works, [Boeing] Phantom Works, DARPA [Defense Advanced Research Projects Agency], and extremely creative industry organizations – Google™, Facebook, etc. The head of the current Skunk Works program came here in March and talked about what makes that program so innovative, how leadership and innovation go hand-in-hand. When students start to hear firsthand from people who have been involved in these things, they can't help but get excited and motivated about what's going on in engineering and science. So we just have to figure out how to provide more opportunities for them to hear these things and get involved.

Are there adequate loans, grants, and scholarships available for STEM degree programs?

Today if a kid is accepted into college, there are lots of opportunities to help them get through, so I don't think funding is the challenge. The challenge is getting them to the point where they have the right skills to get into engineering. So many in high school quit taking math and science courses and so have shut out a lot of options, because it is a lot harder to get into engineering if you don't take those courses in high school and then decide that is what you want to do after you get into college.

We have to keep middle and high school students involved in and taking those courses and developing the background and confidence that they can do this. If an eighth-grader takes algebra, it changes his or her life because, if they take it at that level, it gives them time to take other courses later and opens up other opportunities. If they don't take that algebra class until the ninth or 10th grade, the opportunities they have for engineering careers get smaller and smaller.

Most practicing engineers only have a BS degree; it's another stereotype that you have to have a master's or doctorate. If you want to get into more research areas or a narrow focus, you may need a master's or Ph.D., but most industry engineering jobs don't require graduate-level degrees. They do require that you stay current, but that is true in all professions.

Are federal, state, and local budget cuts going to make this worse?

Algebra is not going to be removed from the high school programs, but there may be fewer math teachers, and those teachers may not be as prepared as we would like them to be. But the key question is when will students take algebra? We need teachers, counselors, and parents encouraging kids to take algebra earlier rather than later. That's the big issue.

It takes a lot for a successful education program – teachers, parents, and community support. There is a role for every one of us in helping improve education in our communities and it is very important that all of us become active in that, whether we have children or grandchildren in school or not.

One of the best ways to help get young people interested in engineering and science careers is to get those in middle and high school opportunities to work part time or as interns in industry and research labs.

When I was Assistant Secretary of the Navy and visiting Navy and Marine Corps labs, I always encouraged our researchers and scientists to bring young people into their labs. Just giving young people a chance to shadow engineers and scientists on summer programs makes a lasting impact in helping them begin to think about becoming engineers and scientists. That also helps break

down stereotypes and gets kids thinking about opportunities they can see for themselves.

If you are working in a research lab, you may not have funding but you would be surprised how many young people would volunteer to do this sort of activity. So funding isn't always necessary. If a scientist or engineer is willing to volunteer their time and the organization supports them, it can work.

But it is important to do this at the middle school level or even earlier. Middle school probably is the best candidate, because those seventh- through ninth-grade students haven't yet made a decision to stop taking math or science classes. By the time they get to high school, it may be too late to make a difference. You may not have enough time.

When I visited military labs, I always asked to speak to the last 20 people hired – not the 20 youngest, but the last 20 – so I could get a feel for the whole range of new hires. And while there is a lot in the statistics that is depressing, I was always encouraged when I spoke to those people, some right out of college, some coming out of the military and perhaps returning to school.

I would ask why they were at a Navy research facility, what brought them there. I knew it wasn't money, because government doesn't pay the highest salaries. They told me it was because of the opportunities they would have. One young man, an aerospace engineer at Pax River [Patuxent River Naval Air Station] in Maryland, said he had been there less than a year, with only a bachelor's degree, but after six months, he was developing test programs for the Super Hornet. He said there was no place else in the world where he could do something like that.

If we can help young people understand those are the things they can do as engineers, that is how we will attract them, showing these jobs are interesting and there is a lot of career potential for their lifetimes. But we have to get them involved early so they can build the self-confidence that they can do the work. Then when they see they can make a difference in society, that is when we will start to turn these statistics around.

Do you think some of the new military recruiting ads are helping in that respect?

I do think that works. What you have to do with young people is not only show them things that look interesting, challenging, and fun, but they have to be able to see themselves in those positions. If these ads show young kids sitting in a classroom, then transitioning to involvement in missions where they are flying UAVs [Unmanned Aerial Vehicles], that has to be a great recruiting method for getting them interested. I would like to see that go a step further, where you not only encourage them to be involved with operations but with designing the next level of UAVs, the next functionality; that's where the engineers come in. I think that could be a very successful technique and one we have to work on.

That also gets back to stereotypes, which typically don't include women or ethnic minorities. We have to work hard to make sure young people from those groups also see themselves as engineers. That's an important part of the programs we are developing at the Caruth Institute. It is so important for a young person to go through this transition, getting involved in activities where they see the fun in science and engineering and take some of these rigorous math and science classes. The next step, in their minds, is to see themselves as the engineer, which means they also need to have had some reinforcement through interactions with engineers who are like them. Some won't go into engineering, but you still have had some success by having a more technically literate population out there.

Is the high percentage of foreign students in U.S. STEM degree programs a problem?

There are a lot of advantages to having the very brightest people

you can get in graduate school. So while it is important to increase the number of U.S. students, I don't think we should change our rules on having international students. A lot of those stay in the U.S. and those who do go home build relationships with U.S. companies and agencies. I see a lot positive in that, but I also think it is extremely important to get more U.S. citizens into graduate programs.

There is a lot of science and engineering that has to be done at a classified level, especially in cyber programs. One thing industry does that has been successful is hire students with a bachelor's degree in areas they need, then support their further education toward a graduate degree. But those opportunities only work if you get the kids into and through college, so we're back to my mission of starting back in kindergarten, building the pipeline to give us that opportunity.

How do you deal with youngsters avoiding math and science classes because they are hard?

That is a challenge. You have to provide motivation, because these courses are not easy and the solution is not to make them easy; they must be serious and rigorous. So you have to show them the things they have to do for the kind of careers they want. Which means a 14-year-old already has to have been exposed to possible careers and have some things they really want to do. Then if they understand a course in trigonometry is required in order to have that career later on, that can be motivating.

But we also have to revamp our curriculum. Just because you are doing a math or physics or chemistry course, it doesn't have to be dry. It has to be serious and rigorous hard work, but there are a lot of opportunities to bring in hands-on activities and examples. If you make something interesting and challenging and at the end of the course the students recognize they have acquired some skills and capabilities, those will help motivate them to keep going.

They have a lot of choices, so we have to make them aware of the reasons why they should do well in school. And that requires a whole community of people helping – parents, students, the community at large. In addition, kids always relate more to someone closer to their own age.

In the Skunk Works partnership we've built, the students will be working in small teams to solve real projects and develop prototype solutions. One of the things we're planning is the students then will go back to middle and high schools with their working prototype and explain the problem and the solution they developed. I think those kinds of activities will be helpful in getting younger kids to understand what engineering and science are all about – and see some great role models.

Can we compete against India and China?

Yes, but we have to have enough people going into technical areas. We've been competing very successfully for decades and I don't think today's young Americans are any different than those before them. But there are different activities available today, so we have to do some things differently, not only to compete but to keep the technological edge necessary for our economic as well as our national security.

While the raw numbers are concerning, I don't feel it is overwhelming. What we have to turn around is the decreasing number of young people going into engineering and science. If we can't do that, then it is a very worrisome picture as you look to the future.

Is the SMU program unique?

Yes. That's one of the reasons I came here. When I began looking for places where I could work on this problem, the opportunities at SMU were outstanding. They really understand how important this problem is and are providing lots of assistance with the new Institute and facilities and community support. But they also understand it is not just a local problem; we need to be working on this at a national level.

The Caruth Institute is new, growing out of an existing effort to work with kids on science and engineering, but I'm the first director. In addition to the Caruth family, from Dallas, some funding for the Institute, such as my salary, comes from Texas Instruments, which, along with Lockheed Martin, are our main industry partners. And as I am developing programs, I look to the National Science Foundation, DoD, and the Department of Education for help.

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What?

The first partnership between Lockheed Martin's Skunk Works® and a university engineering program has just been established at SMU in Dallas.

Who?

The SMU/Lockheed Martin Skunk Works® collaboration is led by Dr. Delores M. Etter, former Assistant Secretary of the U.S. Navy, who holds the Texas Instruments Distinguished Chair in Engineering Education.

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Learn more about the program at smu.edu/caruth/skunkworks

At the Lyle School of Engineering, no problem is too big.