Edward Swallow of the National Defense Industrial Association and Susan Lavrakas of the Aerospace Industries Association

State's production of science, technology, engineering and math grads lagging demand

A Civic Caucus Focus on Competitiveness Interview

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Present

Dave Broden, Amir Gharbi, Paul Gilje (coordinator), Sallie Kemper, Paul Ostrow, Dana Schroeder, Clarence Shallbetter. By phone: Audrey Clay, Janis Clay, Rebecca Danahy, Susan Lavrakas, Dan Loritz (chair), Edward Swallow.

Summary of Discussion

Edward Swallow, chair of the board of the National Defense Industrial Association's (NDIA's) Science, Technology Engineering and Mathematics (STEM) Workforce Division, says there is a supply-chain problem in the United States for producing college graduates with STEM degrees. He and Susan Lavrakas, director of workforce at the Aerospace Industries Association (AIA), say the problem starts in elementary school, continues through middle school and high school and on into college. Decisions made by students, parents, teachers and guidance counselors as early as fifth grade can affect students' opportunities to pursue STEM studies and careers. Lavrakas and Swallow

say that a national policy on STEM workforce issues would be helpful, but that the real progress will take place at the local and state levels. Swallow offers examples of successful local models of approaching STEM training issues, including a low-performing high school in the Chicago area that was turned around after conversion to a STEM school.

Swallow says that attracting and retaining high-quality K-12 STEM teachers requires professional development and differential pay for STEM teachers, a concept opposed by teachers unions. He believes charter schools have a STEM advantage over traditional schools because they can use the more effective project-based learning and integrative learning styles.

Swallow notes that the University of Minnesota must better partner its research with business to help create jobs and must focus on attracting STEM students from outside the state who will stay in Minnesota after graduating.

Background

Edward Swallow is vice president, business development, for the federal and defense technologies division of Northrop Grumman's Information Systems sector. Swallow previously worked for SM&A, Space Applications Corporation and Logicon Corporation. He is a retired Air Force Reserve officer and was the Air Force Academy admissions liaison officer director for the Washington, D.C., area. He is chair of the board of the National Defense Industrial Association's (NDIA's) Science, Technology Engineering and Mathematics Workforce Division.

Swallow has a bachelor's degree in physics and astronomy from State University of New York, College-Oneonta, and received a bachelor's degree in electrical engineering from Air Force ROTC at Syracuse University. He has a master's degree in systems management from the University of Southern California.

Susan Lavrakas is director of workforce at the Aerospace Industries Association (AIA). She joined AIA in 2011 to focus her efforts on STEM education and workforce development issues. She has enjoyed a 40-year professional career in national security affairs. Having studied political science and international affairs, she started her career at the Central Intelligence Agency. She conducted research at the RAND Corporation and then joined the defense industry at Northrop Grumman Corporation, where she worked for nearly two decades. From 2003 to 2011, she worked in government relations at BAE Systems. She served as vice president for legislative liaison of the STEM Workforce Division of the National Defense Industrial Association.

Lavrakas was born in Minneapolis and is a White Bear Lake High School graduate. She received her bachelor's degree from Hamline University in St. Paul and did graduate studies at the University of Southern California.

Discussion

There is a mismatch between the competencies of high school graduates and the needs both of colleges for students to be college-ready and of employers for them to be work-ready. Edward Swallow, chair of the board of the National Defense Industrial Association's (NDIA's) Science, Technology Engineering and Mathematics (STEM) Workforce Division, said that over the past 20 to 25 years, there has been a supply-chain problem in the United States for producing college graduates with STEM degrees.

He described several problems in the supply chain of STEM graduates:

In 2001, there were four million students in ninth grade. Only 2.8 million students graduated from high school in 2005.

Only 32 percent of those 2001 ninth graders were proficient in science and/or math.

Among the 2005 high school graduates, 42 percent were proficient in science and math, but only 17 percent of the graduates were proficient and interested in STEM studies beyond high school. Fifteen percent were interested, but not proficient, and 42 percent were neither proficient nor interested.

In 2005, 1.2 million students enrolled in four-year colleges. Of those, 278,000 chose a STEM major. In 2011, only 167,000 graduated with a STEM degree.

Fewer than 80,000 of the STEM graduates were able to get a security clearance. The biggest reason is that many of the graduates are not U.S. citizens.

The "old school" solution, when you have a problem with a supply chain, is to find a different supplier. Swallow said manufacturing jobs went overseas, engineering centers went overseas and, more recently, companies sent their R&D centers overseas, because companies were in search of a different supply chain for their STEM talent.

Alternatively, the "new school" solution is to find the faults in the supply chain and fix them. According to Swallow, when looking at how to fix the U.S. STEM supply chain, NDIA discovered several things:

Eighth-grade algebra is critical in order to graduate with a STEM degree in four years. If students do not have eighth-grade algebra, there is a natural tendency for them to get off the STEM track.

Decisions are made in fifth grade by students stating their preferences and by teachers, guidance counselors and parents determining how proficient and interested a student is in math. That will determine whether to put a student into the college track, the Advanced Placement track, the "let's just get them graduated" track or into a remedial track. So, fifth grade becomes key, which is why the NDIA has focused a lot of effort on K-12 education.

Minnesota hires a lot of high-tech employees, but does not produce them. Minnesota is in the in the first quartile of states in high-tech jobs, but in the third quartile of STEM degrees conferred by states. "That makes Minnesota a ripe state for a dialogue about how to increase STEM education and STEM graduation," Swallow said.

He mentioned several important factors:

Professional development of teachers;

Getting kids excited about science and math early on;

Having meaningful STEM experiences throughout students' K-12 careers;

Advertising and helping kids understand the jobs available in STEM and what a STEM degree means in terms of salaries.

The supply-chain model highlights the fact that this is a systemic problem that takes an all-hands-on-deck approach. Susan Lavrakas, director of workforce at the Aerospace Industries Association (AIA), said all the various stakeholders must be engaged. She said AIA and NDIA have been partners for more than six years to see if they can have an impact, not only at the national level, but also at the state and local levels. They work with local NDIA chapters to convene meetings around the country to advance STEM education and workforce development.

"We estimate that AIA member companies are spending $150 million a year on STEM education and they have been doing so for decades," Lavrakas said. "If we've been investing all that money, why do we still have a problem?"
"It hasn't been systemic," she continued."It hasn't been collaborative. In many cases the money was given to make companies look good or to make people feel good, but it wasn't intentionally geared toward workforce development."

The aerospace industry is trying to address the STEM workforce issue:

AIA member companies are working together, in partnership with NDIA and others, to scope the magnitude and nature of the workforce challenge in the aerospace and defense industry. They are partnered with Aviation Week to conduct an annual study of the aerospace and defense workforce.

In past years, AIA established a Workforce Committee and a more senior Workforce Steering Committee, and is about to elevate the latter to a Workforce Council.

"We can't wait for the federal government to solve this problem," Lavrakas said. "The most positive work is taking place between businesses and educators at the state and local levels. Until recently, most educators didn't know what the business community needed their students to be prepared to do in the workforce."

Lavrakas said some of AIA's member companies have partnered with community colleges in their areas to develop specific training programs tailored to their own immediate workforce needs. She offered the example of the Boeing Company working with 180 Skills in Indiana to develop a specific curriculum for assembly workers they needed and couldn't find. They planted that curriculum in Edmonds Community College in Washington State and guaranteed any graduates an interview at Boeing. Ninety percent of the people who go through the program graduate and get the credentials; 90 percent of those proceeded to an interview with Boeing; and 88 percent of those have been hired. "That's an example of a company taking matters into their own hands, because the system is just not providing what they need," she said.

Through the Business-Higher Education Forum, Lavrakas noted, some of AIA's biggest member companies have developed partnerships between institutions of higher education and specific corporations to grow a workforce in a particular region in the country. For example, Northrop Grumman is partnered with the University of Maryland system to develop cyber security experts.

She explained that AIA runs its own STEM program, the Team America Rocketry Challenge. The largest student rocket competition in the world, the program has involved 60,000 students since its inception 11 years ago. It helps excite kids about STEM studies and careers and gets them involved

with mentors very early on, in middle school and high school. "They get exposed to what people in these fields do and what kind of education and skills they need to have," Lavrakas said.

A national STEM strategy is helpful, but it takes local action to address specific workforce mismatches. In response to a question, Swallow said AIA and NDIA have determined that "a national STEM strategy is a good thing, a national policy is a good thing, but it takes local action to determine what the challenge is in a particular location."

"The policy has to emanate and engage from a dialogue between the employers in the area, the school district in the area, higher education institutions in that area and parents," he said. "They must all be engaged in the dialogue to determine where the specific mismatches are that need to be addressed."

Ten years ago, Northrop Grumman decided to do something about the lack of diversity in its technology workforce. "We put computer labs in some elementary schools and reached out to high schools and community colleges," Swallow noted. The company helped expand Project Lead the Way (which provides engaging, hands-on STEM curriculum) in high schools, so kids could graduate with manufacturing skills.

"We have almost tripled our Hispanic workforce and quadrupled our African American workforce hired directly at one location in just four years," he noted. "We can fill all our entry level positions straight out of high school or community college. That's for very sophisticated manufacturing, very high tech jobs. Our hiring costs have gone down and we're seeing a return on our investment."

Wheeling High School near Chicago is another example of an effective local model, where the principal took the initiative to turn the school into a STEM school. Wheeling High School is a Title I school, with 65 percent of the students eligible for free or reduced lunch. It's an 80 percent minority school. According to Swallow, the principal of the school decided that his graduation rate of 45 percent and his post-employment rate of less than 30 percent were not acceptable. He talked to employers in the area, who said they weren't hiring his graduates because they couldn't read or write and they didn't have enough math skills to perform at the basic performance level.

He turned the school into a STEM school. He brought in Project Lead the Way, put in computer-integrated manufacturing and brought in accelerated manufacturing skills certification. The graduation rate has gone from 45 percent to 85 percent in five years. The post-high school employment rate has moved from 30 percent to 75 percent. Those higher rates have held over the last three years.

In 2011, 100 percent of Wheeling graduates who had two or more manufacturing skill certifications were employed within two weeks of graduation, at an average salary of $32,000. In 2012, all kids with two or more certifications had jobs to go to the day after graduation.

Aptitude and attitude are the two deciding factors in going to college. An interviewer said that

many programs and schools emphasize that every kid should go to college. "There are some politics involved in encouraging folks to go right from high school into the jobs you're talking about," he said. "How do you overcome the old-school bias about going to college?"

Swallow said there are two deciding factors about going to college: aptitude and attitude. Society and culture play a great role on the attitude side. "We need better career counselors starting in middle school to identify kids who have the aptitude and attitude to go to college," he said."Then find the kids who have the aptitude and attitude for a two-year degree and for going into a profession where an associate degree is appropriate. Then find the people with the aptitude and attitude to go into the manufacturing workforce."

"The critical part of it is to start engaging at the middle school level and start opening the students' eyes to the full range of possibilities," he said. "Forcing everybody to go to college is the number one reason for dropouts. Students think that's never going to happen to them, so why bother?"

Attracting and keeping qualified, talented STEM teachers in schools requires professional development and differential pay. Teacher professional development is a critical conversation at the state and national level, Swallow said, in response to a question. A very successful strategy at the state level, he said, is using master teachers, people who have degrees in chemistry, physics, mathematics, to act as resources to the mainline teachers at all levels of schools. Bringing practicing STEM people into the classrooms can be effective, but it doesn't necessarily raise the skills of teachers.

Good math teachers who are also good mathematicians have lots of options, so they should get differential pay, Swallow argued. People who have a degree in math and are in the top 10 percent of their class are almost guaranteed to get a job in financial services, starting at $65,000. A math teacher is lucky to get $40,000. "That raises the subject of differential pay, the concept of a market-based pay system," Swallow said. "But teachers unions are the biggest challenge on differential pay. They want teachers to all get paid the same amount, based on seniority."

The University of Minnesota could learn from the examples of universities in Maryland, the District of Columbia and Virginia. In response to a question about how Minnesota can develop more STEM-trained people, Swallow said Maryland, the District of Columbia and Virginia all have very high STEM employment and high STEM graduation rates.

The District of Columbia has three major universities, all of which have engineering schools. Maryland has six major public universities with engineering schools. Two of the premier research universities are in Maryland. The Virginia state university system has 14 engineering colleges or universities. Three of the largest ones, George Mason, James Madison and Virginia Tech, have applied research institutes that partner on research with industry to create jobs.

"You have to look to the University of Minnesota system and determine how to make a stronger university focus on building business and also on attracting STEM students from outside the state at the undergraduate and graduate levels to come to Minnesota and stay there,"he said.

He cited the example of Virginia Tech University, which has its own industry advisory board. The board helps plan out the curriculum and helps shape it to meet the needs of industry.

Charter schools using project-based learning and integrative learning have a STEM advantage over traditional schools. An interviewer asked if charter schools have any advantage with STEM

compared to traditional schools. Swallow responded that charter schools have more flexibility, because they don't have to teach along strict subject lines. Many charter schools have gone to project-based learning and integrative learning.

He said studies have shown that integrative learning and project-based learning are significantly more effective than traditional classroom learning. He gave the following statistics: If you read something, you retain about 10 percent of it. If you hear something, you retain about 20 percent. If you read and hear something, you retain about 40 percent. If you read, hear and do something with it or about it, you retain about 85 percent. "That's why project-based learning is so powerful, because you get the long-term retention," he said. "Kids remember what they did, not what they heard. Until we can break the stranglehold in curriculum on subject-based learning, charter schools will have an advantage," he said.

The long-term health of the U.S. economy is built on our ability to manufacture. Swallow is concerned that our economy is becoming more and more focused on STEM guest workers. "We need to get more manufacturing back on shore and we need to get more of our kids involved in science and engineering," he said. We have graduated all the lawyers we'll need for the next 150 years. Lots of research at law firms is now automated. We don't need lawyers and accountants now. We need more scientists and engineers to create more products that we can sell to other people."