SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH

Reaching Target Audiences in Middle School

Susan H. Palisano
CONNECTICUT CENTER FOR ADVANCED TECHNOLOGY INC.

With an eye to maintaining its competitive edge in the global economy, Connecticut is working to increase the pipeline of interested and competent science, technology, engineering, and mathematics students.

A rich tradition of invention and entrepreneurship has been critical to Connecticut's economic success since Colonial times. Today, the state is a leader in industries such as aerospace, hydrogen fuel cells, signal processing, advanced propulsion, medical devices, and biotechnology. Manufacturing accounts for over $24 billion of the state's gross product.[1] With almost 4,400 manufacturers employing over 150,000 workers, manufacturing companies pay nearly $10 billion in wages per year. Workers in the state's manufacturing sector receive an average of almost $64,000 in annual total compensation.[2]

Given the importance of manufacturing to the state, many observers have expressed concern about the persistent achievement gaps in math and science in Connecticut public schools—including marked achievement differences between whites and minorities, and between boys and girls. Although Connecticut's colleges and universities are recognized for their contributions to applied research, undergraduate enrollment in STEM (science, technology, engineering, and mathematics) is modest at best. And it is worth noting that nationwide, women account for only 24 percent of STEM jobs.[3]

Advanced Skills Needed

With nearly half of the 60 fastest-growing occupations identified by the Connecticut Department of Labor classified as having a reliance on solid math and science—and with the proportion of Connecticut workers over the age of 55 seventh-highest in the nation—we need to engage more students in STEM learning early. Of particular concern is the fact that compared with their male counterparts, fewer young women are choosing to pursue higher-level studies in STEM areas. Like the rest of the country, the state is not succeeding in attracting and preparing students—particularly girls and urban youth—to enter the skilled workforce. And since manufacturing and many other sectors today require technology literacy, reasoning, and problem-solving proficiency, we need to convey to students that academic achievement in STEM is important. In Connecticut, the focus is on being able to sustain advanced manufacturing.[4]

Despite the clear imperative to inspire more young people to pursue STEM-related educational and career pathways, a recent survey by the American Society for Quality revealed that more than 85 percent of students today are not considering STEM-related careers—and that parents are more likely to encourage their daughters to become actresses than engineers. In the same survey, 44 percent of respondents cited a lack of knowledge about STEM careers as the top reason they would not pursue such jobs.[5]

Adding to the problem, society as a whole has negative attitudes about manufacturing jobs. Although advanced manufacturing is creating opportunities for a well-educated workforce, one of the main reasons companies struggle to find employees is that public perception has not evolved at the same rate that the field has. A common but outdated perception is that manufacturing entails dirty and dangerous assembly lines and that such jobs are male dominated, low skilled, and poorly paid. In reality, U.S. manufacturing now takes place in high-tech facilities, offering opportunities for young men and women with the right skills to earn top wages in careers that stress innovation, creativity, and entrepreneurship.

The Connecticut Center for Advanced Technology Inc. (CCAT) in East Hartford is finding ways to reach students—especially girls and students from underserved communities—to get them excited about STEM early. The Center has developed an educational program that emphasizes hands-on learning of contemporary manufacturing skills, informed by authentic industry experiences, so that students can make real-world connections and see concrete examples of rewarding careers.

Starting Young

CCAT's education programs provide middle school students with both formal and informal learning opportunities designed to retain their interest in STEM as they move through secondary education into a career pipeline. The programs use advanced manufacturing as context and provide opportunities for students to experience firsthand a range of high-wage, interesting jobs.

One such program is CCAT's "Young Manufacturers Summer Academy" (YMSA), a two-week experiential-learning opportunity for boys and girls entering grades 7 to 9. The primary goal is to build the manufacturing workforce pipeline in the middle grades, a critical juncture in need of attention. At the core of the program is a gender-neutral focus on those 21st century skills that support innovation and entrepreneurship. From the first day, students engage in realistic manufacturing scenarios that highlight the importance of leadership, problem solving, critical thinking, creativity, efficiency, competition, collaboration, customer service, and the like.

The students are asked, for example, not only to create product designs that meet stringent criteria, but also to pay for equipment, supplies, and labor out of provided budgets. They manufacture products by hand, virtually, or with 3-D printers. They must compete for customers and find ways to maximize productivity and quality. Manufacturers and engineers of diverse backgrounds and working in a variety of positions and companies speak to about their own on-the-job struggles and triumphs—and about how an entrepreneurial mind-set contributes to their success. Students engage in mock interviews for jobs with real manufacturers. Along the way, they compile a portfolio of completed engineering and manufacturing projects. Throughout, students discover their strengths and interests and develop a personalized education and career plan.

The Academy begins with a series of STEM team-building activities to establish a collaborative environment. As the program

progresses, students learn how manufacturing has changed over the years into a high-skill, high-tech industry. In addition to gaining machine-shop floor experience, students participate in workshops that demonstrate the real-world application of math concepts such as the Cartesian coordinate system and virtual machining environments. They use industry tools and computer-aided-design software to build their own virtual race cars. They apply scientific concepts such as the laws of gravity and friction within an engineering framework. And they design products from digital models and produce them using 3-D printers.

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Throughout the program, Lunch and Learn events allow students to further explore educational and career pathways by interacting with manufacturing employees in a round-table environment. Visits to local companies provide firsthand exposure to manufacturing facilities and allow students to speak with engineers and other professionals who help to dispel negative stereotypes about the manufacturing workplace. The program's culminating event is a mock career fair, where students present their résumés and portfolios during conversations with real manufacturers, and parents and families have an opportunity to see program outcomes.

A Sector's Image

YMSA has been highly successful at raising student and family awareness of manufacturing-related careers and of the educational pathways leading to such careers. The Academy has resulted in improved student confidence—especially among girls and minorities—in their ability to succeed in STEM courses and manufacturing careers. It also has developed students' 21st century job-acquisition skills and has improved manufacturing-related STEM content knowledge.

The program model is based on research and on evidence from four years of successful implementation. According to evaluation data, 86 percent of all students who completed the YMSA program acknowledged the importance of doing well in both math and science. An amazing 91 percent admitted the program made them think about a career in manufacturing. In addition to increasing students' awareness about manufacturing, the program improved career awareness, skills, and interest in STEM. YMSA has been a primary contributor to increased enrollment in manufacturing technology programs at Connecticut technical high schools. In fact, since YMSA was launched, some schools have shown more than 50 percent growth in enrollment in manufacturing programs. The number of females enrolled increased by 45 percent, reinforcing the success of the program in attracting interest in manufacturing among young women.

The Academy is part of "Connecticut. Dream It. Do It."—a statewide initiative operated and administered by CCAT to promote a positive image of manufacturing, to educate Connecticut residents about rewarding career pathways in manufacturing, and to align educational systems with industry needs.

The national "Dream It. Do It."—sponsored by the Manufacturing Institute, the nonprofit subsidiary of the National Association of Manufacturers—supports national and local activities to engage, educate, and employ the next generation of skilled manufacturing talent. The initiative, in combination with YMSA and CCAT, also engages regularly with the Connecticut Women's Education and Legal Fund's "Girls and STEM Expos," delivering to middle school girls across the state a hands-on workshop that is based on a factory-floor simulation model.

Susan H. Palisano *is the director of education and workforce development at the Connecticut Center for Advanced Technology Inc. She is based in East Hartford. Contact her at spalisano@ccat.us.*

Acknowledgments

The Connecticut Center for Advanced Technology, Inc. (CCAT), an economic development organization headquartered in East Hartford, Conn., leads partnerships between industry, academia, and government, creating a collaborative framework for tackling today's economic challenges. CCAT combines expertise in cutting-edge manufacturing and information technology with specialized centers of excellence in education and workforce development and alternative energy solutions to help organizations increase efficiencies, compete, and succeed.

Endnotes

1 U.S. Bureau of Economic Analysis, GDP & Personal Income Data Tool, 2012, http://www.bea.gov/iTable/index_regional.cfm.

2 U.S. Bureau of the Census, *County Business Patterns (NAICS)*, 2011, http://censtats.census.gov/cgi-bin/cbpnaic/cbpdetl.pl.

3 David Beede et al., "Women in STEM: A Gender Gap to Innovation" (ESA Issue Brief no. 04-11, U.S. Department of Commerce, Economics, and Statistics Administration, Washington, August 2011), http://www.esa.doc.gov/Blog/2011/08/03/stem-where-are-women.

4 *A Talent-Based Strategy to Keep Connecticut Competitive in the 21st Century* (Hartford: Connecticut Office for Workforce Competitiveness, 2007), http://www.hartfordinfo.org/issues/wsd/EconomicDevelopment/2007KeepingCTCompetitive.pdf.

5 Nicole Adrian, *Engaging More Young Students in Engineering*, http://www.asq.org/edu/2009/02/engaging-more-young-students-in-engineering.final1.html?shl=091782. (ASQ membership required for access.)