TECH TOOLS

Fuel Today's CTE & Inspire Tomorrow's World Leaders

By Ginny Mumm

Career and technical education (CTE) has always been forward-looking, aiming to prepare students with the skills, knowledge and training necessary to succeed in their future careers. Technology can be a strong ally in this mission. Technical tools that empower students to design and produce 3D prototypes, signs, packaging, apparel and more, and that can be used right out of the box in classroom environments, are providing educators with new opportunities to engage learners.

As these tools become more common in the workplace, many CTE institutions are incorporating on-site maker spaces or fabrication labs that allow students to design, engineer and output their projects. Hands-on innovation and learning engages students from across the campus in projects related to science, technology, engineering and mathematics (STEM) and beyond, preparing them for life after school with real-world experience.

In fact, New Media Consortium research lists "fostering authentic learning," including project-based learning (PBL), among its six meta categories of future trends in the NMC Horizon Report: 2017 Higher Education Edition. The report states that, "Rather than being regarded as mere participants and consumers of knowledge, the embedding of maker culture in higher education has made [students] active contributors to the knowledge ecosystem."

CTE Tech Tools Offer Learning + "Real Life" Experiences

"It's hard to even get numbers for [the growth of] this field because it's growing so fast," said Matt Anderson, product manager Roland DGA, a manufacturer of digital devices. "Educators are eager for versatile high-tech equipment that helps students engage, while preparing them for their future."

Sherry Lassiter, MIT's Fab Lab Program director and president of the Fab Foundation, confirmed this view, noting that they've seen a "huge push" in the K–12 Fab Labs as a platform for STEM education. In addition to managing a network of more than 1,000 Fab Labs in 78 countries, the Fab Foundation works with the Teaching Institute for Excellence in STEM (TIES),

and other organizations, to develop on-site Fab Labs. In rural areas, the Fab Foundation and its partner organizations have even helped to develop mobile Fab Labs that can travel from one educational setting to another.

Alan Rydlund, an engineering technologies instructor at Grandview High School in Denver, Colorado, added that today's high school students can take a variety of classes that expose them to many different tech-intensive careers, and show them exactly what employers are looking for. Rydlund noted that, at his school, engineering classes are increasingly popular and student enrollment has been expanding. "We have waiting lists for some of our classes. These are elective courses, and they are thriving," he said.

Dee Stark, assistant principal for teaching and learning at the Auburn Career Center, in Painesville, Ohio, notes that the "real life" experience provided in their fabrication classes quickly yields benefits for students. "Many of our students are eligible for internships after their first year in their program; they are well-qualified for these positions due to their abilities and knowledge of the current technology that is used in industry."

Which Tech Tools Yield the Biggest Bang for the Buck?

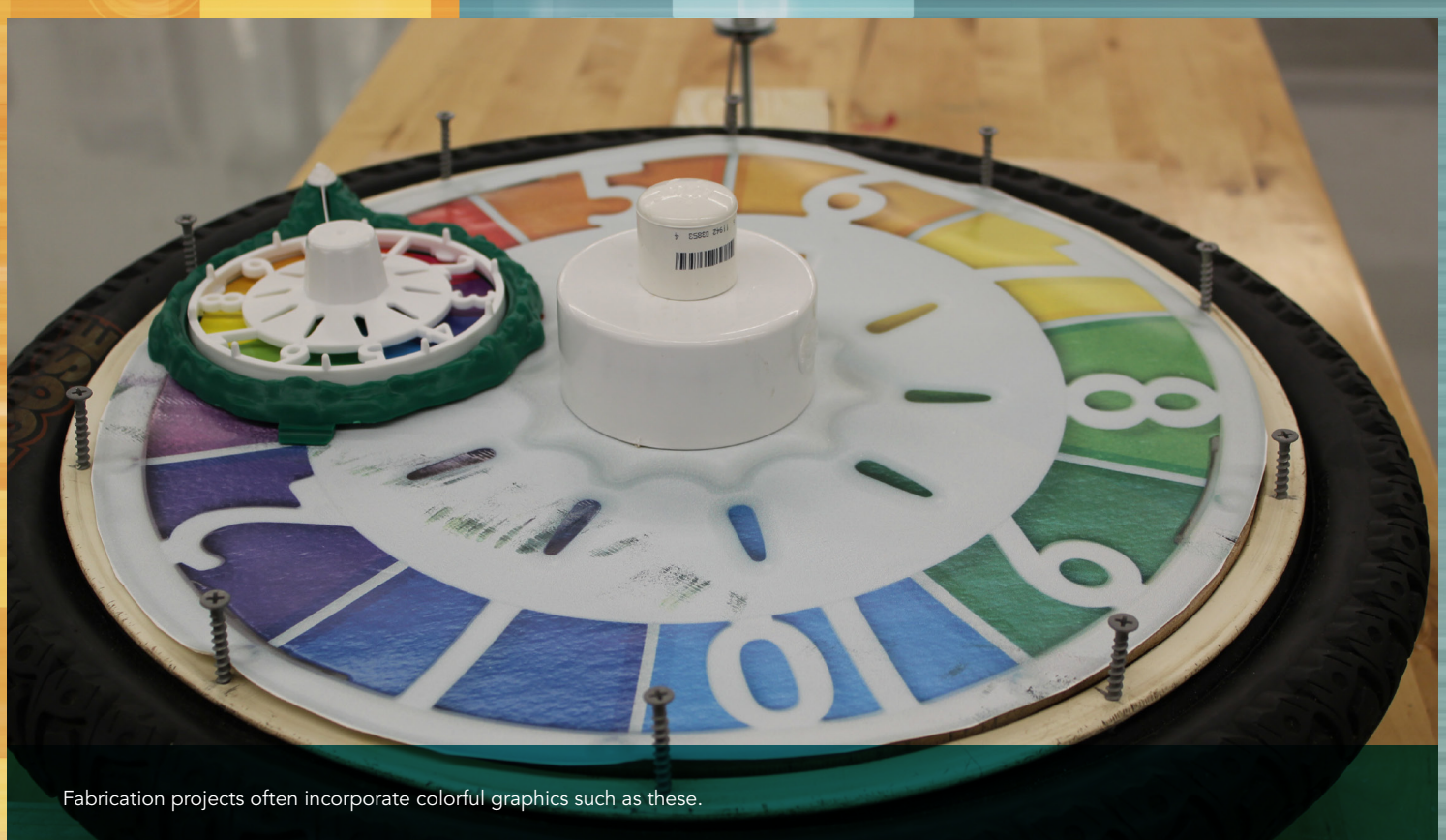
Though funding for maker spaces and the high-tech tools they require has become more accessible in recent years, CTE institutions and instructors remain focused on efficacy in both the short and long term. Tech tools need to be durable, versatile and easy to use for both beginners and more advanced learners. Other factors come into play as well, including upkeep requirements, material costs and access to support.

Technology manufacturers are responding to the call for hands-on learning with suites of instruments that are robust, versatile and simple to operate. Some have even developed project-based learning tutorials specifically designed for use with advanced digital devices in educational settings. These ready-to-teach solutions facilitate the incorporation of digital fabrication projects throughout the school year.

"Roland has always sold its digital devices to educational institutions — what's new is the way we are approaching this market. With a suite of devices and project-based learning tutorials, we can offer educators and administrators a more complete digital fabrication solution for the classroom," said Anderson.

Lassiter described the production engine of a typical Fab Lab as a rapid prototyping facility comprised of five core instruments, including a Roland desktop milling machine and GX-24 24-inch vinyl cutter, along with a giant computer numeric control (CNC) wood router, a computer-controlled laser cutter and electronic assembly and programming tools for low-cost, high-speed embedded processors. "People of all ages and with all levels of technological ability make use of the facilities in a Fab Lab," said Lassiter. "The equipment is advanced technology, but is easy to use and very dependable."

Dee Stark lists lasers, UV printers, CNC machines, 3D printers, digital cameras video equipment, computers and software among the top tech choices for her facility. These tools, she says, offer versatility, giving students "the opportunity to create and provide innovative



Fabrication projects often incorporate colorful graphics such as these.

solutions to problems and projects that we have not even thought about yet."

Rydlund emphasized the need for 3D CAD design software. "It's the engine that drives our entire program," he said. His campus uses SolidWorks, and even offers students the opportunity to become Certified SolidWorks Associates (CSWA), a certification that can be valuable for college and future employment.

In addition to software, Rydlund's engineering program values CNC mills, 3D printers and laser engravers. Though they also employ more traditional tools, such as drill presses and table saws, in the program, he said the technology must be there as well.

Anderson noted that many educators are also working eco-solvent and UV printing technologies into their classrooms. "We've seen a strong demand from schools for our printer/cutters and UV direct printers," he said. "Students are very interested in projects like signage, vehicle wraps and personalized graphics for consumer electronics and other applications."

Educator Support is Critical to Success.

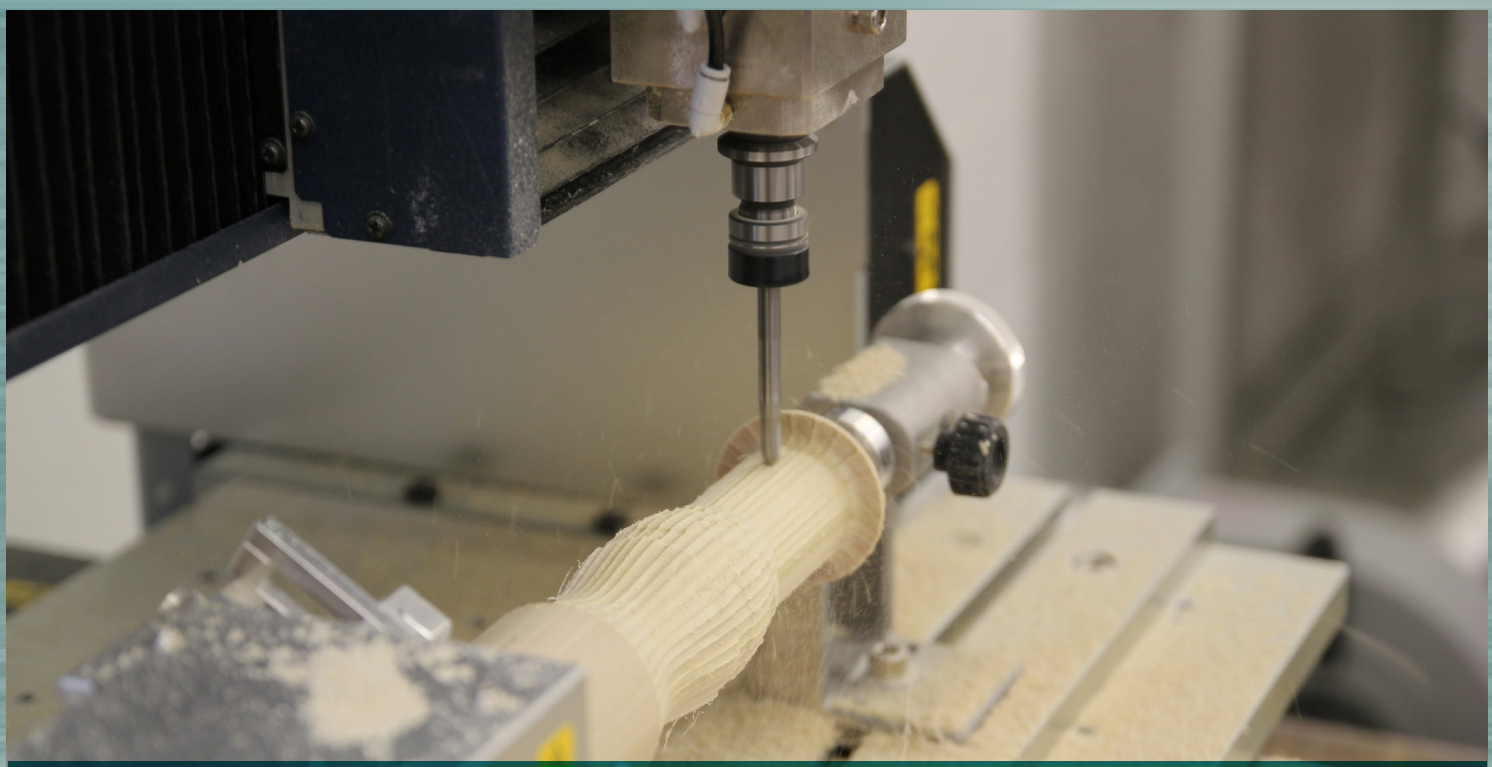
As the digital fabrication market grows, administrators and teachers have access to a growing number of webinars and workshops. "More and more support is available on the use of these tech tools and how to incorporate them into classrooms and labs, said Stark. "Educators are collaborating more often than ever before to provide integrated learning across curriculums, age groups and distances."

In her view, "Education needs to find a way to personalize learning for students to become actively involved, find meaning and relevance. The administration must also provide support by making the time and tech tools available for educators to learn these new techniques and technologies. "

Rydlund also credits the cooperation between his district and the local colleges and corporations in helping their high schools create a curriculum that meets students' future needs. For example, in their final year, Rydlund's high school students take a capstone class built around a senior project that intends to prepare them for the types of projects they will undertake on the job, or in courses at colleges such as nearby Colorado School of Mines.

Manufacturers are helping to meet the challenges of incorporating project-based learning curriculum by offering Web-based step-by-step project tutorials. "PBL tutorials provide an easy way to quickly get students and educators up to speed with their equipment as they complete a project," said Anderson. "From there, instructors can add layers of complexity by incorporating images or graphics, or by taking a project through multiple iterations."

Roland's PBL tutorial projects range from a milled yo-yo to heat transfers for T-shirts, to direct printing on items like flash drives. The PBL software makes it easy for several students to access the tutorial simultaneously from their computers or tablets, thereby increasing the tool's collaborative value as well as its educational throughput. Tutorials are available for use with a wide range of devices, including 3D milling machines, eco-solvent printers, vinyl cutters and UV flatbed printers.



Advanced technologies such as this Roland benchtop milling machine allow students to fabricate CAD/CAM projects.

Partnerships and Project-based Learning

In addition to developing facilities on their campuses equipped with high-tech equipment, many schools are finding ways to partner with other schools, civic organizations and corporations to bring additional project-based learning opportunities to their students.

According to Lassiter, corporate sponsorships from Chevron, Google, SolidWorks, Autodesk, Roland and others are vital components to growing the Fab Foundation's worldwide network of educational and independent Fab Labs. "We are truly fortunate to have corporate sponsors and professional collaborators who share their resources with us, so we can then share them with the world," said Lassiter.

Rydlund's district has partnered with Swiss-based Micron Denver to bring junior-year high school students to the company for summer internships as mechanical technicians. Following the five-week program, the top performing interns are offered apprenticeships during their senior year and a chance at a paid two-year college degree.

To further reinforce the partnership, several teachers from the district are invited to participate as mechanical technicians during the summer. This allows instructors a firsthand view of the day-to-day activities at local companies. "Not only did I learn more about the skills my students will need, I got to see my students in a whole new light — as employees," noted Rydlund. "Their growth during the summer was amazing."

"Other businesses are going to be looking at this model," Rydlund predicted. He pointed out that, along with developing connections to potential employers, these kinds of partnerships allow students to find out what they do and don't like about particular careers while they are still in high school.

Auburn Career Center also has plenty of cross-program integration with local businesses and community service partners. For example, the Center's Plant Turf and Landscape Management, Architecture Program Management and Construction departments collaboratively designed and built an Easter Bunny display for the Great Lakes Mall. Their Construction Technology department also worked with the United Way of Lake County to mass-produce lighthouses that were artfully decorated for an auction fundraiser.

On Auburn's own campus, administrators have orchestrated several inter-departmental projects. For example, its Interactive Multimedia students created backlit signboards for the cafeteria to display menus, and Welding students worked with the Culinary students to design and fabricate a smoker for the culinary restaurant.

Rydlund's Engineering Technologies department uses a wide variety of projects to teach basic processes and skills, including the production of wooden clocks,

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CO^2-powered race cars, mousetrap vehicles, balsawood bridges and medieval designs such as catapults and trebuchets. Some of the projects are determined by the various competitions in which they participate, including the CO^2 and medieval weapons competitions sponsored by the statewide Technology Student Association.

No matter what the project, Rydlund says their design process remains the same: Design, test, problem solve and redesign. "There are so many projects out there that can easily be put through this process," he said. "The tech tools we have allow us to run through each of the steps, sometimes many times over, in the course of a semester."

What Lies Ahead for Project-based Learning?

As corporations and civic institutions understand the benefits of project-based learning in developing a skilled workforce, collaborative funding for maker spaces is increasing. Growing numbers of grants and partnership arrangements are helping schools fund access to tech tools and curriculum, either by developing their centers onsite, or by accessing facilities and expertise in their communities, such as those found in maker spaces and Fab Labs.

In the next few years, Lassiter sees the Fab Foundation expanding its reach through continuing partnerships with corporations and manufacturers. She also sees the Foundation continuing to act as a hub for disseminating research and best practices for STEM and STEAM learning from MIT and other Fab Labs.

Stark predicts that project-based learning in her area will grow to include more business partners and civic organizations collaborating with higher education institutions. "In our own district, more often than not, our project-based learning units are incorporating business partners and community service members. The projects showcase our students' technical skills on top of their creative abilities to problem solve, think critically and collaborate effectively," said Stark.

Anderson commented that project-based learning is growing so rapidly right now that the advancement of new ideas is happening organically. "Educators and students both want learning to move in this direction. We anticipate more cross-platform pollination — where students design, for example, a simple plaque, then use direct printing, vinyl cutting or digital printing to customize it. Students are going to leave the classroom with the tangible results of the knowledge they've gained."

Rydlund sees the growth in high-tech fabrication in education as a direct result of the integration of advanced technologies from in almost every industry. "Project based learning has to develop at exponential speeds because technology is doing so," he said. "Today's students are tomorrow's engineers, doctors, lawyers, military personnel and world problem solvers. ■

Ginny Mumm is a freelance writer based in southern California. Email her at ginnymumm@gmail.com.

REFERENCE

New Media Consortium. (2017). NMC horizon report: 2017 higher education edition. Retrieved from http://cdn.nmc.org/media/2017-nmc-horizon-report-he-EN.pdf.

Opportunities for collaborative learning abound at facilities like Fab Lab San Diego.