

6 Steps to Building Business Partnerships in Your Engineering Program with 3D Printing

One of the most effective ways to teach students is to give them projects and problems from real life. Here's how you can offer your students usable career skills by creating partnerships with local businesses.

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The first time Mike Bruggeman understood the power of business partnerships for his engineering students was when he had them work on a project for Klean Kanteen, a Northern California company that makes reusable water bottles and food containers. The owners were attending a community college class Bruggeman was teaching to learn how to use AutoCAD so they could develop sippy cup lids for a “kid canteen” line. Bruggeman suggested they let his students at Chico High School in Northern California tackle the project. With a day of effort the high schoolers had come up with potential designs, and a day after that, they had created prototypes on their 3D printer. The Klean Kanteen team brought their bottles into the school, tested out the lids and, impressed, agreed to sponsor the high school’s conversion from its education license for SolidWorks into a commercial version that would let them legally share their CAD files.

“That launched us,” says Bruggeman. From that moment on, the high schoolers could go to other businesses and offer similar services, giving students real-life experience in 3D design and prototyping, interaction with clients and other skills that have proven valuable in college and career.

The Chico Unified School District program is unique, and is something a lot of other school systems would like to emulate for their students. This paper offers six rules of practice to set up a business partnering operation in your school district in order to create a career-focused learning environment for your students.

1. Go into this only after you have ample experience.

You can’t expect your first- or second-year students to be able to tackle professional design jobs. Save those for the older students. In fact, advises Bruggeman, if you don’t have at least several years of teaching on the design software and working with 3D printing, it may be premature for you to go hunting for business partnerships. Why? Because “you can’t fail on these people, or they’ll get impatient with you and they won’t call you back,” he says.

Chico Unified School District has two high schools, Chico High and Pleasant Valley High, which have a combined attendance of about 3,700 students. Bruggeman and fellow instructor Tom Phelan teach nearly 500 students a year in their industrial technology courses—the biggest elective program in the district—and run regional occupational programs (ROP) in CAD drafting and architecture for juniors and seniors. Unless they’re part of an internship out in the field, ROP students meet for class two hours a day, and that’s when the commercial work is done.

TIP

Follow a zero-failure policy. That applies to the internships Bruggeman’s students have as well as the design and prototyping jobs they tackle. “When a project comes in the door, we won’t take on another one unless we’ve completely satisfied that customer.”

The Hunt for Good Curriculum

Chico Unified School District's Mike Bruggeman maintains a website (chsitech.wix.com/chsitech) where he posts the entire curriculum that he and colleague Tom Phelan have developed for classes in their industrial technology program. To find them, choose the "Resources" link in the main menu and pick either "Teacher Curriculum" or "Tutorials."

Bruggeman says he makes the content freely available to help other teachers "build a sequential set of classes that provide the skills necessary to be able to approach businesses." Working through those tutorials will give the teacher "evidence" that the students "are capable of doing this kind of work."

2. Work your contacts.

Selling the use of student services in your local community will require heroic effort by you and your students. Expect to hit up your own network, ask your students to talk with their family contacts, and go to your school's supporter network to make inroads into the offices of decision-makers.

Bruggeman says he "put a lot of miles" on his truck, visiting local companies, knocking on doors and talking to business owners. Although they'd say, " 'We'll get back to you on that,' we would never hear from them again," he recalls.

Bruggeman struggled to parlay the success with Klean Kanteen into additional projects—until a local salesman and installer who worked for MJB Welding Supply, a

TIP

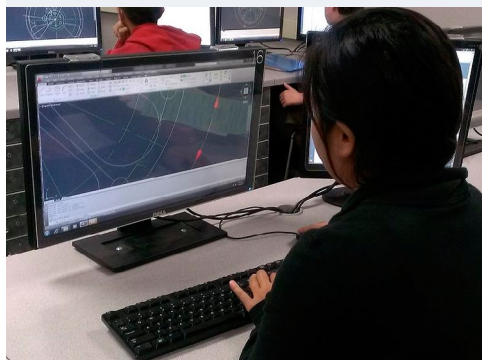
Local companies look good when they support local schools. Be prepared to allow them to publicize the work they're doing with your students and make sure to give them upbeat press in your own school communications to amplify the news about the kinds of projects your students are doing with them.

company that serves the Chico region, offered to take him around to meet clients. "He had seen what we'd been doing. He saw the skill sets and the type of software and equipment we had. He felt comfortable enough to do that for us," explains Bruggeman.

Armed with that salesman's recommendations and introductions, Bruggeman and Phelan finally found the traction they needed to gain more work from the business community.

3. Provide in-person service.

The advantage of working with local businesses is that they can visit the school to bring the objects they're hoping to accessorize or add components to. That's important because it lets the students get involved at the beginning of the project. They become a part of the initial planning phase and can begin to do whatever reverse-engineering they require and study the setting where their parts will have to fit.



As an example, recently, a new client came into Chico High with his Can-Am Spyder, a three-wheeled motorcycle. He had designed a prototype for a wheelchair carrier that would fit on the motorcycle. What he wanted was a SolidWorks design file. The students set to work taking photographs and measurements from which to start their work.

6 Rules for an Excellent Business Partnership

- Do persist. It's going to be tough to get your program off the ground.
- Don't go into a business partnership before you and your students are really ready for it.
- Do take advantage of face-to-face contact with clients to help your students learn how to work with customers.
- Don't take on more projects than your students can complete with absolute success and total customer satisfaction.
- Do help your students build up their professional portfolios by documenting the projects they work on.
- Don't think you're going to get rich; business partnerships are about adding real-life experience to your curriculum.

"Most of the time people who walk through the door don't have much in the way of drawings or sketches. That's why they're coming to us. Our students are very talented with computers," notes Bruggeman. During the design process, if there's a part that just doesn't seem to be working, they'll redesign it and print it on the 3D printer to give the client a better idea of what's needed.

In another example, Woodzee, a wooden sunglass company based in Chico, was going to get its own 3D printer until the cofounder's high school-age son convinced him to use the services of the ROP students. Now he brings his staff in to try on the sunglasses the students have prototyped, mark them up and tweak the drawings. "We keep going at it until they're happy," says Bruggeman.

4. Be conservative about timing.

Use your industry experience when estimating how much time a project will take for students to finish. What you don't want to do is give business partners less than they're expecting.

When a job comes in, Bruggeman is upfront about finding out just how fast turnaround needs to be. "Things do go slowly at a school. We only meet for two hours a day," he says. "I don't want to be the one to hold them up. If I don't think we can meet their deadline, we don't take it."

If a project runs longer than the estimate, he won't take on any additional projects until it's finished. "Sometimes I have a waiting list. People will say, 'Hey, no problem! If

TIP

The interactions between students and design clients are as important as the computer and 3D printing work, because these meetings teach students what kinds of questions to ask, how to record the information and how to approach a new design problem.

TIP

The use of professional-grade 3D printers pays off for Chico Unified by producing "better quality" prototypes and parts than hobby-grade 3D printers—particularly important when the project involves business partners, says Bruggeman. Currently, he runs Stratasys 3D printers for client work. "The Dimension 3D Printer has offered legitimacy to my programs," he says. "And the way I see it, it was well worth the money as far as motivation for the students. It encourages them to do higher quality work from the start, and has been the catalyst for teaching them how to communicate technology with our industry partners."

you guys can get to us, we would love to have you do it. Just let us know.' " Involving students in the process of creating a timeline and holding them to it is one way to

How to Acquire a 3D Printer for Your School

Wondering how to obtain the kind professional-grade 3D printing gear that will impress potential partners? Chico Unified's Bruggeman cobbled together money from multiple sources: grants from the federal Perkins Career and Technical Education Improvement Act and the state's Regional Occupational Centers and Programs, as well as "a little district funding."

Besides pursuing grant funding, you can supplement those options with other sources:

- Partner with your local community college or state university for access to their printing equipment. Let them know also that you're interested in acquiring their high-end quality equipment when they choose to upgrade.
- Team up with other school districts in a consortium sharing arrangement. That's how Campbell-Tintah Public School in Minnesota does it. For \$3000 a year, the high school gains access to 3D printers and other maker gear for a scheduled period, then it goes off to the next district.

Learn more about how to persuade your district decision-makers to add 3D printing to the curriculum by downloading the T|H|E Journal report, "The Case for 3D Printing at Your School."

make sure projects move forward on schedule. By enforcing deadlines you will ensure the project gets done and students learn the importance of delivering on a business agreement in a reasonable amount of time.

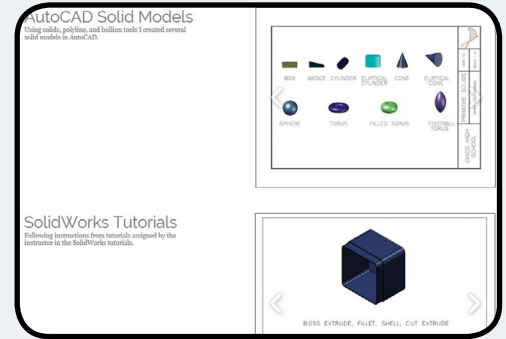
5. Create a bartering system.

Don't expect monetary payment from your business partners. There's something much more valuable than money that they can provide for your program: class mentoring and supplies.

Bruggeman estimates that the work his students are doing saves their clients "thousands" by producing 3D printed prototypes and parts. In return, "All we ever really ask is to keep supporting the students, give them the chance to learn and materials to do it with."

For example, the students have worked extensively with Tim Dexter, whose company, Westside Research in nearby Orland, Calif., creates designs for automotive cargo gear. When they're developing projects for Dexter (such as fasteners or collapsible mudflaps), he comes into the classroom weekly. His focus is twofold: to help the students improve their engineering skills by learning how to do research and rework 3D parts to work better together; and to help them improve the product's functionality, look and safety to better satisfy the ultimate consumer. The personal mentoring time is invaluable to students who are able to interface with a professional who is running a successful business—a kind of learning that students are not always able to get in a classroom setting.

Besides mentoring, Dexter also supplies material—filament—to keep the 3D printers running. That extra material lets Bruggeman's younger students—the ones not yet in ROP—practice their design and prototyping skills as well.



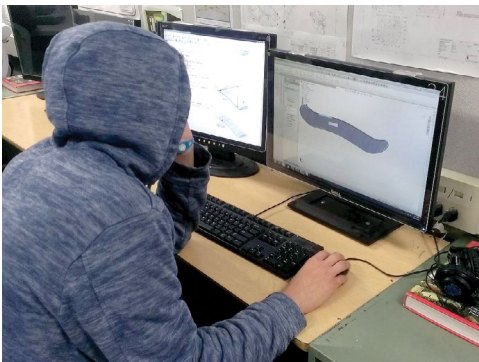
TIP

Internships are the ultimate payoff as far as Bruggeman is concerned. "My approach is, if we can do something for you, will you do something for the students—give them a chance?" Probably the ROP's number one supporter is Thomas Manufacturing in Chico, which keeps two interns working in their engineering department "around the clock, all year long." There's always one senior and one junior, the older student training the younger one, and both are paid for their hours. The welding company, which fabricates agricultural equipment, has been hiring Chico Unified students as interns for five years. "We've pretty much become an integral part of their engineering department," Bruggeman says.

Other Educational Uses for a 3D Printer

The process of working with business clients to develop designs, prototypes and products will provide your students with real-world skills that will serve them their entire college and professional careers. But there are other invaluable educational uses for 3D printing in the classroom as well:

- Students can design and print out 3D objects for studying in science, English or social studies to allow them to feel and handle bones, organs, molecules, historical artifacts or other components that would traditionally be viewed in photographs or illustrations.
- When parts break, students can reproduce them for robotics, science projects, even the maintenance department, offering authentic learning experiences in practical problem solving.
- The use of 3D printing in art and multimedia classes will allow your students' imaginations to soar in a way that clay and collage just won't. Learners can create their own artistic masterpieces in three dimensions, produce objects for stop-motion animation, invent new fashion accessories and manipulate models of ordinary, everyday objects to push the boundaries of their creativity.



6. Prime your students to work with business.

The results of engineering classes cry out to be contained in a student portfolio, preferably online in digital form and maintained in a way that it can grow as a student moves through high school. One of the first assignments freshmen at Chico Unified have to complete is to write a resume. That starts their portfolio, which grows as they complete work samples.

Bruggeman has turned to website builder WIX (wix.com), a service that lets people create sites for free. There, he maintains his own website (chsitech.wix.com/chsitech) and his students create their websites. Now, when students go to an interview related to their ROP work, they take a laptop computer and share their digital portfolios. "Business owners see that, they go 'that's impressive.' They like that a lot," he says.

He also has them document the processes they follow in their design and prototyping work, serving two purposes: That "tutorial" is used as curriculum by the next student to come along and tackle the same assignment; and it provides more portfolio fodder. "We have turned the writing over to the students so they learn how to do technical writing," explains Bruggeman. One recent project required a team of students to create a "functional hinge" in SolidWorks and then print it out "with the proper tolerances to accept the pin and perform correctly." Once they've created a working prototype, they have to write up the process to help other students "achieve a successful outcome."

Every one of the students in ROP for industrial technology at Chico Unified for the last three years has gone to college. Before they head out the high school door, they've already earned up to nine college credits. On top of the technical skills students have gained, adds Bruggeman, they've learned how to be dependable, communicate with adults and "get the job done."

Even as schools are putting a bigger emphasis on project- and competency-based learning in their academic programs, Bruggeman believes partnering with local businesses can give students the extra boost they need to succeed. "The students who only have academics—they're a dime a dozen. They really don't have anything tangible to apply to their learning. They don't know why they're doing it," he says. "The best students are the ones who combine their academics and a career pathway."

TIP

Be prepared to modify your curriculum as you get feedback from your business partners. Bruggeman maintains an informal advisory board to stay on top of new skills companies want students to have. And then make sure those skills are reflected in the projects profiled in student portfolios.

About Stratasys

Stratasys® manufactures 3D printing equipment and materials that create physical objects directly from digital data. Its systems range from affordable desktop 3D printers to large, advanced 3D production systems. Its specially engineered 3D printing materials include hundreds of photopolymers and thermoplastics.

Manufacturers use Stratasys 3D Printers to create models and prototypes for new product design and testing, and for low-volume finished goods. Educators use the technology to elevate research and learning in science, engineering, design and art. Hobbyists and entrepreneurs use Stratasys 3D Printing to expand manufacturing into the home — creating novelties, customized devices and inventions.

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Stratasys
5 Fortune Drive
Billerica, MA 01821
(877) 489-9449



9201 Oakdale Ave.
Suite 101
Chatsworth, CA 91311
(818) 814-5277