Makerspaces

Scenario

Jerry, a freshman in fine arts at a private college renowned for its cross-disciplinary curriculum, is new to the campus makerspace. He's here to work on his first assignment in a course called "On the Corner of Art and Technology." Jerry's assignment is to build a portion of a pinball machine using any medium: cardboard, plastic, felt, clay. The finished product must react to a rolling ball in an appropriate manner. Before he takes a seat at one of the tables, Jerry pokes through labeled Plexiglas bins with arduinos, Legos, Tesla coils, cardboard, rockets, yarn, LED lights, duct tape, batteries, and solar receptors. He's looking for ideas for his project. One bin in a row of art supplies even has a selection of tiny silk flowers. He takes a few of these.

Other students are working on projects, alone or in groups. Some are talking quietly. Jerry takes some construction paper from one of the supply stations on the counter and notes the signs that point to a laser cutter, a laminating machine, and a 3D printer. He sets to work with the orange construction paper, figuring he'll use a stronger material once he has his design worked out. The chute he is building should cause his tiny flower arrangement to pop up as a ball passes over the trigger. But when he tests his first attempt, he finds a Ping-Pong ball lacks the mass to trigger the reaction.

A student named Carrie is sitting across from him. She's in the same class and is building a clay structure. She's using a golf ball to test and suggests Jerry try it. The heavier ball rolls over the side of the track before it reaches the trigger, but a plastic ball he makes with the 3D Printer does cause the bouquet to bounce up and off the flimsy track. Jerry disassembles his paper construction, thinking to use it as a pattern for a cardboard version. A glance at the clock alerts him that he's been here for two hours. He'll have to hurry to get to his psychology class.

At the door, he checks the schedule for open hours at the makerspace. As he moves hastily down the sidewalk to the next building, he ponders a design change. Maybe if the cardboard mockup works, he should build his final version in plaster of Paris. He could paint it with Bavarian motifs and add two men in lederhosen at a beer garden table that flies up on one hinged side as the ball passes...

1 What is it?

A makerspace is a physical location where people gather to share resources and knowledge, work on projects, network, and build. Makerspaces provide tools and space in a community environment—a library, community center, private organization, or campus. Expert advisors may be available some of the time, but often novices get help from other users. The makerspace—sometimes referred to as a hackerspace—is often associated with fields such as engineering, computer science, and graphic design. The concept emerges from the technology-driven "maker culture," associated with *Make* magazine and the Maker Faires it promotes. This idea of a collaborative studio space for creative endeavors has caught hold in education, where the informal combination of lab, shop, and conference room form a compelling argument for learning through hands-on exploration. On campus, the makerspace is being embraced by the arts as well as the sciences, and a new energy is building around multidisciplinary collaborative efforts.

2 How does it work?

Makerspaces owe a considerable debt to the hacker culture that inspired them, and **many are still primarily places for technological experimentation, hardware development, and idea prototyping**. But self-directed individual inventors and creative teams are increasingly using these free or fee-based services in fields other than engineering and technology. Makerspaces are often open for informal, unscheduled activity; in some cases, an organization will host scheduled classes in a makerspace. These classes are generally not for credit and focus on a single skill, such as coding, soldering, or woodcarving. Supplies such as cardboard, plastic, metal, gears, wood, and batteries may be on hand, and available tools may include anything from a welding machine to a laser cutter. But certain materials and tools are emblematic of makerspaces, such as microcontrollers called arduinos and 3D printers, valuable for fast prototyping. As the notion of providing space for project design and construction has caught on in education, such places have acquired other accoutrements, from paints and easels and impromptu stage sets to cooktops and candy molds. Used by students, faculty, and staff, makerspaces have become arenas for informal, project-driven, self-directed learning, providing workspace to tinker, try out solutions, and hear input from colleagues with similar interests.

Makerspaces

3 Who's doing it?

The makerspace emerged initially as a powerful learning force in the nonacademic community. One member-supported effort that reflects that origin is the Milwaukee Makerspace, which invites the public to attend meetings. Members see sharing and learning skills as a key purpose of their makerspace, resulting in a dynamic studio environment that builds member projects, which have included electronic modifications to musical instruments, mini robots, giant wind chimes, a biodiesel reactor, and an electric car. Colleges and universities have also been quick to recognize the value of the makerspace as a learning opportunity, with such options as the ThinkLab at the University of Mary Washington, Headquarters at Rutgers University, and the FabLab at Stanford University. At Case Western Reserve University, the current ThinkBox invention center is seen as so important that it will soon expand to a seven-story building with 50,000 square feet of space. All these spaces function similarly. At Wheaton College, for example, the WHALE Lab (Wheaton Autonomous Learning Lab) is an interdisciplinary makerspace where students embroider, solder, weld, sculpt, or otherwise design and manufacture creative projects. The emphasis is on community-provided mutual assistance, and the output from student activity might be a robot or a knitted sweater that lights up. At the Georgia Tech Invention Studio, students can even apply for project funding in the form of Maker Grants. Multidisciplinary projects are encouraged, and winning teams must work on their projects at the Invention Studio. Completed projects are presented as portfolio pieces at the Georgia Tech Capstone Expo.

4 Why is it significant?

Makerspaces are zones of self-directed learning. Their hands-on character, coupled with the tools and raw materials that support invention, provide the ultimate workshop for the tinkerer and the perfect educational space for individuals who learn best by doing. Interaction among inventors at these facilities fosters a highly collaborative learning dynamic that is excellent for team efforts and for peer support, advice, and assistance. Where these spaces are open to use by faculty, students, and staff from a cross-section of content areas, they promote multidisciplinary thinking and learning, enriching the projects that are built there and the value of the makerspace as an educational venue.

5 What are the downsides?

Space in learning facilities is often at a premium, and cost is a consideration in setting up an area for making. High-end 3D printers that print with a variety of media can be expensive. Smaller, more affordable 3D printers generally create only small items, often from a single medium in only one color. Equipment such as milling machines, welding equipment, lathes, 3D printers, and laser cutters may be in high demand, which can result in long wait times for students trying to use these facilities. Some of these machines can be dangerous, too, raising liability issues. Finally, much of the value of a makerspace lies in its informal character and its appeal to the spirit of invention, and some of this advantage can be negated if well-meaning faculty choreograph student activity to a degree that squelches experimentation.

6 Where is it going?

One key demand of a makerspace is that it exist as a physical location where participants have room and opportunity for hands-on work, but as these environments evolve, we may see more virtual participation. Video may invite input from remote experts, and teleoperation may enable manipulation of machinery from afar. As makerspaces have become more common on campuses and have found their place in public libraries and community centers, their influence has spread to other disciplines and may one day be embraced across the curriculum. **Eventually makerspaces may become linked from campus to campus, encouraging joint project collaboration.** Students who use these studios to create tangible portfolio pieces may find their work of interest to future employers. As education assessment evolves, the project work done in makerspaces may one day be accepted and reviewed for college credit in lieu of more conventional coursework.

7 What are the implications for teaching and learning?

The makerspace gives room and materials for physical learning. Because these spaces can easily be cross-disciplinary, students in many fields can use them, often finding technical help for work they are undertaking in their areas. At the same time, those in engineering and technology will find their work enriched by contributions from those in other fields. **Makerspaces allow students to take control of their own learning** as they take ownership of projects they have not just designed but defined. At the same time, students often appreciate the hands-on use of emerging technologies and a comfortable acquaintance with the kind of experimentation that leads to a completed project. Where makerspaces exist on campus, they provide a physical laboratory for inquiry-based learning.