

**Incorporating a MakerSpace Project into an Introduction to Agricultural Engineering  
Course**

**Brittney Heibel**

Texas State University  
601 University Dr.  
San Marcos, TX. 78666  
512-245-2130  
bhh19@txstate.edu

**Bradley D. Borges**

Texas State University  
601 University Dr.  
San Marcos, TX. 78666  
512-245-7106  
b\_b518@txstate.edu

**Ryan G. Anderson**

Texas State University  
601 University Dr.  
San Marcos, TX. 78666  
512-245-3325  
r\_a461@txstate.edu

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### **Introduction**

The Ingram Hall Academic MakerSpace (IHM) on Texas State University campus is an invaluable resource, costless to university faculty and students. The IHM benefits students through hands-on learning and varying perspectives on multi-disciplinary engineering. Academic MakerSpaces encourage students to complete projects that require complex, collaborative, and creative efforts (Bouwma-Gearhart et al., 2021). The MakerSpace encompasses three fabricating sections: rapid prototyping, industrial manufacturing, and woodworking. Notable equipment in the rapid prototyping section ranges from 3D printers to CO<sub>2</sub> lasers. In the industrial manufacturing section, machinery available to students include waterjet cutters, 5-axis CNC mills, fiberoptic lasers, and multi-process welding machines. Lastly, the woodworking section comprises CNC routers, table saws, and basic woodworking tools. The IHM also features five teaching labs containing advanced teaching equipment like universal testing machines, CAD engineering equipment, and more (Texas State University, 2020).

Students recognize MakerSpaces as spaces with a welcoming and encouraging environment that promotes participation from a diverse group of people, including students who were intimidated or uninterested at first (Bouwma-Gearhart et al., 2021). By empowering them to pursue more innovative ideas, students' utilization of MakerSpaces has led to high levels of teamwork, communication, and time management, all valued skills within agricultural engineering industries (Lagoudas et al., 2016). Incorporating MakerSpace projects into the agricultural engineering curriculum will allow students to receive meaningful learning through hands-on experience that attends to physical, technical, and social components across systems.

### **How It Works**

Instructors for the Introduction to Agricultural Engineering courses will introduce the MakerSpace and potential projects that can be created. Following a tour of the MakerSpace, instructors provide students with the MakerSpace Project Assignment: to create a unique project utilizing at least one piece of equipment within the MakerSpace. Students are encouraged to be creative with this opportunity. Once students create their project design, receive approval from the instructor, and complete necessary training protocol for machines they wish to operate, they are allowed into the MakerSpace to begin fabrication. Table 1 outlines steps of the MakerSpace Project process.

**Table 1**

#### *MakerSpace Project Assignment Outline*

<b>Steps</b>	<b>Action</b>	<b>Description</b>
Step 1	Students tour the on-campus MakerSpace	Accompanied by the instructor, students receive a comprehensive tour of the MakerSpace by a MakerSpace Technician (MST).
Step 2	Students are instructed to develop a project outline	The instructor gives examples of projects created using the MakerSpace. Students must identify their desired project and which MakerSpace machine(s) they will use.

Step 3	Instructor reviews project design outlines	The instructor reviews project design submissions from the students, confirming machine selection. The purpose of this step is to ensure the feasibility of the proposed project.
Step 4	Students complete required training protocol for specific machines they plan to use	Virtual training is provided through CANVAS. Students must score 100% on all training quizzes before access to the machine is granted. Additional in-person trainings are required for specialized equipment.
Step 5	Students complete their MakerSpace project over the course of the semester	Students may work on their individual projects, at their own pace, over the semester to provide adequate time for complex project construction.
Step 6	Students submit their project report for grading at the end of semester	Projects are graded according to completion, as the purpose is to engage students in using the MakerSpace.

### Results to Date

Of the ( $n = 91$ ) students who created a MakerSpace project during the class, 37 used 3D printers, 13 used laser cutters, 12 used CNC embroidering machines, 10 used waterjet cutters, and eight used laser etching machines. Less than five students opted to use other machines such as the CNC lathe, CNC mill, vinyl cutter, table saw, MIG welding machine, or plasma cutting table. All projects were designed and executed completely by students. Noteworthy projects include a layered wooden shadowbox etched with images, a welded metal hat rack embellished with decorative designs, 3D printed topographic maps, and a laser-cut aluminum deck to be fitted on a boat. Some students elected for simpler designs such as embroidered pillowcases or design-printed t-shirts. It was not determined if students continued to utilize the MakerSpace resources on campus following project completion.

### Future Use of MakerSpaces

Partnering with institutions across campuses, like the MakerSpace, can improve students' college experience through diversifying and enhancing their education. Students operating technical equipment firsthand receive advanced training they otherwise wouldn't have received. Through these experiences within the MakerSpace, students acquire skills and experiences that better prepare them to integrate into the agricultural engineering industry.

Future implementation of MakerSpace projects in university-level courses should allow students ample time within the MakerSpace to acquaint themselves with the many machines. Implementation should also blend team-based learning with project assignment to further enhance heterogenous engineering experience. Further, plans to monitor whether students continue their use of the MakerSpace after the project lesson is needed.

### Costs and Resources Needed

The MakerSpace is a free resource to all students, staff, and faculty on campus that provides training for basic and specialized equipment at no cost, thus the only cost incurred was that of specific materials needed for their projects (i.e., lumber, steel, or fabric). Materials sold in the IHM Stock Store were available to students at-cost. This on-campus resource is something to be marveled and taken advantage of as students are given extensive exposure to advanced project development and production at minimal or no costs.

## References

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