Old Dominion University
Engineering Makerspace and Invention Center (EMIC)
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Introduction

The Old Dominion University Engineering Makerspace and Invention Center (EMIC) is a nearly 7,000 square feet $2M facility that provides engineering and technology students the ability to learn the use of cross-disciplinary tools, build a learning community across students from different programs and years, connect with industry, have paid discipline related jobs, pursue innovation and entrepreneurial activities, engage in curricular and extracurricular activities, and develop knowledge and skills. The space is divided into the following sections: bioengineering, additive manufacturing, wood and composites, metal, welding, extended reality, and audio/video production. This facility is supported by the Dean's Office and led by the student board with the support of the faculty director. The student board positions include safety manager, training manager, secretary, and operations manager, as well as multiple shadow or member-at-large positions.

Conceptualization

The EMIC was first conceptualized in 2017. The beginning stages involved extensive research and visits to academic makerspaces in the United States and abroad. From the beginning, it was the goal of the Dean's office to involve students in all aspects of the space from design to operation. Architects were brought in to work with students and faculty to design the space. The location of the space, in Monarch Hall, was the former location of a STEM Lab. Extensive remodeling of the space was conducted before machines would be able to be moved in. All decisions from the placement of windows to the selection of machines were driven by students with guidance from faculty and the architects. Construction completed in the summer of 2019 and machines were moved into the space in late 2019 and early 2020. The EMIC was set to have a ribbon cutting and grand opening in March 2020, but that was canceled due to the COVID-19 Pandemic. With new restrictions imposed on campus, the space sat dormant for the fall 2020 semester while the student board worked on administrative tasks that could be completed virtually. Restrictions started to lift for the spring 2021 semester, but limited capacity prevented the space from fully opening. The University made the decision to allow students to return to campus in fall 2021 and the space was able to open to the student body for the first time. The space has been formally open since that semester, with summer access being granted by appointment.

Training and Safety

When students first enter the space, they are classified as a trainee on all equipment. Students must schedule a training time with a space certified expert to complete physical training as well as read through provided training materials. Once the student has completed the necessary hours and proved proficiency on the machine, they become a user. Users are authorized to use the machine they have been trained on during normal operating hours. It is important to note that a minimum of three people must be present in the space before any heavy equipment can be operated. This includes the front desk worker, the shop supervisor, and the student operating the machine. Users are only allowed to operate the machine and are not permitted to conduct any maintenance or make any substantial changes to the machine set up. If a student shows great proficiency and interest, they can continue their training and become an expert. The role of the expert is to familiarize themselves with all training procedures related to the machine so they can train others. Experts also complete routine maintenance and communicate any issues related to the machines to the student board. The EMIC has a zero-tolerance policy when it comes to the safety and cleanliness of the space. Failure to comply with the rules set forth by the student board and posted around the space can result in restricted access or banning from the space as determined by the student board and faculty director.

Areas and Capabilities

The EMIC is made of eight main areas. Each area is outfitted with equipment selected by students with input from faculty and industry professionals. The areas and the equipment are discussed below.

A. *Bioengineering Area*

This area is designed to allow for a variety of bioengineering projects to be completed. The stereo microscope and camera can be used for both biomedical and microelectronic capabilities. This area also has an incubator, UV crosslinker, and thermal cycler, among other equipment. Additionally, there are two ductless fume hoods and a sterilizer to provide a safe working environment.

B. *Electrical Area*

The electronics area has the capabilities for both prototyping and permanent electronics projects. The space is outfitted

with soldering irons and helping hands for the creation of permanent circuits. Students have worked with faculty in the department of electrical and computer engineering to select equipment similar to the equipment used in the electrical engineering curriculum. These include oscilloscopes, AC and DC power supplies, and Arduino Uno kits. Certain smaller components were selected to be used with the breadboards including a wide range of chips, seven segment displays, and jumper wires.

C. *Additive Manufacturing Area*

The additive manufacturing area is the most popular area of the space due to inexpensive materials and easy to learn usage. This area has nine Fuse Deposition Modelling (FDM) printers and two Stereolithography (SLA) or resin printers. The FDM printers see the most usage at this stage and can use a variety of filament from hard plastic to more soft rubber. The SLA printers were recent additions to the space having been added in the spring of 2022. Rinse and cure stations have also been added to ensure safe and clean post processing of SLA printed parts. In addition, this area has a vacuum former and laser cutter.

D. *Metal Area*

The metal area has been outfitted with industry standard metal working tools ranging from milling to sheet metal. These machines were selected with assistance from industry professionals as well as staff from the on-site machine shop currently serving the college of engineering. In addition to full size milling and lathe machines, the space is also outfitted with a smaller mill/drill machine and benchtop lathe. On the sheet metal side, the area is equipped with machines such as the shear/brake/roll, pipe notcher Planishing Hammer, and metal shrinker stretcher.

E. *Welding Area*

The welding area has the largest amount of open floor space of any area. There is a large welding jig table with modular clamps for part holding and additional table for workspace. Both areas sit below the adjustable exhaust system that can be maneuvered to provide consistent ventilation of the work area. The welding machines have the capabilities to do both MIG and TIG. A spot-welding machine also provides additional welding capabilities.

F. *Wood and Composites Area*

The wood and composites area is housed on the opposite side of the shop to aid in dust collection. The dust collection system on the wood side is deposited in a barrel which is then taken off site and disposed of. This area is home to many traditional woodworking tools and machines including a wood lathe, drill press, and combination table saw/planer/joiner. This area also includes a CNC router table and desktop computer. The computer includes all the necessary software to import a design and create the tool paths, as well as control the machine.

G. *Extended Reality Area*

The extended reality station is housed in the back corner of the ideation area. This station includes two HTC Vive Cosmos headsets that are supported by an Alienware desktop computer. Additional hardware and software is being evaluated to further enhance this space.

H. *Ideation Area*

The ideation area is a modular space designed for collaboration. The tables and chairs in this space are designed to fold up and roll so the space can be customized to fit the students' needs. A large television on the wall is equipped with a desktop computer and web conferencing capabilities. An engineering workstation in the corner provides students access to the engineering software they utilize in their coursework on a wide monitor. This area also has a separate conference room that can be reserved for team meetings and quiet study time.

I. *Audio and Video Production Area*

The audio and video production area is designed to give students the opportunity to create high quality videos and presentations of their projects. Cameras, sound recording, and lighting equipment are available as well as video and image editing software.

Projects

The space is intended not to be a place for formal classes to be taught, but a place to augment and enhance coursework. Throughout the first year of being open, faculty from all departments have been encouraged to assign students projects to be completed in the space. These projects have included 3D printing, milling, and welding. Additionally, the space has been utilized by many teams working on their senior design capstone projects which are a graduation requirement for undergraduate students. Some of these projects have been funded by industry and grants and have received awards at the Engineering Student Projects Exp. Not all projects completed in the space are required to be academic. Students have built electric skateboards and scooters, a desk, a cosplay helmet, and many more. At this stage, all resources at the space are completely free for students to use, students are required to provide materials. Sources of funding are currently being evaluated to be able to provide project materials.

Lessons Learned

One critical lesson learned throughout the creation of the space has been that students respond well when responsibility and trust is placed in them. Many critical procedures have been developed by students and allow the space to function in a manner that best aids students' learning. It also allows the development of a community which aids in overall program retention. The space is also able to employ students through federal and state work study programs, allowing students to learn about the operation of the machines and organization of the space while being paid. The overall goal of the student board is to continually improve the space with each semester. This can include purchasing new machines or simply rearranging areas based on observed usage. This idea also applies to the administrative side of the space. Policies and procedures are adjusted at the end of each semester based on observed behaviors of the users. Connections are being strengthened with industry to allow for real-world projects to be presented for students to apply their knowledge gained through coursework.