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Utilizing an Existing College Manufacturing Facility in the Creation of a New Engineering Technology Degree Program

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Abstract

Engineering technologists can help bridge a gap between engineers and technicians/operators in industry. To prepare for careers, engineering technologists benefit from having extensive hands-on experience with common industry standard manufacturing equipment. Recently, a mid-Atlantic R1 institution developed an engineering technology program within the college of engineering to utilize existing related student support services (ex: advising, tutoring, and career exploration) and to provide an opportunity for engineering students and engineering technology students to collaborate outside the classroom. For students to have significant hands-on experience, this new degree program will utilize an existing manufacturing facility housed within the college. This facility combines a manufacturing service center with a student focused maker space. The facility's service center is staffed with full-time manufacturing and fabrication professionals dedicated to producing the designs of students, faculty, and staff from across the institution at cost. The existing maker space provides all institution students with access to training and equipment available for course, research, and private projects. All equipment, maintenance, and training expenses for the maker space are paid by the college. Additionally, both service center and maker space staff provide design consultation to students and researchers throughout the institution. The facility is currently used to enhance a number of existing courses, clubs, and outreach events within the college. This paper presents how the new engineering technology degree program will utilize the existing facility's maker space, what classes it will be incorporated in, and what changes are necessary for the maker space to help provide the program's required level of hands-on experience.

Introduction

Experiential learning has been studied extensively for over 40 years. Burch et al. [1] performed a meta-analysis of studies about the relationship between experiential learning and learning outcomes and found over 13,000 journal articles, conference proceedings, dissertations, and theses on the subject. Of the over 13,000 studies, they were able to find 89 studies that had empirical data and experimental and control groups which they used to perform a meta-analysis.

They found that experiential learning activities generate better learner outcomes compared to the control groups who did not receive the experiential activity. Lee et al. [2] applied experiential learning theory to construction engineering education; they reported students' responses and potential future research. Lancastle et al. [3] implemented a flipped classroom in a module that taught sound integration in video games. They replaced the lecture portion that covered the theory with videos and used class time for practical applications. They asked students to write a technical report discussing the theory related to the assignment. The authors found increased engagement and student satisfaction, but they did not see an increase in student grade averages. They did, however, find that it decreased the number of failing students. Kahangamage and Leung [4] remodeled a second-year mechanical engineering design course to include more active learning methods by shortening lecture periods, incorporating in-class activities, providing additional self-paced learning material, including guest lecturers, and eliminating an end of the semester exam. They found through student pre- and post- surveys that the remodeled class achieved student learning outcomes and were positively viewed by the students. Abdulwahed and Nagy [5] studied the effects of incorporating the Kolb experiential learning cycle in a lab class. They found that including pre- and post-lab tests, virtual labs, and remote labs helped increase student conceptual learning. Taheri et al. [6] studied the effect of incorporating makerspaces into first year project-based courses and found positive impacts on student learning.

This paper presents a plan to utilize an existing manufacturing facility housed in the Statler College of Engineering at West Virginia University for lab courses for a new B.S. program in Engineering Technology to provide relevant experiential learning activities. This program will begin classes in Fall 2023. Four lab courses are planned to be taught in the manufacturing facility, Lane Innovation Hub. They are an introductory manufacturing processes lab, a course that combines CAD software and manufacturing processes, a more advanced manufacturing processes lab, and an electronic circuits lab. The Lane Innovation Hub facilities and equipment as well as the tentative course structure and class considerations are discussed.

Lane Innovation Hub

The Lane Innovation Hub is a facility combining a manufacturing service center and a student focused maker space. The manufacturing service center produces designs of students, faculty, and staff within the institution at cost as well as providing a manufacturing option to individuals outside of the university, including companies and other institutions. The maker space provides students, faculty, and staff with access to manufacturing and prototyping equipment as well as training to support courses, research, and private projects. The Lane Innovation Hub began operating in 2020 and was officially dedicated in November 2021. Equipment available within the maker space includes manual mills, MIG welders, vacuum former, small scale waterjet, laser cutters/engravers, PCB rework system, sheet metal forming equipment, woodworking tools, computer lab focused on providing access to a variety of engineering software, and a fully stocked electronics component wall. Within the service center, there are multiple pieces of industrial manual and CNC machining equipment, including mills and lathes, an industrial scale water jet, 5-axis wire EDM, an array of 3D printers including FDM, SLA, DMLS, MIG and TIG welding, 4'x8' CNC routing table, large format laser cutter/engraver, and PCB fabrication equipment. Lane Innovation Hub staff also provide manufacturing design consulting services in both the service center and the maker space. Currently this facility focuses on enhancing existing courses, clubs, student competition teams, and the entrepreneurial efforts within the university and supporting research projects for the university and outreach events for the college. The new engineering technology degree program plans to use the Lane Innovation Hub as a critical component of the curriculum.

Engineering Technology Degree Program

Recently the West Virginia University Board of Governors has approved a new Bachelor of Science degree program for engineering technology with plans to admit students in Fall 2023. This degree program will feature a core set of required courses in addition to five possible areas of emphasis in which students select two. The core set of classes includes courses from several different areas of engineering including manufacturing, CAD, project management, computer aided analysis, electronic circuits, industrial automation, material science, engineering economics, and technical communication. The five areas of emphasis are: industrial engineering technology, mechanical engineering technology, engineering management and entrepreneurship, energy technology, and multidisciplinary engineering technology. The number of areas of emphasis could potentially grow in the future as the program grows. By offering a core curriculum and letting students choose two areas of emphasis in which they will take 12 credit hours each allows flexibility in the program so that students can select courses that fit their interests and career goals. Many of the courses in the area of emphasis are offered by other departments within the college and other colleges within the university which give students the opportunity to have a broad range of experiences. Additionally, students are required to take three 1 credit hour applied workshops which can be fulfilled in a variety of ways that gives the students meaningful hands-on experiences including participating in competition teams, internships, and completing certifications that would not be normally offered within the curriculum.

Several lab courses are planned to utilize the Lane Innovation Hub in different capacities. These courses include Manufacturing Processes Lab 1 and 2 (ETEC 130L and 330L), Applications of Technology Lab (ETEC 220L) and Electronic Circuits Lab (ETEC 340L). For Manufacturing Processes 1, students will be in the Rapid Prototyping Lab inside the Innovation Hub using equipment including manual mills, manual lathes, welders, a press brake, and a drill press. One goal of the Engineering Technology program is let students have substantial time using industry standard equipment. To meet this goal, the Innovation Hub has purchased two new industrial manual mills, two new industrial manual lathes, a CNC press brake, and an additional multi-process welder. The lab capacity is currently capped at 24 students for a 3-hour lab. Students will be separated into groups of 2. Each group will rotate to two machine-types with each group getting approximately 50 minutes with each machine so 8 students would be in the lab at a time. Topics in lab will be covered for 1 – 3 weeks depending on the complexity of the machines with manual mills and lathes being a larger focus in the course. Other topics covered in the lab include sheet metal fabrication, drilling and tapping, and welding. Stock material will be purchased by the Engineering Technology Program. Tooling and dies will be purchased by the Lane Innovation Hub. Safety will also be a focus in all lab courses where students will be operating equipment. Students will be expected to pass a safety exam before working in the Innovation Hub and to use best operating practices within the Lane Innovation Hub at all times.

ETEC 220L (Applications of Technology Laboratory) is the next course in the plan of study that utilizes the Lane Innovation Hub. This lab and the corresponding lecture course (ETEC 220) will focus on computer integration into manufacturing processes. ETEC 220L will split time between honing SolidWorks skills outside of the Innovation Hub and utilizing manufacturing equipment within the Lane Innovation Hub. Manufacturing equipment planned for use in the class are 2D cutting machines including laser, plasma, and waterjet cutters, FDM & SLA 3D printers, and anodizing equipment. These topics will be covered in 1 – 2 weeks each in the Lane Innovation Hub. The Engineering Technology program will reimburse the Innovation Hub for consumables used by Engineering Technology students during lab. As with ETEC 130L students must pass a safety exam within the course before working in the facility and will be expected to use best operating practices while using manufacturing equipment.

For the Manufacturing Processes 2 Laboratory (ETEC 330L) course, the lab will focus on similar processes and equipment in ETEC 130L but with CNC controlled machines. The topics covered in ETEC 330L include CNC programming, CNC mills, CNC lathes, and CNC press brakes. For these topics, the Lane Innovation Hub plans to utilize a previously mentioned CNC press brake and purchase multiple industrial scale CNC mills and lathes. Each topic will be covered in 2 – 3 weeks depending on the complexity of the topic. Safety also will be emphasized in this course before students are permitted to use the equipment.

Electronic Circuits Lab (ETEC 340L) will be hosted in the Electronics Prototyping Lab within the Lane Innovation Hub. Topics within this course include basic circuits, oscilloscopes, transformers, and diodes. The topics will be covered for 1 – 3 weeks depending on the topic complexity. The Innovation Hub will supply much of the equipment for this course. Consumables will be purchased by the Lane Innovation Hub which will then be reimbursed by the Engineering Technology degree program.

For many of the topics covered in the lab courses, lab time alone will not be enough to have students proficient in using the equipment. Therefore, students will need time outside of lab time to practice and work on assignments. For some equipment guided instruction during lab should be enough training to allow students to work on their own unsupervised. For example, lab time with sheet metal fabrication, MIG welding, 3D printing, and laser cutting in ETEC 130L and 220L respectively should be enough time for students to be able to complete simple assignments without supervision. For these topics students will then be able to enter the Lane Innovation Hub and use that equipment when the Facility is open, and the equipment is available after the students complete necessary Lane Innovation Hub training documentation. For other equipment such as mills and lathes the limited lab time is not enough time for students to be able to run the machines unsupervised. So, in order for students to be able to practice outside of lab time, the engineering technology program will use trained graduate teaching assistants to monitor students working on the equipment during set hours outside of lab time. The Lane Innovation Hub staff are currently not able to use their staff to monitor students who are not fully trained on the manufacturing equipment.

A goal of the engineering technology program is to give students the opportunity to be familiar with common manufacturing and industry used equipment. To do this, the program will need to maximize students' time on the machine while also ensuring that students are adequately trained in order to safely operate the equipment while servicing a class size of up to 24 students. A few potential methods to achieve this include disseminating pertinent Lane Innovation Hub standard operating procedures before scheduled lab, assigning a quiz before lab that covers basic information about the applicable machine including any potential safety concerns, and providing instructional videos that students can watch before, during, and after lab. For students who would like more in depth experience with certain equipment, they could potentially find a certificate program such as NIMS to become certified on a piece of equipment which could then be counted as an applied workshop course (ETEC 370).

Conclusions and Future Work

How the authors plan to incorporate the existing Lane Innovation Hub in Statler College of Engineering at West Virginia University into a new engineering technology program is presented in this paper. Currently four labs are planned to be housed within the Lane Innovation Hub: ETEC 130L, ETEC 220L, ETEC 330L, and ETEC 340L. The equipment housed within the Innovation Hub will allow students to have hands-on experiences with industry grade machinery with the goal of increasing student marketability when searching for jobs post-graduation. Over the next few months, the authors intend to implement the planned lab activities and learning outcomes. Possible future work includes planning more in depth activities in the courses, establishing a formal program advisory board, incorporating additional material to meet student and industry needs into the program, and improving learning outcomes through evidence-based pedagogical approaches and program assessment.

References

[1] G. F. Burch, R. Giambatista, J. H. Batchelor, J. J. Burch, J. D. Hoover and N. A. Heller, "A Meta-Analysis of the Relationship Between Experiential Learning and Learning Outcomes," *Decision Sciences Journal of Innovative Education,* vol. 17, no. 3, 2019.

[2] J. H. Lee, B. G. McCullouch and L. M. Chang, "Macrolevel and microlevel frameworks of experiential learning theory in construction engineering educatio," *Journal of Professional Issues in Engineering Education and Practice,* vol. 134, no. 2, 2008.

[3] S. Lancastle, C. Barlow and L. Davidson, "A Flipped Classroom in Engineering Education - Student Perception and Effect on Learning," in *ICICTE,* 2016.

[4] U. Kahangamage and R. C. Leung, "Remodelling an engineering design subject to enhance students' learning outcomes," *International Journal of Technology and Design Education,* vol. 30, no. 4, 2020.

[5] M. Abdulwahed and Z. K. Nagy, "Applying Kolb's Experiential Learning Cycle for Laboratory Education," *Journal of Engineering Education,* vol. 98, no. 3, 2009.

[6] P. Taheri, P. Robbins and S. Maalej, "Makerspaces in first-year engineering education," *Education Sciences*, vol. 10, no. 1, 2020.