WESTERN CAROLINA UNIVERSITY
DEPARTMENT OF ENGINEERING &TECHNOLOGY
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PROPOSAL FOR AN ECETDHA MINI-GRANT

MOBILE LAB BENCH TO PROMOTE ECET EDUCATION IN SUSTAINABILITY TOPICS

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Abstract
"Demonstration" and "Discussion" are two important learning tools that effectively promote student retention and comprehension as outlined in the famous learning pyramid of the National Training Labs (Figure 1). In a laboratory setting where resources are limited to accommodate all students, these tools together can be the best alternatives next to the "practice doing" tool as shown in Figure 1. In order to incorporate these tools into a laboratory environment, this project aims to implement a portable multipurpose lab bench. Through the usage of this single bench cohesively with introduction of basic theory, improved student engagement and learning enhancement are targeted. Lab assessments and end of course surveys are also designed to assess the learning experience as well as the sustainability of the established mobile lab bench concept.

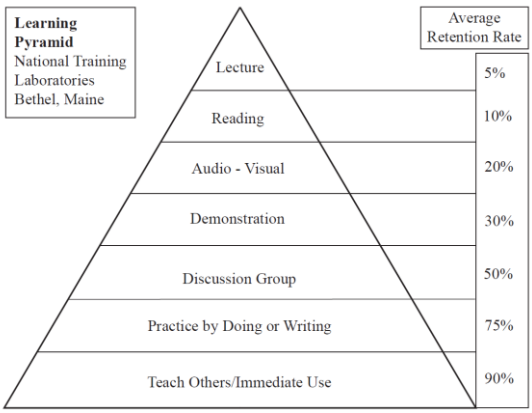

Figure 1. Learning Pyramid[1]

Justification
Growing the demand of electrical energy from sustainable sources requires a skilled workforce that is educated and trained to take the lead on main sub-tasks of generation, transmission & distribution and utilization. In addition, it has been projected that the current power industry will soon be facing a manpower crisis due to attrition within its "soon-to-be-retiring" workforce[1]. The demands of the power industry for a skilled workforce in power engineering disciplines combined with a lack of educational programs that support the power industry suggest the immediate need for the development and

teaching of courses in power engineering[2]. One collaborative effort to fill this gap in skilled workforce is the Consortium of Universities for Sustainable Power (CUSP™) which is currently offered by the research group led by Professor Ned Mohan of the University of Minnesota. This consortium includes universities that have come together to utilize, collectively evolve and promote the curriculum developed at the University of Minnesota – Twin Cities with the help of funding from various organizations including NSF, ONR (Office of Naval Research), NASA and EPRI. Western Carolina University joined this consortium in 2012 to enable the development of a state of the art curriculum in electric power/energy systems.

In the Electrical and Computer Engineering Technology program at Western Carolina University, the Modern Power System Analysis course has been developed and implemented for the past two years under the guidance of CUSP™. One common student survey feedback was to have additional lab equipment associated with this course to improve student learning. However, the inclusion of full-fledged new lab equipment is a difficult task with the currently limited resources for both for the faculty and the department. Therefore, this proposal seeks grant funding for a pilot implementation of a low cost mobile lab bench associated with lab activities that can be used to facilitate both demonstration and discussion mediums.

Project Objective or Goals

The main project objective is to promote electrical and computer engineering technology education in sustainability topics. The sources of sustainable power such as wind and solar systems today primarily utilize power electronics as an enabling technology. Therefore teaching power electronics and associated technology in an engaging manner will eventually serve this objective. The proposed teaching methodology includes a portable lab bench which is capable of performing various lab activities that support the lecture module sequence related to sustainability topics presented in the class. The lab activities are not intended to be exhaustive but simple enough to stimulate student interest in the topic. The activities that are selected from CUSP™ curriculum resources and will be modified and integrated into the mobile lab bench include:

1. Mobile Lab Bench and Power Pole Circuit Board Familiarization
2. Buck Converters
3. Boost Converters
4. Buck-Boost Converters

A short demonstration along with the theory of operation not to exceed 25-30 minutes will be prepared and presented by the instructor to the students during specific lab hours that cover aforementioned four lab activities. The goal of these demonstrations is to engage students in the learning process and initiate productive discussions. In order to facilitate this engagement, the instructor will scope various input and output variables in the lab setup and project them on the screen for easier observation by students. After the demonstration, the student teams will be given the opportunity to examine and review the lab setup to complete the lab assessment activity worksheet.

An evaluation plan will be developed and implemented with the purpose of measuring this project's impact in enhancing student learning and retaining students for careers in sustainable power industry. Part of the plan will include a survey for all students who take the Modern Power System Analysis course in the Department of Engineering and Technology at WCU. This plan will be an addition to the existing institutional evaluations of our project's performance in retaining students and preparing them for entry into either the workplace or graduate school. At the end of the semester, the students will be provided with a survey that assesses the performance of the project through:

1. Student's sense of learning process associated with the mobile lab bench.
2. Student's interest to work in the industry or graduate school related to sustainability.
3. Student's desire to enroll in future courses of similar subject matters.
4. Overall student feedback and suggestions.

The mobile lab bench will include the items for Power Electronics Lab Station, an oscilloscope, a grounding plate, and a utility cart that will serve the entire class of approximately 24 students. A sample lab bench setup can be seen in Figure 2. The lab activities will be tested and prepared for demonstration during the summer of 2016 with a help from a graduate student.

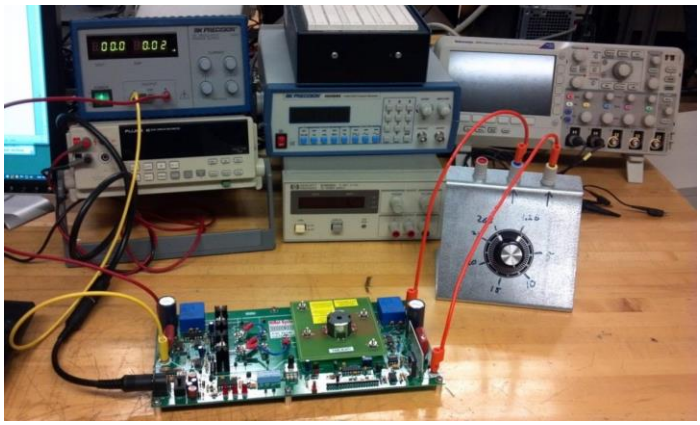

Figure 2. A sample power electronics lab bench setup

The deliverables in the final report to ASEE-ECETDHA at the completion of this project will include:

1. The design of the mobile lab bench.
2. The description of lab demonstration
3. Assessment activities (instructor evaluation of educational outcomes).
4. The survey results (student evaluations).
5. The details of the grant funding usage.

In addition, the findings/results for the first semester will be presented at the Conference for Industry and Education Collaboration and an article that contains two semesters of data will be prepared and submitted to the *Journal of Engineering and Technology*. The design of the test bench will be included in the final report. Other methods of disseminating the results through CUSP™, WCU, and other related professional groups will also be explored. The bench design and laboratory activities will be made available and useful for adaptation by other educational institutions.

Time Line

Development of Survey	Summer 2016
Development of Mobile Lab Bench	Summer 2016
Development of Lab Demonstrations	Summer 2016
Course Offering	Fall 2016
Compilation of Fall 2016 Data	Summer 2017
Submission of CIEC paper	Fall 2017
Compilation of Fall 2017 Data	December 2017
Submission of JET Article	January 2018
Presentation at CIEC	February 2018
Submission of Report	March 2018

References

1. Learning Pyramid, http://www.fitnyc.edu/files/pdfs/CET_Pyramid.pdf, 03/28/2016.
2. Karayaka, H., Adams, R., "An Implementation of Power System Analysis Course for ECET Students," presented in ASEE Annual Conference 2013, Atlanta, GA. Available at www.asee.org.

Budget

As seen on the budget below, the mini-grant will help the institution and the faculty member to fund a commercial utility cart along with shipping and publication fees. Publication fees include CIEC registration/travel expenses and Journal of Engineering Technology publication charges. The additional funds to support a graduate student along with a portion of publication fees will come from WCU Kimmel School operating funds. Graduate student responsibilities include:

1. The design of the mobile laboratory bench which includes the items for Power Electronics Lab Station, an oscilloscope, a grounding plate, and a commercial utility cart.
2. Testing and preparing the lab activities for demonstration during the summer of 2016.

Budget Item:	ECETDHA Funding Amount	Match Amount
Commercial Utility Cart	$165	
Shipping Charges	$35	
Publication Fees	$800	$200
Graduate Student Summer Support		$1800
Total:	$1,000	$2000

Western Carolina University | Kimmel School

28 March 2016

American Society for Engineering Education
ECETDHA Mini-grants Program

The Kimmel School of Construction Management and Technology at Western Carolina University commits to matching funds as a result of the funding received for the ETD Mini-grant, "Mobile Lab Bench to Promote ECET Education in Sustainability Topics".

Matching funds will be provided by the Kimmel School Dean's office. Funding of the proposed ETD mini-grant program will enable the university to continue its commitment to Advanced Manufacturing and Sustainable Energy initiatives in the western North Carolina region.

Western Carolina University and The Kimmel School has the available funding and is committed to the matching funds from this award during and after the award period.

If you have any additional questions feel free to contact me. Regards,

Jeffrey L. Ray, Ph.D., F.ASEE
Professor and Dean
The Kimmel School
Programs in Engineering, Technology, and Construction