

AC 2010-1646: ENGINEERING TECHNOLOGY LABORATORY ENHANCEMENT WITH LABVIEW

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Engineering Technology Laboratory Enhancement with LabVIEW

Abstract

Engineering Technology (ET) is the application of engineering principles and modern technology to help solve or prevent technical problems. The programs are designed to meet the growing need created by the technology revolution for college-educated problem solvers who can support the engineering process. Thus, the ET program is featured with its emphasis on hands-on skills training, to enable ET students to solve production and system implementation problems and help them explain solutions. Therefore, in order to cater to the industry requirements in the job market, the need for updating the educational infrastructure along with technology trend is urgent in the ET program.

In response to the recognition and support of federal agencies to make progress toward a diverse, competitive and globally engaged US workforce of scientists, engineers, technologists and well prepared citizens, as well as to better fulfill its departmental primary purpose to prepare students for a successful professional career in engineering technology and related fields, authors are now collaborating on 4 external grants, including 3 from NSF and 1 from Dept of Education, to propel the curriculum development and laboratory enhancement. And this paper introduces the current progress and following implementation strategies on the undergraduate laboratory enhancement plan.

I. Background

Prairie View A&M University (PVAMU) is the second oldest higher education institution in Texas founded in 1876. During its 130 years history, PVAMU has established its reputation as one of the nation's top producers of African American engineers, and has produced more African American three-star generals than any other HBCU in the country. As a component of Texas A&M University System, PVAMU is also a state-assisted institution by legislative designation, serving a diverse ethnic and socioeconomic population and a land-grant institution by federal statute. As a predominantly undergraduate teaching institution with 6,324 undergraduates, African Americans constitute 92% of undergraduate enrollment at PVAMU.

The Department of Engineering Technology at PVAMU is now offering the Bachelor of Science degree in Electrical Engineering Technology (ELET) program and Computer Engineering Technology (CPET) program. Both programs are accredited nationally by ABET. The total enrollments in both ELET and CPET programs are 141, taking up 15% of the overall 969 undergraduate population in Roy G. Perry College of Engineering. Particularly, black students and female students constitute 93% and 18% of the Engineering Technology department enrollment, respectively.

Due to the aging workforce^{1,2,3}, and emerging techniques⁴, almost four of five companies surveyed are complaining moderate to severe shortages in human resources. On the other hand, many fresh graduates could not fulfill the requirements of industry, which leads to the further deterioration of this situation. To address this concern, a group of faculty members in Engineering Technology at PVAMU are working together with industry partners and federal funding agencies of NSF, Army and Dept of Education to improve the undergraduate teaching, aiming to propel university curricula development to keep up with the pace of technology development, and to enhance the enrollment, retention and graduation rate for the STEM (Science, Technology, Engineering, Mathematics) majors.

Engineering Technology (ET) is defined by American Society for Engineering Education (ASEE) as “the profession in which knowledge of mathematics and natural sciences gained by higher education, experience, and practice is devoted primarily to the implementation and extension of existing technology for the benefit of humanity”. The particular feature requires ET graduates to be more skillful in hands-on. In ET undergraduate curricula at PVAMU, each major technical lecture course with three-hour is accompanied by a one-hour laboratory course. Through physical experiments in the lab, students can achieve better understandings of theories in lecture courses, and gain experience in real world applications. In order to achieve a sustainable improvement of laboratory facilities in alignment with current technologies, faculties need to establish an effective collaboration with industry and funding agencies to seek external resources in education enhancement. Especially, Electrical and Computer technology has experienced significant developments in the past several decades. Among tremendous emerging IT products, faculties have to be able to select the right products which are useful in the improvement of student learning as well as faculty teaching.

II. Graphical Programming Tool

Two authors received Army Research Office Grant #W911NF06-1-0507 in 2006, to conduct state-of-the-art research on dynamic system control. Through the real-time control facilities driven by LabVIEW and dSPACE, authors realized the significant convenience provided by graphical development tools. And by leveraging on the research achievement, it led to several education grants to expand its benefit in undergraduate teaching.

Graphical programming has been proved to be very effective in facilitating student learning. For example, LabVIEW, provided by NI (National Instruments), has been widely utilized in both industry and academia. Its tremendous customers include 24,000 companies and 5,000 laboratories in worldwide. Targeted for the educational market, NI provides a design and prototyping platform called ELVIS (Educational Laboratory Virtual Instrumentation Suite). With such a multi-functional platform, as well as many third-party compatible products, the same platform can be used in a wide variety of subjects including circuit, electronics, digital logic, network analysis, digital hardware, robotics, control, microcontroller, mixed-signal, DSP, etc.

Based on the consistent hardware platform of ELVIS and software environment of LabVIEW, a sequence of lab courses in both CPET and ELET programs can be developed, from freshmen, sophomore level courses, all the way to junior and senior level courses. And these following projects are all centered on this idea.

NSF CCLI Phase II with Grant #0717854, October 1, 2007—September 30, 2011. The Smart Vibration Platform (SVP) is utilized to teach engineering dynamics concepts such as damping and stiffness. As a touchable and drivable device, it is a very useful tool in the teaching of robotics and control.

Title III, October 1, 2007—September 30, 2012. This project is to initiate two undergraduate teaching laboratories including Mixed Signal Systems Lab and DSP Solutions Lab. Also, an Engineering Technology Advanced Research Laboratory will be established in the ET Department to enhance the faculty body's research capability.

NSF HBCU-UP with Grant #0714885, September 15, 2008—August 31, 2010. This project is to revamp the current ET undergraduate lab courses with LabVIEW, aiming to improve the delivery of laboratory and corresponding lecture contents, deepening student understanding of the abstract concepts through physical implementation, enhancing their comprehensive skills from theory to practice, inspiring their interests in STEM subjects, and strengthening their marketability upon graduation.

NSF CCLI with Grant #0942807, January 1, 2010—December 31, 2011. Based on the previous work, this collaborative project is to develop a virtual, remote accessible, scalable, and shared web-based laboratory experiment framework. Based on this framework, several virtual and remote laboratories (VR-Labs) will be developed and utilized to improve the student learning as well as to promote inter-institutional collaboration in sharing VR-Lab courseware.

III. Project Activities

1. Facilities Upgrade

AC/DC Lab: Sponsored by NSF Grant #0714885, 10-training stations were purchased with the budget of \$38,000. Each station includes one DELL computer, one ELVIS, and LabVIEW software.

Mixed Signal Lab, DSP Lab: Sponsored by Title III Grant, each lab was equipped with 12-training stations, where each station includes one DELL computer with LabVIEW, one ELVIS, one NI Speed-33 DSP. Other equipments include Agilent logic analyzer/signal generator/pulse pattern generator, etc.

Advanced Control Lab: Sponsored by US Army Research Office Grant #W911NF-06-1-0507, \$200,000 were utilized to purchase advanced experiment facilities. In addition, National Instruments provided a \$24,000 cost-sharing donation. Major equipments include dSPACE DSP, NI cRIO FPGA, Quanser 2D/3D helicopter/coupling tank, ECP torsion plant/gyro/rectilinear plant, Motorsoft motor kit, etc.

The enhanced facilities greatly improved instructor teaching, and benefited student learning in a state-of-the-art environment.



Fig.1A. AC/DC Lab



Fig.1B. DSP Lab

2. Faculty Workshop

To engage more faculties in educational innovations, faculty workshop was organized in Aug 19–21, 2009. Four faculties (other than project PIs), including one from nearby institution, received the training for LabVIEW and ELVIS. The faculty workshop promoted the inter-institutional collaboration in two HBCUs, helpful to establish a scholar community in Houston area who are interested in improving undergraduate teaching by utilizing LabVIEW and related technologies.



Fig.2A. Presentation



Fig.2B. Discussion

3. Industry Workshop / Roadshow

Except for cost-sharing equipment donation, industry partners like NI and Quanser are very much active in organizing training workshops / road show / seminar, to secure its leadership in graphical programming market. Through such interactive events, students not only received training, but also established their confidence and curiosity in exploring the latest technologies.



Fig.2A. LabVIEW training workshop



Fig.2B. Quanser roadshow

4. Student Symposium / Project Competition

Except for courseware renovation, students are also encouraged to involve in extra-curriculum events. Fig. 3A is about campus research symposium, student is introducing their online remote laboratory development to the faculty referee. Fig. 3B is the vibration control project competition held in ASCE Earth & Space Conference, Honolulu, HI, Mar 14-17, 2010, in which one group of two minority students (Romie Phelps and Emmanuel Ekong) from PVAMU won the third place award.

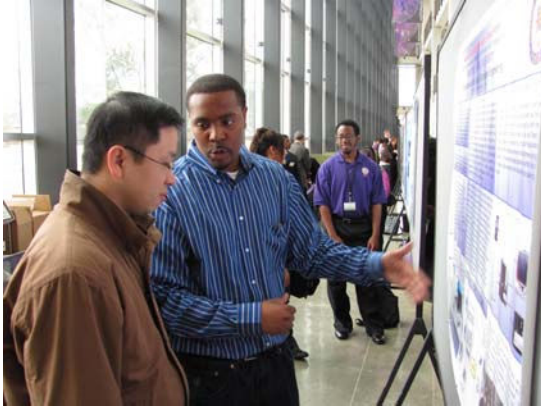


Fig.3A. Student Symposium



Fig.3B. Project Competition

5. Outreach / Dissemination

Project achievements are disseminated through open house, conference, publications, etc, to expose the projects in education community, and to attract more students involved in STEM majors. Fig. 4A is the project exposure to Lone Star College, to attract more two-year college students to continue their undergraduate study at PVAMU. Fig. 4B is the conference discussion with other faculties to exchange ideas, to establish connections, and to seek a sustainable success in professional development.



Fig.4A. Open House



Fig.4B. Professional Conference

IV. Conclusions

Sponsored by federal research agencies including NSF, Army and Dept of Education, a series of pipelined laboratories including both equipment and courseware have been revamped, and these changes achieved great responses among students. In order to achieve a sustainable success for the ET department in seeking external resources to further enhance its teaching and research, it is critical to engage more faculties in the revamping plan, such that the latest facilities can be further utilized in the other related courses, as well as to provide a leverage for the other faculties to achieve their success in professional developments.

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Bibliography

1. Industries Studies 2000 Report, Industrial College of the Armed Forces (ICAF), National Defense University.
2. Industries Studies 2003 Report, Industrial College of the Armed Forces (ICAF), National Defense University.
3. Industries Studies 2006 Report, Industrial College of the Armed Forces (ICAF), National Defense University.
4. Industries Studies 2001 Report, Industrial College of the Armed Forces (ICAF), National Defense University.