Penn State Surveying Programs

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Abstract

In 2010, the faculty in the Surveying Engineering program conducted an extensive review of the courses offered in the program due to advances in surveying technology. At that time it was decided to expand some courses, combine others, and add new courses to the curricula. Additionally at this time it was decided to expand and replace instrumentation available for use in the classes and purchase a terrestrial laser scanner. This paper discusses the changes to the programs including new courses being offered, integration of new equipment into the curricula, and the creation of video lessons designed for student use with smart phones.

Introduction

In 1957 Penn State admitted its first students in the associate degree program in Surveying Technology. This program first received ECPD (ABET-TAC[1]) accreditation in 1962. In 2011 the name of this program was changed to Surveying Engineering Technology, still maintaining the same ABET-ETAC (formerly ABET-TAC) accreditation.

In 1994 Penn State admitted its first freshman class into the baccalaureate program. It produced its first graduates in 1996, and received ABET-RAC accreditation the following year. In 2003 the baccalaureate program name was changed to Surveying Engineering with a purpose of seeking ABET-EAC accreditation, which it received in 2005. Both the associate Surveying Engineering Technology and baccalaureate Surveying Engineering programs are currently offered. Thus Penn State has a history of over 57 years in surveying education. The programs have evolved over the years to meet student, industry, and societal needs. This paper discusses the programmatic changes over the past four to five years.

Recruiting and Enrollment

Penn State has two surveying programs comprising an associate degree in Surveying Engineering Technology and a baccalaureate degree in Surveying Engineering with an

[1] Information on ABET accreditation is available at http://www.abet.org.

average, combined enrollment between 60 and 70 students. Of these 18 are first-year students, 23 are second-year students, 5 are juniors, and 14 are seniors. Of these only 4 first-year students are enrolled in the associate degree program, which implies growth in the upcoming years.

In 2010, Penn State released a self-study on all programs at all campuses throughout the system. The self-study committee recommended that the Wilkes-Barre campus of Penn State put more emphasis and focus on recruiting for the Surveying Engineering since it is a unique program in the Commonwealth of Pennsylvania. In the Spring of 2012 the Admissions Office added a program-specific open house among its recruiting efforts. In the fall semester, faculty members of the program are involved in an Engineering Open House, which also highlights the surveying programs.

In the Spring of 2013 with Pennsylvania Society of Land Surveyors support, the campus held its first regional NSPS Trig-Star competition for high school students. The program announcement to high schools was provided in April, which as too late for many schools. However, 3 high schools brought 28 students to the all-day event. The attendees were given the exam, which was then reviewed and followed by a presentation on how trigonometry is used in surveying to create a global coordinate system. In the afternoon, the attendees competed in a mapping competition involving 5 separate teams, surveying engineering students, total stations, and a protractor and engineer's scale. The members of the teams were given separate tasks, which included taking and recording field notes, reducing slope distances to horizontal distances, and creating a map on an 11 by 17 in. paper with border and title block. They had 30 min to complete a map of the atrium of the building with the members of the team producing the best map given prizes at the end of the day. The students seemingly enjoyed this exercise since several asked for more time to complete their map.

The 3 highest scores from the Trig-Star event were given plaques signifying their achievements. The school with the student having the highest score received a large trophy, which they can display until next year when it will be returned. Both the teachers and the students indicated that they enjoyed the day and looked forward to next year's event.

The admission team will be distributing posters announcing the event next year's May 9th event as they visit the surrounding high schools next fall. By doing this early it is hoped that more schools will participate in the event, and thus expose more potential students to surveying.

Eventually, it is hoped to extend this program to other campuses that offering Engineering curriculums in the Penn State system.

While it is still too early to see the results of this additional recruiting emphasis, one change did occur in 2012 freshman class. Traditionally, the freshman class has 1 or 2 students interested in our concurrent-degree program with Civil Engineering at the University Park campus. This past freshman class has six students interested in both degrees.

Changes to Curricula

The introductory Plane Surveying course offered in the first semester of the surveying programs at Penn State was always an intensive and demanding course for incoming freshman. While the design of this course may have been acceptable to a third-year college student, it did not allow the time necessary to help a student new to college. Thus it was decided to add one more credit to the course to provide more time to review and demonstrate assigned problems in the course. The change in credits occurred during the fall 2012 semester. In its first implementation, the success rate in the class (passing the course with a grade of C or better) was 15 out of 16 or 94%. Past typical success rates have ranged from 60% to 85%. It is too soon to say for certain that this change has a significant impact, however, the first year results look very promising.

Figure 1 QR code to conventional instrumentation videos.

As anyone who has taught an introductory field practicum in surveying knows, there is seldom time to answer all the questions that occur in the field when student lab groups are separated by distance. Additionally, often the same questions come up when an instructor does reach the students in the field. To help alleviate this problem, very short video lessons (< 5 min) were created demonstrating solutions to some of the common problems that students experience. A QR code was then placed on the instruments that allow students to view these videos using their smart phones. Topics in these videos include leveling an instrument, removing parallax,

reading a differential leveling rod, the differential leveling process, precise leveling, centering an instrument over a point, turning an angle, creating a project in TopSurv™, editing points and layers, using the setup menu, and performing a traverse survey. Each of these videos has an animated PowerPoint lesson that instructors can access at http://www.personal.psu.edu/cdg3 for use in their lectures. This provides students with two methods of learning these field topics, which are typically part of an instructor's demonstration. This entire package will first be implemented in the Plane Surveying course starting in the fall of 2013. It counterpart with GNSS equipment and software was implemented in the precise positioning course in the spring of 2012. Students have since used these videos in independent studies and in the Integrated Surveying course where students perform a GNSS control survey.

In the original design of the surveying curricula, the programs had two construction-related courses. The first, a three-credit course entitled Curve Geometry, taught computations and layout of alignment curves. This course was taken in the second semester. The other course entitled Construction Surveying Applications dealt with the layout of structures. This was a required course in the associate degree program and an elective in the baccalaureate degree program. By their design, a baccalaureate degree-seeking student, who took the Construction Surveying Applications course, ended up needing one credit to meet the requirements for graduation. It was decided to combine these two courses into a single, four-credit course called Route and Construction Surveying. This removed one credit from the overall curricula, and additionally some of the overlap that was inherent in the previous two courses. In addition, the combined course provided the necessary knowledge in staking out structures to students in both programs.

Additionally two, two-credit elective courses in the baccalaureate program, Drainage Design and Stormwater Management were combined into a single four-credit course titled more generally as Stormwater Hydraulics and Hydrology. The new course is required course for the baccalaureate students. Surveyors may perform storm water management surveys and sedimentation and erosion control surveys in Pennsylvania.

The Penn State Surveying programs are reviewed on a regular basis by our Industrial Advisory Committee (IAC). Comments from this committee included the observation that our students did not have any instruction in engineering economics, particularly since it is one of the question categories on the fundamentals of surveying (FS) exam for state licensure. Therefore, a

new required course Engineering Economics was added to the curriculum. Some other minor changes were in course names. The Practical Field Problems course was renamed Integrated Surveying. The Multipurpose Land Information Systems course was renamed Introduction to Geographic Information Engineering. Content of neither course was changed significantly.

New required courses were also added to the Surveying Engineering program. These included *Precise Positioning Systems*, *Parcel-Based Geospatial Information Systems*, and *Digital Photogrammetry*. These were added to the curriculum to replace what was a broad-based technical elective list. This alleviated a problem of under-enrolled elective courses in the last semesters of the program. The Precise Positioning Systems course covers the theory and procedures behind GNSS surveys. This course was an elective course in the previous curriculum that almost all students selected. The Parcel-Based Information System course is designed to address land management issues for sustainable development. It is based on the premise that land and related resources are finite in extent.

The digital photogrammetry course is designed to provide a deeper understanding of the mathematical principles of digital aerial photogrammetry as well as current applications of photogrammetric products. In recognition of the increasing use of digital images in geospatial technologies, especially in applications involving natural resource inventory and mapping, this course provides advanced knowledge in softcopy photogrammetry.

Equipment and Software Changes

In 2010 the program had ten working total station instruments, eight auto levels, a digital, and a precise automatic level with accompanying rods, eight GNSS receivers, and 21 survey controllers from different manufacturers. Students also had access to the Civil3D drafting software, Topcon Tools to process GNSS data, Leica Geosystems for digital photogrammetry, and ESRI's ArcGIS for a GIS platform. Besides these software packages, students used Microsoft Word, Excel, Mathcad, and PowerPoint extensively along with WolfPack, Stats, Matrix, and Adjust, which came with their text books.

Two of the total stations were purchased in 1989. While still functional, these instruments were far from their modern counterparts. It was decided to replace these instruments with new models but save them as backup when another was sent for repairs. The program had access to several survey controllers, included in this were four Carlson Explorers, two Topcon FC100 and

two FC200s, four TDS Rangers, and nine TDS recons. Courses using conventional instruments used TDS Recons in their classes while courses using GNSS receivers used a combination of Topcon controllers, TDS recons, and TDS Rangers. While the students were exposed to several software packages, the instructors and the students were never fully versed in anyone package. Thus students were always being confronted with different software in the field. It was decided to standardize controllers to one system. Since the Topcon GNSS receivers integrated best with Topcon controllers, it was decided to standardize on this controller. Thus eight new Topcon controllers (four FC2200s and four FC2500s) were purchased over a two-year time frame. This means that students will be trained in their first class on the use of these controllers for conventional surveys, and this knowledge will transfer into GNSS surveys. Unfortunately, these new controllers did not support two of our Nikon total stations thus forcing us to find a working solution to the problem or replace the Nikon instruments.

Figure 2 QR code to GNSS videos.

With a common survey controller for GNSS surveys, very short video lessons on the use of GNSS hardware and software in the field were also developed. Like the videos developed for conventional instrumentation, these video lessons were accessible using a smart phone through a QR code, which was placed on the instruments and their cases. Included in these video lessons are Hiper Lite+ familiarization, GR-3 familiarization, performing a static survey, and seven videos to support RTK surveys. These videos include starting your base, checking your receiver settings, starting your roving receiver, using the Topo option, using the Auto Topo option, using the Tape Dim option, and localizing the survey.

In 2011, the program purchased a Topcon GLS1500 terrestrial laser scanner. Included with the hardware was a software package to manipulate the point clouds, and two days of training with the hardware and software. In the 2012 – 2013 school year, this hardware and software was used by seniors in the program in an independent study. A special topics course is being planned

for the 2013-2014 school year. After this, the special topics course will be proposed as a new elective course in the curriculum.

Changes to Outcome Assessment for ABET Review

Following the last general review of the SUR E program in October 2005 program faculty developed a new outcome assessment for the interim report in 2009. The assessment was continued in preparation for successful general reviews of both the SUR E and SUR ET programs in 2012.

For the 2005 review, the program used a list of 24 program outcomes. Since ABET EAC requires that ABET outcomes “a” to “k” and all program outcomes be assessed, the programs adopted student outcomes of EAC for the SUR E program and student outcomes of ETAC for the SUR ET Program. The assessment of the degree to which the SUR E Program meets student outcomes is described here; the assessment for the SUR ET Program is essentially the same, only the specific outcomes are different.

The program assesses the extent to which EAC student outcomes "a" to "k" are met using a procedure adapted from material in the ABET manual "Faculty Workshop on Assessing Outcomes” prepared by and used in conjunction with a workshop presented by Gloria Rogers, Ph.D., Associate Executive Director, Professional Services, ABET. Dr. Parks participated in this workshop.

Assessments of the degree to which the program has attained EAC student outcomes "a" to "k" are made by outcome, defined by the procedure as "a statement that describe what students are expected to know and able to do by the time of graduation (Workshop Manual)." The assessment of a specific outcome uses material from strategies, defined as the collection of required courses or other organized program activities that can be used to assess the attainment of an outcome. Performance criteria for an outcome are those specific actions that students do that indicate that they have satisfactorily learned the subject content described by the outcome. The assessment method is the specific activity (e.g. exam question, project report or student survey question) on which student performance can be measured. Grading criteria are the specific ways student performance is measured.

Following assessment of student performance on performance criteria linked to a student outcome results are evaluated. The mean (overall or a sample of students) grade of performance is reported normalized, as a percentage. The evaluation of performance on the criterion is by the following rubric designed to reflect a working surveyor's ability: ≥ 90% = Expert, 80 - 89% = Very competent, 70 - 79% = Competent and < 70% = Less than competent.

The assessment of the degree to which the student outcome is met involves reporting the performance evaluation for all criteria linked to the outcome considered separately and pooled. Where the score for any grading criterion of any assessment method is less than 70% the faculty member delivering course that is among the strategies by which the outcome is assessed comments on his interpretation of this result and suggests actions to improve the score when the course is used in the future to assess the outcome.

The Faculty Curriculum Committee reviews the outcome assessment and any instructors' comments and recommends any changes to courses or assessment plan. The Surveying Industrial Advisory Committee then reviews the assessment, any instructor comments, and Curriculum Committee recommendations and either endorses these or makes its own recommendations. Finally faculty members delivering courses used to assess the outcome review the complete assessment and declare their intended actions with respect to the recommendations.

The final assessment of the degree to which an EAC student outcome is met is made using a rubric relating the pooled performance evaluation for that outcome and dictating any action suggested by the result of assessment. The rubric assesses the level of achievement of the outcome, as indicated by the assessment score pooled over all criteria, as outstanding, very good, acceptable, or unacceptable. For each level the rubric suggests specific actions to be taken (e.g. improvements to courses) to improve the level of achievement in future assessments.

The Penn State SUR E and SUR ET programs intend to assess the extent to which each of the 11 EAC student outcomes "a" to "k" are met every three years or twice during the period between consecutive ABET general reviews.

Summary and Conclusions

The Penn State surveying programs have four full-time faculty members and one part-time faculty member. Total enrollment over the past five years has been consistently between 60 and

70 students. Recruitment efforts continue to reach out to prospective high school and non-traditional students through open house activities and recently the Trig-Star activity. The program has continued to update the equipment to meet the demands and expectations of the modern professionals. Given Penn State's 57 year tradition in surveying education, our faculty believe that the outlook for the future remains solid and looks forward to supporting the advancement of the surveying profession.

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