NSF Funded PHOTON-2 project and course development in photonics

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Abstract: In the recent years, optical electronics and lasers have been vastly employed in various realms of the electronics industry such as bioengineering, communication, CNC and routing in cheap designs. While optics has become a vital part of electronics, it has unfortunately been absent in most four-year college/university engineering technology programs. The Electronic and Computer Engineering Technology (ECET) program at California State Polytechnic University - Pomona has recognized this deficiency and in order to help alleviate this problem has joined the NSF funded PHOTON-2 project. The PHOTON-2 project is a New England Board of Higher Education (NBHE) sponsored program. By working closely with the NBHE, we developed a senior level photonic course using modified PHOTON-2 materials and laboratory experiments. This course also uses discounted optical and laser parts and equipment supplied by the NBHE. This paper tends to show how the NSF funded PHOTON-2 project helped the ECET program, at California State Polytechnic University – Pomona, develop its photonic course.

Introduction: In order to stay current with the industry, produce a knowledgeable workforce, and respond to industry needs, Electronic Engineering and Engineering Technology departments need to continuously update their curriculum. Optics is one of the areas to which engineering schools need to pay more attention. In the last decade, optics and its applications have become an integral part of almost every facet of the electronics industry such as medical, communication, heavy industry, lighting, and routing in cheap design.

Optical Company in the Southern California: Many optics related companies, that produce a wide range of optical systems and accessories, are located in southern California (1). These companies produce everything from Lasers, tunable lasers, diode lasers, to spectroscopy, sensor, motion control, telescope, High Speed Camera, visible, and UV, IR optics. These companies range from large to small and include many established industry names such as Newport, Opteck, Photron, Micro Laser Systems, Asahi, Lambda Research, and Meade. Most of them employ tens to hundreds of technical people and it can be assumed that their future employees will be graduates of southern California Engineering and Engineering Technology schools.

Engineering Schools in Southern California and Optic related courses: A majority of Engineering and Engineering Technology students attend California State Universities. In Southern California, Cal-State Los Angeles, Long Beach, Fullerton, Northridge, San Diego, and CalPoly-Pomona offer Engineering programs. CalPoly Pomona is the only California State University that offers an Engineering Technology program in Electronics and Computer. The remaining California State Universities either do not offer optics or optical related course or they offer these courses as an option from 15-20 technical elective courses; this results in the optics or optical related course not being offered on a regular basis (2). Table (1) shows the optical related courses available in the engineering

programs at several southern California State Universities.

Table (1)

Institution	**Optics and related courses**
Cal-State L.A.	One course (Fiber Optics), Elective
Cal-State Fullerton	Two courses (Eng. Optics and Electro-Optics Systems), both elective
Cal-State Northridge	None
Ca-State San Diego	Two courses (Electro-Optics and Optical Fiber Communications) both elective
Cal-State Long Beach	None
CalPoly-Pomona	Two courses (Laser and Optical Fiber Communications) both elective

Research and Findings: The research we conducted showed that the ratio of courses offering in optics by Southern California State universities is at the lowest level possible while the demand from the optical industry in the area is continuously rising. To respond to this deficiency, the Electronics and Computer Engineering Technology program at CalPoly Pomona developed a plan to add a four unit (three unit lecture and one unit laboratory) optics course to its curriculum. This course would cover geometric optics, fiber optics, and optical communication. The inception plan for this course had two stages: 1) Search for funding/donation of laboratory equipment, develop an elective course, and offer the elective course once year. 2) Establish relationships with the local optics industry, get their feedback, revise course based on feedback and change the optics course from an elective to a core course. The end result of the first stage of our research and study was joining the NSF funded PHOTON2 as a Southern California Alliance.

NSF Funded PHOTON2: PHOTON2 is a New England Board of Higher Education (NEBHE) project. The "NEBHE was founded in 1955, when six visionary New England governors – realizing that the future prosperity of New England rested on higher education – committed their states to the shared pursuit of academic excellence. Soon thereafter, NEBHE was approved by New England's six state legislatures and authorized by the U.S. Congress" and the mission of the "NEBHE [is to promote] greater educational opportunities and services for the residents of New England" (3). The NEBHE was granted a three-year fund from the Advanced Technological Education (ATE) program of the National Science Foundation (NSF) for their PHOTON2 project. In the PHOTON2 project, "educators from several geographic locations (four to six regions nationally) are brought together to facilitate photonics technology education at their institutions that is intelligently developed and seamlessly articulated. The 'Alliances' consist of four to six participants per region, including high school and two- and four-year college science, technology, engineering, and math instructors, as well as their institution's career and admissions counselors." (4)

In August of 2004, the Electronic and Computer Engineering Technology (ECET) program at CalPoly University Pomona approached the NEBHE and requested approval for the creation of a Southern California "Alliance" of the PHOTON2 project. Upon the approval of our request by Senior Director of Program, Principal Investigator, Mrs. Fenna Hanes and Co-Principal Investigator, Mrs. Judith Donnelly, CalPoly Pomona hosted a two day PHOTON2 hands-on seminar/workshop. Local high school science teachers, community college professors along with some members of the other alliances were among the attendees of this seminar/workshop. For each institution of the alliance, the PHOTON2 project was able to provide a complete set of curriculum material and a optics laboratory kit at a 50% reduced rate. The laboratory kit consists of various types of lenses, optical filters, lasers, light sources, light detectors, as well as a variety of accessories. ECET purchased five laboratory kits to use in an optics course of 24 students.

The alliance with the PHOTON2 project helped the ECET department accomplish the first stage of plans to have enough optical equipment to offer a course in optics.

Course outline: The PHOTON2 topics in optics did not completely match the course outline that ECET program created. The curriculum materials from PHOTON2 covered the following topics: Laser safety overview, the nature of light, geometric optics, lenses and mirrors, waves: interference and diffraction, polarization, optical instruments, introduction to laser physics and characteristics, lasers and materials processing, introduction to fiber optics, and holography. We adopted all the above topics except the laser safety and holography. We also added two additional topics: optical sensors and optical communications topics

Laboratory Experiments: Out of the twenty laboratory experiments created by the PHOTON2 project, we adopted the following six experiments: Snell's law, lens-makers formula, systems of two lenses, Guassian beam profile of a laser beam, laser bar code scanner, and numerical aperture of an optical fiber. To complete the ECET plan for laboratory experiments, we added two more experiments on optical sensors and communication. In order to satisfy TAC-ABET criteria "g" which states students must have the "ability to communicate effectively," the course plans also include a group project where students are asked to create a team of three, write a term paper on the recent developments in optics and its applications, and present it to the entire class.

Optics course and TAC-ABET's A-K criteria: The new optic course in the ECET program satisfies the following TAC-ABET criteria: a, b, c, d, e, f, g, h, and k.

Conclusion: The year and a half plan to establish a new course in optics and optical communications that was successfully accomplished with the help of the PHOTON2 project. We have been able to offer this course twice in last six quarters. One of our goals was to create a course that would help produce a knowledgeable technical workforce for local optical companies. Many optical companies in southern California are looking for graduates who have some knowledge in optics and laser and those ECET graduates who took this photonic course have since found gainful employment. This effort was deemed a success when it reached its goal of helping match its graduates with local optical companies.

References:

1. See following web sites for optical companies in the Southern California
2. See following web sites for Electronic/Electrical Engineering program at California State Universities
3. See the official web site of NEBHE
4. See the official web site of PHOTON2 Project