Outreach Activities to Enlist High School Students for Electro-Optics Technician Programs at Indiana University of Pennsylvania, Northpointe Two-Year Campus

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IUP

OP-TEC
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Foreword

The shortage of photonics technicians in the U.S. poses an impediment to our national security and an important sector of our economy. In 2009 U.S. employers need over 2100 new photonics techs; our colleges will produce fewer than 300 program completers. And many highly rewarding jobs are going unfilled while capable young people search for careers they are not fully aware of, or do not believe that they can compete for. The best way to make potential students aware of the science underlying the field of photonics, as well as the opportunities and career fulfillment that await those who pursue the field, is to provide hands-on experiences for high school teachers, guidance counselors, parents, and students at community and technical colleges.

Most of the 30+ U.S. colleges that offer technician programs in photonics and related technologies need more "qualified" students to enroll in and complete their programs. These students should be knowledgeable of the field, interested in technician careers in photonics, and math-ready (proficient in high school algebra, geometry, and trigonometry). The most promising source of students is recent high school graduates. This monograph describes successful strategies for increasing student enrollment by "building the high school pipeline." Feng Zhou describes activities that he has developed and tested at IUP. If you are interested in adopting some of these practices, I encourage you to contact him at fzhou@iup.edu or the OP-TEC office at www.op-tec.org.

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OUTREACH ACTIVITIES TO ENLIST HIGH SCHOOL STUDENTS FOR ELECTRO-OPTICS TECHNICIAN PROGRAMS AT INDIANA UNIVERSITY OF PENNSYLVANIA, NORTHPOINTE TWO-YEAR CAMPUS

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ABSTRACT: This paper describes the basic formats of four outreach activities for the newly established electro-optics (EO) program at Indiana University of Pennsylvania (IUP). As the only program, to the author's knowledge, that offers both associate and bachelor's degrees in EO, it has successfully implemented a 2+2+2 initiative that enables a wide range of students to enter the rapidly evolving EO workforce. To sustain the program's growth, a series of outreach activities has been offered to create a broad awareness of EO engineering in the community. A multi-dimensional approach has been carried out to achieve short- and long-term outreach strategies. Students, teachers, and parents are informed of educational and career opportunities in EO engineering. The outreach activities have exposed participants to the excitement of EO engineering through tours of on-campus labs and local EO engineering companies and research organizations. In addition, students undergo a valuable learning process through the On-Campus EO Experience and EO Summer Camp, both of which provide opportunities for interaction with college faculty and staff, students enrolled in the program, and local EO professionals.

I. Introduction

In 2002, Indiana University of Pennsylvania (IUP) launched an innovative education program in electro-optics (EO) that offers options for both associate degrees and bachelor's degrees [1, 2]. This paper describes extensive, multi-dimensional outreach activities that have attracted students to the EO program [3–6]. Outreach is a powerful tool for introducing students to the excitement and challenges of this emerging high-tech field, and to the field's career and educational opportunities. More important, outreach helps students to identify their interests and gain the confidence necessary to pursue those interests. Also, student retention is higher when students have the information necessary to make informed career choices.

II. Outreach Efforts

The outreach activities—which involve components such as hands-on experiences; interaction with faculty, staff, alumni, and students already enrolled in the program; on- and off-campus field trips; and social activities—are designed to target four groups: students, teachers, guidance counselors, and parents. As shown in Figure 1, 4233 local students were reached between fall 2005 and summer 2008. On average, the outreach activities had a direct impact on over 1000 students every year. Table 1 provides the outreach breakdown by

activity during the 2006–2007 school year. Activities have included classroom presentations, the On-Campus EO Experience, career fairs, parent information sessions, the EO Summer Camp, and other outreach activities. The basic formats of the activities are described in sections A–E.

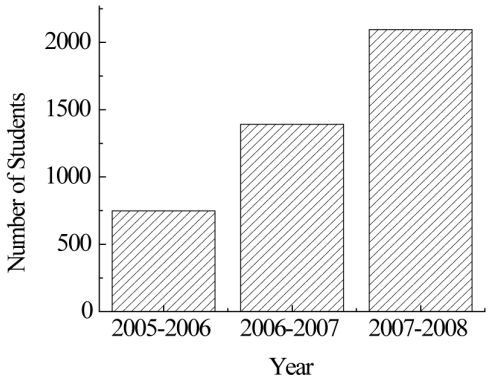

Figure 1. Total number of students who attended outreach activities between fall 2005 and summer 2008

Table 1. Outreach Breakdown by Activity in 2006–2007

Outreach Activities	Students Attended
On-Campus EO Experience	147
Classroom presentations	709
High school career days	403
"Starry Night" (astronomy night)	15
IUP Science Festival	60
EO Summer Camp	27
Total number of students reached	1361

A. Classroom Presentations

Classroom presentations provide an opportunity to speak to relatively large numbers of students in their sophomore and junior years. These presentations are arranged through contacts at the schools, typically through physics or math instructors or guidance counselors. Presentation style and format depend on the time allotted, which can vary from a few minutes to an hour.

A typical presentation includes overviews of EO engineering, potential career paths, and the educational opportunities at IUP, along with hands-on activities and demonstrations. The following topics are covered:

- What is electro-optics?
- Careers and job outlook
- Hands-on optics activities
- 2+2+2 EO program at IUP

Classroom presentations increase awareness of EO's underlying science. The presentations typically include information on how EO is applied in industry, along with information on

job opportunities and salaries. Devices from daily life such as remote controls, DVD players, and digital cameras are used to illustrate the wide range of applications in EO engineering. Students learn about the technologies encompassed by EO—lasers, holograms, night vision and thermal imaging, and optical communication, to name a few. Students also learn about EO through hands-on activities that promote experimental education. These might include a "magic stripe" kit, which has a basic polariscope that allows students to view the stress and strain of various transparent objects through crossed polarizers; a "magic patch" kit, which incorporates a thin liquid crystal film with good sensitivity at low temperatures; diffraction-grating glasses; night-vision scopes; and "optical take-home theme packets" [7]. These materials help to enhance students' understanding of EO at a variety of age levels. For example, the "magic patch" enables students to observe thermal-optical effects and gain an understanding of how liquid crystals are used in electro-optical devices such as calculators and flat-panel displays. Diffraction-grating glasses are also distributed to students so they can view the diffraction of light and measure the grating spacing using laser pointers.

Because many appealing and challenging EO careers are open to today's young people, emphasis is placed on the importance and benefits that EO brings to quality of life and economic prosperity. A simple survey is conducted at the end of each presentation. From the surveys, the names of students who indicate an interest in the EO program and would like to know more about the program are collected for the On-Campus EO Experience.

B. The On-Campus EO Experience

Students who express interest in the EO program are invited to an On-Campus EO Experience that runs from 9 A.M. to noon. This activity accommodates 30–40 high school sophomores, juniors, and seniors, who may come from different schools. Student transportation is provided through funding from the Pennsylvania Department of Community and Economic Development (PA DCED).

Following a short introduction, the students are divided into two groups. One group tours the labs and engages in hands-on lab activities with two instructors, a lab technician, and students already enrolled in the program. The students in this group participate in activities that demonstrate processes and devices such as diffraction and the measurement of human hair diameter, the splicing of fiber optic ends, lasers and holography, spectroscopy and forensics applications, interferometry and DVD players, and the use of lasers in light shows. Topics may vary according to the backgrounds of the students and requests from the teachers. (Example: How is EO used in forensics or biology?) The other students first go to a classroom, where they learn more about the principles that underlie the hands-on experiments and discuss career opportunities in the field. Approximately midway through the morning, the two groups swap places. A typical sequence of events is outlined in Table 2.

Every participating student and teacher is surveyed to determine his or her opinion of the visit, interest in EO, and interest in future outreach and educational opportunities in the field. In 2007, 147 high school students attended the On-Campus EO Experience. On the survey, approximately 40 percent expressed interest in careers in EO. This showed an immense interest in EO as a result of the On-Campus EO Experience. Prior to the event, many of the participating students knew nothing about EO.

Table 2. The On-Campus EO Experience

Introduction and lab safety rules
Divide into two groups for breakout sessions
Session One Tour of labs Hands-on activities in IUP's state-of-the-art EO laboratory at Northpointe. Typical topics: • Computer interface and open space communication • Diffraction measurement of human hair • Fiber optics • Forensics applications • Interferometry • Lasers • Spectrometry • XY pattern generator and laser light show • Thermal infrared technology and night vision camera
Session Two: • Learn about the science of EO and career opportunities in the field and play "Optics Jeopardy"
Groups rotate
Survey and wrap-up
Pizza lunch for students, participants, and teachers prior to returning to school

C. EO Summer Camps

High school students who indicate interest (via the survey) in pursuing careers in EO are invited to attend a one-week day camp free of charge during the summer. The camp is also open to any student entering tenth, eleventh, or twelfth grade in the fall of the upcoming year. The camp is perhaps the most important and empowering part of the outreach. It unifies the other outreach components and gives students an idea of the resources available to them. (The first camp was offered in June 2006 with funding from PA DCED.) Participating students attend daily lectures on topics such as the nature of light, wave optics, electronics, fiber optics, holography, infrared imaging technology, lasers, and nanotechnology. Students are then guided through hands-on activities related to those topics. For example, in electronics, they learn how to solder and complete a simple transmitter and receiver set. In optics, students are introduced to activities using a grating spectrometer and an interferometer. Table 3 lists the activities for the first day of the 2007 camp.

To enhance their understanding of EO engineering and enable them to gain in-depth information about the field, students are taken to visit local EO manufacturing companies and laboratories that specialize in the applications discussed. These companies include II-VI Incorporated (world leader in CO_2 laser optics and laser crystal growth technology), L^3 Communications (producer of complex electro-optical and electro-mechanical systems and instrumentation for the commercial and defense markets), Sabeus (designer and manufacturer of fiber optics components), and the Penn State Electro-Optics Center (renowned for lasers, night vision, and robotics imaging). During these visits, personnel from the EO companies share information about internship and career opportunities in electro-optics engineering and describe examples of projects underway at their companies.

Table 3: Activities for Summer Camp: Day 1

Time	Activity
8:30 A.M.	Breakfast
8:45 A.M.	Welcome and introductions
9:00 A.M.	Camp pretest
9:30 A.M.	Nature of light and color spectra activity
10:00 A.M.	Break
10:15 A.M.	Wave optics
12:00 P.M.	Lunch
12:45 P.M.	Forensics applications activity
1:30 P.M.	Break
1:45 P.M.	Tour: Optical Systems Technology, Inc.
4:00 P.M.	Dismissal

Guest speakers are invited to take part in the camp to provide further insight into EO and its applications. A highlight of the 2006 and 2008 camps, for example, was a videoconference in which personnel at NASA's Jet Propulsion Laboratory in Pasadena, California, provided insights into the significance of optical imaging. A forensics trooper from the Pennsylvania Police Department who took part in the 2008 camp provided an overview of EO applications in forensics and demonstrated alternate light sources and other techniques.

Each camp concludes with a dinner for student participants and parents, as well as business and educational leaders. Students present posters on projects completed during the week and compete for prizes. The projects, whether completed by individuals or by small teams, give the students a sense of accomplishment for the end of the camp and make the field of EO more readily accessible to them. Attendees are always impressed with the quality of the students' posters and have difficulty choosing winners. The winning posters are awarded EO-related prizes such as *Deflexion*, an innovative laser board game. The dinner also benefits the students (as well as their parents) by providing an opportunity for informal interaction with faculty and staff.

The camps have experienced steady growth in student interest in EO. Due to the large attendance at the 2007 camp, two camps were offered in summer 2008, resulting in more opportunities for individualized attention to students. For the past three years, the average scores on the camp pre- and posttests were 42 percent and 85 percent, respectively. Also, the students were asked to complete a survey at the end of the week. The survey included questions such as "How has this camp changed your understanding of electro-optics?" One student responded that it "greatly improved" her understanding. Another student wrote, "I learned a lot more and this went beyond my expectations of electro-optics." Students were also asked how the camp helped them make decisions about their future careers. Some students wrote that the camp helped them to decide on EO as their future career choice. Students who attend the camps become the pipeline for the EO program.

D. EO Workshops for Teachers and Guidance Counselors

As part of our long-term strategy, professional development activities such as workshops for high school personnel are also provided. Through the workshops, area math and science teachers and guidance counselors are invited to take part in hands-on EO activities that can be used in the classroom. An overview of EO is provided and career and educational opportunities in the field are introduced. The workshops provide lecture components

integrated with hands-on activities, as well as tours of local EO companies and opportunities to meet IUP EO graduates working in the field. To facilitate further investigation, teachers and counselors receive kits containing a curriculum guide designed to help them teach their students about the exciting field of EO. Each participating teacher or guidance counselor can earn Act 48 credit. Table 4 details a typical workshop schedule.

Table 4: Agenda of EO Workshops for Teachers

Time	Topic
8:30 A.M.	Welcome and continental breakfast • Introductions • Act 48 sign-up

8:45 A.M.	Overview
	• EO program
	• Opportunities for students
	  ○ Classroom visits
	  ○ On-Campus EO Experience
	  ○ EO Summer Camp

9:30 A.M.	EO lab activities • LED color kit
10:30 A.M.	Break
10:45 A.M.	• LED color kit (cont'd)
12:00 P.M.	Lunch
12:45 P.M.	EO career opportunities
1:15 P.M.	Company tours • Sabeus, Inc. • RAPT Industries
2:30 P.M.	Wrap-up • EO resources • Evaluation (required for Act 48 credit)

Survey results from the 18 participants who had attended workshops in 2006 indicated 97 percent satisfaction; 15 indicated that more workshops should be offered. As a follow-up to the workshops and other outreach activities, IUP's EO lab facilities and diagnostic equipment have been made available to high school classes for lab experiments—a special benefit to high schools with poor science facilities. As a result, teachers have brought their students to the facilities to experience advanced topics such as laser holography and nuclear radiation.

E. Other Outreach Activities

In addition to the outreach activities provided for students and their teachers and guidance counselors, outreach activities are provided for parents and more general audiences. These include, for example, information sessions for parents and open houses for the public. Area parents have been invited to attend information sessions on EO and tour the teaching facility and campus. Focus groups are invited to attend sessions on special topics such as "Women in

Forensics," which is offered for the purpose of increasing the number of female students in the program.

III. Evaluation

For each outreach activity, a survey is conducted to gain feedback from the participants. The survey results collected thus far indicate a favorable response. A typical result is shown in Table 5, which reflects the evaluation survey completed in 2007 by a group of 42 students (24 juniors, 18 sophomores) who attended the On-Campus EO Experience.

Table 5. Evaluation Example for the On-Campus EO Experience

What was your favorite activity during the EO experience today?		
Response	**Number of students**	**% of total students**
Laser demonstrations/lab activities Comments: • "The lasers show and the pulsing laser" • "Hands on experiences" • "Playing with red and green lasers" • "The sound rides with laser – if you interrupted the laser the sound stopped!"	18	43%
Jeopardy Comments: • "winning jeopardy" • "playing jeopardy"	8	21%
Night Vision	7	17%
Fiber Optics Comments: • "Cleaving fiber ends" • "Splicing the optical fiber to form a necklace with beads"	7	15%
Everything	1	2%
No comment	1	2%
Request for information about the following programs:		
Interested in the Electro-Optics Program	**Number of students**	
"Yes"	16 (38%)	

Of 147 students from 7 schools who attended the On-Campus EO Experience in 2007, approximately 40 percent expressed an interest in careers in EO engineering. From the surveys, the effectiveness of the outreach activities is evaluated and changes for future improvements are made. More important, students who are interested in EO engineering are identified.

Surveys are administered at the conclusion of the summer camps. Survey statistics gathered thus far indicate that, as a result of the camps, students have a better understanding of careers in science, math, and technology (4.67 out of 5) and a better understanding of the field of EO (4.79 out of 5). While some campers have indicated that they plan to pursue science or

engineering studies at other universities, the increase in camp enrollment from year to year—as well as increases in the quality of students, retention, and student academic performance and satisfaction—can be viewed as measures of the success of the outreach activities.

IV. Conclusion

IUP's EO outreach activities have succeeded in attracting students, as indicated by continuous growth in student enrollment, improvement in freshman quality, the success of the program's graduates and current students, nearly 100 percent job placement of graduates, and positive reviews from local industrial leaders. The activities and outcomes are both interesting and useful to engineering education in general. Any of the formats discussed in this paper could be adapted to and implemented in other technical programs.

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