

#### WINTER 2006

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**PHOTON2** is a project of the NEW ENGLAND BOARD OF HIGHER EDUCATION (NEBHE) and is funded in part by the Advanced Technological Education (ATE) program of the National Science Foundation (NSF). For more information, please visit our web site: www.nebhe2.org/photon2.html. You may also contact the program staff at NEBHE:

Fenna Hanes Senior Director, Office of Programs 617/357-9620 x129 fhanes@nebhe.org

Chuck O'Toole Program Assistant & Newsletter Editor 617/357-9620 x113 cotoole@nebhe.org NEBHE 45 Temple Place Boston, MA 02111



www.nebhe.org/photon2.html

ISSUE FOUR

## **PHOTON2** Participants Complete Summer Educator Internships

This summer 24 teachers and faculty and six career counselors traveled to nearby photonics companies and research labs to work as educator interns, as Project PHOTON2 entered its next phase.

The internships were the third of four main phases in the National Science Foundation-funded project. Phase 1 was a series of regional introductory workshops; Phase 2 was a web-based distance learning course in photonics technology; Phase 3 was the internships; and Phase 4 is now taking place as participants <u>Continued on page 4</u>



Professor David Miller and counselor Lin Tamulonis from New Hampshire Community Technical College, Pease with a plasma etcher that is being refurbished at Photomachining, Inc.

## Engineering vs. Engineering Technology: What's the Difference?

In the 1960s, prospective engineering students were often asked the question "Do you work on your own car?" Hands-on experience was an essential prerequisite to the education and training of an engineer. However, as the practice of engineering became more theoretical and design oriented, a new field of study arose – engineering technology.

Although engineering and engineering technology sound similar, there are significant differences between them. A glance at typical four-year engineering and engineering technology programs of study reveals differences in the level of mathematics and the number of hands-on laboratory courses. Engineering programs require three or more calculus courses, plus in-depth study of physics and chemistry. In many cases, students begin their program of interest (electrical engineering, mechanical engineering, and so on) only after 3 or 4 semesters of math and science preparation. In contrast, engineering Continued on page 7



A student at Three Rivers Community College fusion splices optical fiber. Training for handson work like fiber splicing typically falls under Engineering Technology programs.

## New England Alliance Meets for Lab-Based Workshop

Members of the PHOTON2 New England Alliance, after having previously attended an introductory workshop and completed the one-semester "Introduction to Photonics" distance learning course, requested that the PHOTON2 team hold a one-day laboratory-based workshop. The purpose of the workshop was to share instructional materials and strategies among the participating educators. Workshop activities such as this gathering are intended to enhance content knowledge and strengthen alliance networks among the educators.

On Saturday, June 4, 2005 the educators gathered at the New Hampshire Community Technical College at Pease. PHOTON2 attendees included Bill Dolan, Kennebec Valley Community College, Maine; Ken Franson, Kingswood Regional High School, New Hampshire; Rick Reardon, Eastern Maine Community College; Adrian Sebborn, Southwest Career Development Center, Vt.; and Dave Miller, New Hampshire Community Technical College at Pease.

To increase the impact of this workshop, instructors who participated in NEBHE's previous Project PHOTON were also invited. Martin Drexhage of Tantasqua High School in Mass., Jake Mendelssohn of the Greater Hartford Academy of Math and Science in Conn., and Edd Spidell of the Cranston Area Career & Technical Center in Rhode Island traveled to New Hampshire to attend the workshop.



Jake Mendelssohn of Greater Hartfor Academy of Math and Science and Edd Spidell of Cranston Area Career & Technical Center discuss Spidell's presentation of a fiber optic video link.

The Alliance instructors took turns sharing the lab activities that they use with their students. Mendelssohn brought some air-filled lenses in water and did some demos with LEDs to illustrate color addition and persistence of vision. Martin Drexhage set up a large transmission hologram. Dolan used a video camera to look at the Infra Red (IR) signal of a remote control.



L. to R., PHOTON2 PI Nick Massa of Springfield Technical Community College, Mass., Southwestern Vermont Career Development Center teacher Adrian Sebborn and Kennebec Valley Community College professor Bill Dolan contemplate Sebborn's color-following robot at the NE Alliance's June workshop.

Co-PI Donnelly demonstrated a "Magic (Polarization)" box originally demonstrated by Agawam Junior High School's instructor John Burns, during his participation in Project PHOTON. She also showed how to make polarized light art. **Co-PI** Massa ingeniously created a stable table for holograms using packing material and optical breadboards so that each participant had a chance to make their own hologram.

## Some Field-Tested Websites

Other instructive activities included sharing the following field-tested web sites:

Fiber Optics kits RSR Electronics http://www.elexp.com/

"Edible Photons" (custom printed M&Ms) http://shop2.mms.com/customprint/index.asp

Inexpensive board-level camera (plus mini cameras for would-be spies) http://www.supercircuits.com/

Batteries at low prices http://www.onlybatteries.com

LEDS in lots of colors (including tri-color and blinking) http://www.superbrightleds.com/index.htm

"Draw holograms by hand" http://amasci.com/amateur/holol.html

The New England Board of Higher Education's NEW ENGLAND HIGHER EDUCATION \*\*\* 2006 EXCELLENCE \*\*\* AWARDS DINNER

SAVE THE DATE! Feb. 24, 2006 The Fairmont Copley Plaza Boston, Mass. www.nebhe.org

## **PHOTON 2**: A Year in Review

After a year of workshops, courses, course revisions, and internships, the PHOTON2 team used last fall's ETOP 2005 conference as an opportunity to take stock of the project's accomplishments.

The goal of Project PHOTON2 is to increase the number of high school teachers and college faculty across the US prepared to teach photonics technology at their own institutions. The PHOTON2 project also sought to answer research questions regarding the viability of web-based professional development in a lab-based course.

As far as learning outcomes are concerned, PHOTON2 incorporated pre- and post-course tests to monitor how much each of two cohorts learned during the online course. These test scores were comparable with pre-post content knowledge scores recorded in previous classroom-based versions of the same course (*Introduction to Photonics Technology*), suggesting that learning outcomes in an online laboratory-based course in photonics technology are comparable to learning outcomes in traditional classroom/laboratory instruction.

The reality is that most web-based courses take at least as much time as classroom courses, if not more.

But just because online and face-to-face learning have similar outcomes does not necessarily mean that the same learning strategies work in both situations. The experiences of cohorts 1 and 2 provided some valuable insight into considerations in a lab-based online professional development course.

Much of what the project team learned had to do with the earliest stages of an online course. In order to engage adult learners successfully, instructors must pay careful attention to how those learners interact, think, and understand the course structure.

First, early socialization proved to be key. As was discussed in the article, "Adult Learning Principles: A Key to PHOTON2," from the Spring 2004 issue of *PHOTON2 News*, learner-to-learner interaction plays a major role in successful adult learning (visit the web page www.nebhe2.org/photon2/photonnewsletter.html to read the article). Working with the two cohorts, the project team found that participants performed better in the course if they spent more time at the beginning establishing a social rapport with one another. Teachers who were comfortable with the learning environment and who felt that they were part of a supportive community were more likely to engage in online dialog and to collaborate on coursework.

Moreover, when the instructors explicitly encouraged the participants at the start of the course to interact with their peers and to share knowledge and experience, the participants tended to interact more readily with one another online and "behind the scenes."

On an individual level, good critical thinking skills make all the difference between dull and engaging online discussions. The project instructors found that by providing cohort 2 learners with an online guide to better critical thinking, they promoted more substantive and thoughtful contributions to the online discussion.

Along with critical thought, online learners need the ability to monitor their own progress and to make adjustments to their study strategies. Those students who lack that ability tend to start with enthusiasm and then drop off quickly in their level of involvement. These selfregulation skills can be nurtured through early instructor support.

Course structure and delivery were two other broad areas where the project stimulated new ideas for cohort 2 based on the experiences of cohort 1.

The most common complaint from participants was the lack of time to perform course work, conduct lab experiments, work with alliance members on curriculum development, or participate in online threaded discussions. Both cohorts showed a significant dropoff in participation after approximately 8 weeks.

Based on that data, the project team recommended that future online professional development courses offer their material in smaller, more manageable "chunks" spread out over a longer period of time.

The more spread-out course would allow separate curriculum development and reflective activities. Structuring learning activities so that learners have some "down time" for reflection and experimentation with course material would help them make better decisions about classroom implementation.

Hand-in-hand with revamping course structure is clarifying that structure and its requirements to each participant. Some of the cohort 1 participants commented that they "did not expect the course to take up so much time." The reality is that most web-based courses take at least as much time as classroom courses, if not more. By clarifying expectations such as time commitment, deadlines, rules for engaging in online discussions, and level of participation, learners can better plan for the amount of work required for successful completion of web-based courses.

This is a summary of PI Nick Massa's presentation, "The PHOTON2 Web-Based Professional Development Model: A Year in Review," at SPIE's 2005 ETOP conference in Marseilles, France. For complete text visit www.nebbe2.org/photon2.btml.

#### Internships, continued from page 1

develop new curricular materials with the knowledge they have gained.

PHOTON2 will conclude in 2006 with the final showcase workshop, when the participants gather to share with one another their experiences integrating photonics education into their classrooms.



IFOS Founder and CEO Dr. Behzad Moslehi at corporate headquarters in Santa Clara, Calif. with Tuskegee University PHOTON2 participant Professor Akshaya Kumar.

Phase 3's internships have been a key part of PHOTON2 since the project's conception. Conversations with photonics industry representatives had again and again come back to the same issue: Employers need students who know not only the theories behind the technology, but also how to apply those theories in an industrial or research environment. As the project team set to work on adapting the original Project PHOTON instructional materials for web-based delivery, they turned to internships as an ideal way to emphasize hands-on, experiential learning.

"Internships for students are not a new idea," said principal investigator Fenna Hanes. "But internships for teachers and counselors are

## Summer 2005 Internship Hosts

## ADC Communications, Inc. (www.adc.com)

ADC, a supplier of global network infrastructure products, software solutions, and integration services for broadband and multiservice networks, has facilities in Bennington, Vt.

## The Boeing Co. (www.boeing.com)

Boeing's business group on Maui, "Laser and Electro Optical Systems, Hawaii," works in space-based communications, missile defense and battle space management. Boeing utilizes its advanced optical systems on the Air Force's telescope on Mt. Haleakala.

## IPG Photonics Corp. (www.ipgphotonics.com)

Headquartered in Oxford, Mass., IPG Photonics designs and manufactures high and low power fiber lasers, as well as amplifiers for a broad variety of applications.

## Intelligence Fiber Optic Systems Inc. (IFOS, www.ifos.com)

IFOS, with headquarters in Santa Clara, Calif., engineers, manufactures and markets progressive photonic modules, fiber optic sensors, optical sensing systems and wavelength monitoring subsystems.

not as common, and yet they can have tremendous payoff since each teacher will impact a significant number of students."

But if coming up with the idea of internships was not difficult, securing placements for PHOTON2 participants proved much more of a challenge than anticipated.

Using contact lists provided by SPIE—The International Society for Optical Engineering, the Optical Society of America (OSA) and the Photonics Spectra 2004 Photonics Directory, PHOTON2 intern Gorkem Arsoy sent out letters, e-mailed representatives and cold-called company headquarters. Meanwhile personal contacts by teachers, PIs and PHOTON2 project advisors led to several opportunities, as did the site visits in the introductory PHOTON2 workshops.

The range of internships reflected photonics' breadth as a field. Participants worked at telecommunications firms, high-tech machinist companies, military contractors and research labs. They operated missile-tracking systems and built cutting lasers; they sliced glass fibers and learned about optical applications in biotechnology.

They even discovered some of the more artistic uses of lasers. Warren Atkinson of Minuteman Regional High School in Lexington, Mass., interned at Rofin-Baasel, Inc. In his internship report he wrote, "It was a particular pleasure to learn about some of the industry uses for laser repair of fine art and antique jewelry."

Mark Kondracky, at teacher at Plainfield High School in Connecticut, had a typical, and typically busy, internship at TRUMPF Inc. He spent most of his time working on laser alignment, "including helping with mode burns, M.A.F., and mirror adjustment." In addition, he worked in a clean room helping to build a CO2 TIF laser, and attended classes on laser operation and laser repair.

Most internships leaned more toward "job-shadowing," with interns pairing up with one or more employees in a given <u>Continued on next page</u>

## The Jackson Laboratory (www.jax.org)

The Jackson Laboratory in Bar Harbor, Maine, employs a variety of photonics technologies to ensure the genetic quality of their JAX®Mice, which are used in research laboratories.

## NP Photonics (www.npphotonics.com)

Tucson-based NP Photonics uses progressive fiber and glass technology to manufacture products including high power sources and fiber lasers.

Northeastern University, School of Engineering and Technology (www.coe.neu.edu/Depts/SET) Northeastern's SET, in Boston, focuses on the applications of technology. The Optics Lab complements coursework in Optical System Design and Photonics for Engineers courses.

## Noyes Fiber Systems (www.noyes-fiber.com)

Noyes Fiber Systems in Belmont, N.H., produces and provides technical support and services for a variety of fiber optic equipment to field installers.

## OFS Fitel LLC (www.ofsoptics.com)

OFS's research foci include photonic devices, optical fiber and systems. The Sturbridge, Mass. plant patents and manufactures glass optical fiber.

### Continued from previous page

day and watching them do their jobs. A smaller number of participants arranged more extended internships that allowed for more in-depth experiences.

In addition to seeing first-hand the different types of work that rely on photonics technology, participants also took opportunities to find out what kind of people succeed in that work. Yolanda Fernandez-Carr, a career counselor from Tucson's Sunnyside School District, talked to employees at NP Photonics about the skills needed to enter the field.

## Many participants finished their internships with clear ideas about how to work their experiences into their classroom instruction.

"[One engineer at NP Photonics] felt that [students] would have to be dedicated, meticulous self-starters interested in how things work and why," she explained. "He mentioned that the art of machining is dying, and that this is a tragedy since all new equipment is touched by a machinist somewhere."

"Ideally the hands-on learning offered by the internship experience will better prepare teachers to make photonics exciting and engaging for their students," said Professor Nicholas Massa, a PHOTON2 co-principal investigator whose academic work applies current learning theory to engineering technology education. "We hope that by bringing that kind of energy into their classes, our participants will convince more graduates to enter these fields."

Many participants finished their internships with clear ideas about how to work their experiences into their classroom instruction.

Three members of the Frisco (Texas) Alliance—Wayne Jones and Julius Turner of Collin County Community College, and Derek McDowell

#### Penn State University, Electro-Optics Center (www.electro-optics.org)

The Electro-Optics Center, in Kittanning, Pa., promotes the development of electro-optic materials, components, and systems for military use.

#### Penn State University, Materials Research Institute (www.mri.psu.edu)

The Penn State Materials Research Institute is developing a single chip on which numerous multi-functioning components will perform.

#### Photodigm Inc. (www.photodigm.com)

Photodigm, in Richardson, Tex., produces higher power surface-emitting semiconductor lasers and long wavelength surface-emitting communication lasers.

#### PhotoMachining Inc. (www.photomachining.com)

Located in Pelham, N.H., PhotoMachining designs, builds and operates laser systems to simplify precision machining using laser-assisted micromachining.

#### Rofin-Baasel Inc. (www.ablasers.com)

Rofin-Baasel works out of multiple sites in the US, including Billerica, Mass. Products include laser markers, laser welders and laser coding systems.

of Centennial High School—did internships at Photodigm, Inc. Jones felt that his internship experience would complement the work his department has already done in establishing an Electro-Photonics

program. "The most important component," he said, "is the ideas gained in terms of implementing courses within the curriculum in an effective online format."

McDowell said that his internship will enable him "to take back discarded samples of devices to display to my students to help stress the small-scale nature of photonics technology.... My internship directly touched many examples ranging from telecommunications to military targeting to medical



Faculty, teachers and counselors from Kauai, Maui and Hawaii community colleges and high schools visit an observatory at the Maui Space Surveillance Site at Mount Haleakala, Maui, Hawai'i.

treatments." McDowell plans to create an entire new "Introduction to Photonics" course at Centennial.

Even teachers in fields outside of engineering or the hard sciences have plans to work their internships into their classrooms. Wendi Russell, a mathematics teacher at Waimea High School Continued on page 7

#### Textron Systems Corp. (www.systems.textron.com)

Textron Systems., a subsidiary of Textron, Inc. with offices in Kauai, Hawai'i, supplies technology solutions to global defense and aerospace industries.

**Three Rivers Community College Photonics Program (webpages.charter.net/laseroptics)** Connecticut's TRCC Photonics Engineering Technology program, initiated in 1997, focuses on fiber optics, telecommunications and laser materials processing.

#### TRUMPF Inc. (www.us.trumpf.com)

TRUMPE, a subsidiary of TRUMPF Global & Co. KG, has facilities in Farmington, Conn., and produces industrial lasers and fabricating machinery.

#### University of California Riverside (www.physics.ucr.edu)

UC Riverside's Physics Department researches a variety of topics, including the behavior of electron spin in nanostructures.

#### University of Connecticut (www.engr.uconn.edu/prc)

Ongoing endeavors at the Photonics Lab at UConn include understanding the nature of light. The lab is also developing miniaturized spectrometers on a chip.

## New Year's Gifts from OSA and SPIE—and Other Recent PHOTON2 Activities

## New Year's Gifts from OSA and SPIE

This year PHOTON2 project participants received donations of marketing materials from the Optical Society of America (OSA) and SPIE—The International Society for Optical Engineering to share with their students. The donations were mailed out to participants as a New Year's gift packet.

Included were copies of SPIE's 2006 "Women in Optics" calendar (with PHOTON2's own Judy Donnelly one of August's featured scientists!) and their 2006 *Optics Education Directory* that lists degree programs in optics from around the world. OSA provided an attractive monogrammed baseball cap, a book cover aimed at young students, and a laser pointer key chain kit with a variety of attachments.

## Fiberfest (May 2005)

In May, PHOTON2 had a display booth at the annual New England Fiber Optics Council's Fiberfest conference in Boxborough, Mass. Co-PI Judy Donnelly's home institution Three Rivers Community College in Norwich, Conn. also had a display booth. This trade show was an opportunity to meet with companies in the fiber optic industry.

## ASEE (June 2005)

Co-PI Nick Massa and research assistant and UConn graduate student Kelli Vallieres delivered a paper, "Learner Interaction and Self-Regulation in Web-Based Professional Development," at the June annual meeting of the American Association of Electrical Engineering Conference (ASEE) in Portland, Oregon. The paper presented initial research findings on variations in learning outcomes in online learning environments.

## PHOTON2 NVB Annual Meeting (September 2005)

The PHOTON2 National Visiting Board met in September for its annual meeting. The meeting took place at the Boston University Photonics Center. NVB member and BU professor Michael Ruane gave the attendees a tour of the facility. The meeting included presentations by project participants Dave Miller and Lin Tamulonis of the New Hampshire Community Technical College at Pease and host Ron Schaeffer of PhotoMachining, Inc. in Pelham, N.H. Adrian Sebborn of the Southwest Vermont Career Development Center and his internship host Wayne Kachmar of ADC Communications, Inc., in Bennington, Vt., also gave talks about their experiences.

## OSA Frontiers in Optics (October 2005)

Co-PI Donnelly presented a paper, "Optics for Opportunity: PHOTON Materials for Teaching," at OSA's Frontiers in Optics Conference in Tucson, Arizona last October. Donnelly also participated in a tabletop laboratory demonstration attended by more than 30 Tucson area teachers. Pima Community College professor and PHOTON2 participant Chien-Wei Han also presented a tabletop demonstration.

## SPIE Photonics East (October 2005)

Co-PI Donnelly and PI Fenna Hanes both exhibited at the SPIE Annual Photonics East Trade Show and Conference held in Boston, Mass. in October. The conference was an excellent opportunity to disseminate PHOTON2's education and training opportunities to industry representatives and training managers.

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## Connect to New England's Future Become a Friend of NEBHE

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#### Activities, continued from previous page

## ETOP (October 2005)

Co-PI Massa presented "The PHOTON2 Web-Based Professional Development Model: A Year in Review" at the biennial Education and Training in Optics and Photonics (ETOP) Conference held in Marseilles, France in October. The question addressed was, "How do learners' self-regulation skills affect the way they interact in an online environment and what is the effect on learning outcomes?" (See page *3 of this newsletter for an article summarizing the presentation.)* 

## NSF ATE Annual Meeting (October 2005)

The National Science Foundation's Annual Advanced Technological Education Meeting took place in October in Washington, DC. PHOTON2 hosted a display booth during one of the showcase sessions. PIs Hanes and Massa and research assistant Vallieres also presented a roundtable discussion.

## CAEL (October 2005)

PHOTON2 research assistant Kelli Vallieres and fellow UConn graduate student Carolina Orgnero presented "Preparing Successful and Autonomous Adult Learners in Online Environments: Developing Self-regulation Through Feedback" at the annual Council for Adult and Experiential Learning (CAEL) in Chicago in October. There was tremendous interest in the paper due to the lack of empirical research available on learning retention in a distance-learning environment. UConn professor and PHOTON2 consultant Sandy Bell was a co-author and editor of the paper. The paper will be published in the CAEL Forum and News in May 2006.

## Visit PHOTON 2 on the Web at www.nebhe.org/photon2.html

#### Engineering Tech, continued from page I

technology programs emphasize hands-on laboratories, applications oriented courses. and somewhat less math and science.

RESEARCH DESIGN ANALYSIS SAI	ES TEST PRODU CTION QUALITY AS SURANCE ENGINEE RING TECH NO LOGY	MARKETING MANAG EMENT INDUSTR IAL TECHNOLOGY

A graphic representation of the Engineering-Engineering Technology-Industrial Technology continum.

The theoretical rigor of an engineering program allows graduate engineers to design, analyze, develop and optimize systems and processes. Engineers are innovators, who use their knowledge of advanced math, science and engineering principles to create new products. Engineering technologists are "doers" solving technical problems in production, testing, and engineering operations.

### Internships, continued from page 5

on the Hawaiian island of Kauai, interned at Textron Systems Kauai, where she performed field-of-view calculations to assist in laser-guided rocket launches. She explained, "I would like to collaborate with a science teacher in creating an integrative unit on optics. By doing so, my students can experience geometry and algebra applications."

The teachers and faculty, along with their counselor colleagues, will demonstrate their course materials at the final PHOTON2 showcase workshop in 2006.

Hanes says that the project's goal is to have the internships lead to lasting collaborations between the participants and the host companies and labs. Indeed, many of the interns and host companies reported that they had formed such relationships, with possible class visits and equipment donations in the future.

As for lessons the project team has learned, Hanes says that one key is to understand what companies value in interns.

"Employers are eager to have educator interns since they recognize that it will lead to better educated students," she said. "However, as with everything, there is a financial aspect to this." PHOTON2's internships were conceived as short-term job shadowing, but most employers are reluctant to pay for this since they receive little direct benefit in terms of work done.

Hanes added that many companies take interns for longer periods where they are assigned to specific projects. In this instance the internship becomes a fee for services agreement and there is a return on investment. With advanced planning, a paid internship could take the job shadowing experience to a new level. "Most companies plan their budgets a year in advance, so teachers who keep that timeframe in mind may find more longer-term paid opportunities," she added.

> Two-year associate degree engineering technology programs (ASET), like the four-year BSET counterparts, emphasize hands-on labs in addition to

theory. Many ASET graduates enter the workforce immediately upon graduation and work as engineering technicians. Others transfer to bachelor's programs in engineering technology or industrial technology. ASET students who want to transfer to engineering programs generally need to complete additional math courses before enrolling.

Written by PHOTON2 co-principal investigator Judy Donnelly, professor of physics at Three Rivers Community College in Norwich, Conn.

# The Final Showcase is Coming! The Final Showcase is Coming!

The PHOTON2 Showcase Workshop is coming in 2006. Date and location to be announced.

Watch for updates on the Web: www.nebhe2.org/photon2.html-

or contact PHOTON2 PI Fenna Hanes: fhanes@nebhe.org



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