PHOTON2 NEWS

A PROJECT OF THE NEW ENGLAND BOARD OF HIGHER EDUCATION (NEBHE)

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TABLE OF CONTENTS:

PHOTON2 is a project of the New England Board of Higher Education (NEBHE) and is funded in part by the Advanced Technology Education (ATE) program of the National Science Foundation (NSF). For more information, please visit our web site: www.nebhe.org/photon.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, Administrative Assistant
617/357-9620 x113 cotoole@nebhe.org
NEBHE ■ 45 Temple Place ■ Boston, MA 02111

PHOTON2 Second Cohort Selected and Underway

This past fall Project PHOTON2 selected its second cohort of participating schools and held introductory workshops at sites around the country.

The new cohort includes schools from the coast of Maine to the westernmost high school and college in America, on the Hawaiian island of Kauai. In between, institutions from New England, Tennessee, Alabama and California have all joined the project.

In all, Cohort 2 brought 41 faculty and counselors, from 14 new schools, into the PHOTON2 fold. Four workshops—

Continued on page 8

The PHOTON2 Kauai Alliance visited the facilities of TREX Enterprises, a local company that makes compounds for use in optical mirrors.

PHOTON2 Co-PI Spreads the Word about Photonics Education

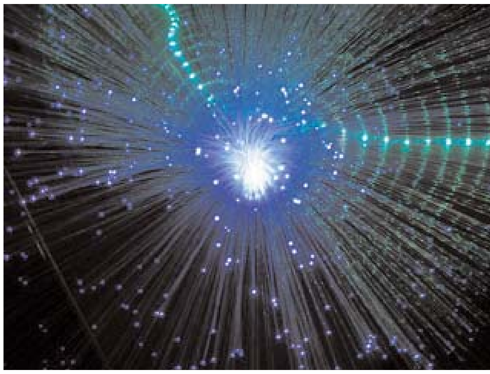
PHOTON2 Co-Principal Investigator Judy Donnelly took part in a variety of conferences, panels and dissemination activities over the winter and spring.

Three Rivers Celebrates 100 Years of Photonics

On Tuesday, March 15th, Three Rivers Community College's (TRCC) Photonics Engineering Department, directed by Judy Donnelly, threw a party to celebrate the 100th anniversary of Einstein's discovery of the photoelectric effect in 1905—in essence, the creation of what would become the modern field of photonics/laser optics.

In conjunction with the internationally recognized World Year of Physics 2005, members of the Three Rivers' student chapter of SPIE (International Society for Optical Engineering) celebrated the birthday of the photon with a laser light show and lab tour that included demonstrations of

Continued on page 3



A burst of brilliant blue from a fiber optic lamp display assembled by students at Three Rivers Community College.

Accomplished Education Leader Dobelle Takes Helm at NEBHE

The New England Board of Higher Education (NEBHE) selected Evan S. Dobelle, who has been president of four colleges and universities and was elected to two terms as mayor of Pittsfield, Mass., while still in his twenties, as president and CEO of the nonprofit, six-state education agency, effective Jan. 1, 2005.

NEBHE President and CEO Evan S. Dobelle

"I find President Dobelle to have extraordinary talent, and I know he will do an outstanding job leading NEBHE," said Louis D'Allesandro, NEBHE chair and the deputy minority leader in the New Hampshire Senate. "It's an exciting time for NEBHE."

NEBHE was established in 1955 by a congressionally authorized, interstate compact designed to encourage cooperation among New England's 270 public and private colleges and universities. NEBHE programs focus on New England higher education and regional economic development.

NEBHE's 48-member board unanimously confirmed Dobelle's appointment during its fall meeting in Woodstock, Vt., on Saturday, after a six-month national search that attracted 142 candidates.

The board is composed of distinguished academics, business leaders and elected officials from Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont.

"I look forward to the opportunity to lead this critically important organization devoted to access, affordability and excellence for students as it begins its fiftieth year serving New England," said Dobelle.

Among NEBHE programs, the Regional Student Program (RSP) provides New England residents with a major tuition break at out-of-state public colleges and universities in the six-state New England region if they pursue certain academic programs not offered by their home institutions. In academic year 2003-2004, more than 8,200 New Englanders enrolled through the program, saving a total of $39 million on their tuition bills. The program also saves New England taxpayers millions of dollars because the states don't have to start up and maintain expensive academic programs offered by other states.

The board also operates programs aimed at encouraging under-represented students to pursue studies and careers in high-growth science, technology, engineering and math fields, oversees professional development programs for high school and college faculty, and publishes the acclaimed journal *Connection: The Journal of the New England Board of Higher Education.*

An independent arms-length search firm found Dobelle had had "successful outcomes of his turnaround efforts as president of Middlesex Community College [in Massachusetts], as chancellor and president of the City College of San Franscisco, as president of Trinity College [in Hartford] and as president of the University of Hawaii System."

Dobelle earned a BA, M.Ed., and Ed.D. from the University of Massachusetts at Amherst and a MPA from Harvard University.

Dobelle succeeds David M. Bartley, the retired Holyoke Community College president and former Massachusetts House speaker who served as NEBHE's interim president from April through December 2004. ■

Dissemination, continued from page 1

high and low power photons in TRCC's laser and nuclear photon labs.

That morning, more than 75 students from Norwich Technical High School, Windham High School and Lyman High School spent two hours touring the photonics and nuclear labs at TRCC. Faculty and students presented demonstrations ranging from interferometry and optical communications to laser beam profiling and detection of high-energy radiation. The students were served a pizza lunch and slices of birthday cake, while watching an ultra-modern custom laser light show, set to dance and hip-hop music by Three Rivers' photonics student/part-time DJ Joe Zanavich. The event was repeated in the late afternoon for nearly 25 visitors from the college and community.

The World Year of Physics 2005 is a United Nations endorsed, international celebration of physics. Events throughout the year will highlight the vitality of physics and its importance in the coming millennium, and will commemorate the pioneering contributions of Albert Einstein in 1905. Through the efforts of a worldwide collaboration of scientific societies, the World Year of Physics hopes to bring the excitement of physics to the public and inspire a new generation of scientists.

OSA Educator's Day

On October 12, 2004 Donnelly presented a workshop during "Educators' Day," a special event during OSA's annual meeting held this year in Rochester, New York. Organized by Doug Goodman (Corning Tropel), the event was designed as a "flea market" of optical demonstrations put on by industry and university folks. Attendees were teachers from the area. An entire ballroom was taken up by demos—half on the "light side" and half on the "dark side." Donnelly showed off some of the "Optics Magic" demos created by PHOTON PIs and participants. They included the Disappearing Beaker, Air Lens, Magic Box and Polarization Art. Each teacher attending the conference received a sack of optics goodies (several lasers, flashlights, lenses, filters) which included a CD with all the demos.

TRCC students use a green inspection lamp to look at interference fringes caused by an air film trapped between flat glass plates.

Connecticut Teachers Participate in Professional Development Day

Saturday, March 12, 2005 was most notable for the awful driving conditions in New England. Nevertheless, Donnelly made it to New Britain and the Connecticut Science Teachers Association Professional Development Day on time. Ten teachers attend the workshop. (The other 10 who signed up must have been stuck at one of the many accident scenes along the way.)

A middle school teacher remarked that light is now part of the 5th grade curriculum under Connecticut's new core curriculum and that many fifth grade t eachers don't know much about the subject. The workshop generated interesting discussions among the teachers. One high school chemistry teacher shared an idea for illustrating optical activity.

She went that-a-way....Co-PI Judy Donnelly at the American Technical Education Association in March.

Donnelly demonstrated four of the PHOTON lab explorations, and handed out the complete exploration instructional materials package, as well as copies of some previous editions of the PHOTON2 newsletters and a copy of the polarization chapter of the soon-to-be published *Introduction to Photonics* text book authored by the PHOTON2 Co-Principal Investigators. Everyone received some polarizing film and a diffraction grating to take home. "That might account for the good evaluations—teachers love freebies; I got great (4.9/5) reviews and there was a lot of enthusiasm in my small group," Donnelly said.

ATEA Conference

Right on the heels of the Connecticut Teachers workshop, Donnelly flew to New Orleans to present a workshop at the March 23-24 Annual Conference of the American Technical Education Association. Her presentation on the materials developed by the PHOTON and PHOTON2 projects again featured some of the "optics magic" from the PHOTON Explorations. Many of the conference attendees were from the Southeast U.S. and were new to photonics technology. Donnelly found the conference to be an opportunity to speak on the importance of teaching optics/photonics, as well as to teach a little physics. Copies of the Explorations and PHOTON2 newsletters were distributed.

Curriculum materials related to the PHOTON2 course can be downloaded from our website at http://www.nebhe.org/photon2.html.

Re-Engineering Engineering Technician Education: A Systems-Based Approach

Adapted from: Massa, N. M., Masciadrelli, G. J., & Mullett, G. J. (2005, June). Re-Engineering Engineering Technician Education for the New Millennium. Paper to be presented at the American Society for Engineering Education (ASEE) Annual Conference, Portland, Oregon.

Engineering technicians play a critical role in the high tech industries that drive this nation's economy. Working side-by-side with engineers and scientists, they are the "hands-on" people who build, test and troubleshoot simple devices and components in complex integrated systems.

A good engineering technician has to be able to design experiments, build prototypes, analyze and interpret data, and work both individually and on interdisciplinary teams. "Interdisciplinary" is the important word here; as new technology blurs the boundaries between the traditional engineering disciplines, flexibility and a broad understanding of engineering concepts have become the keys to a successful career in this field.

It's ironic, then, that most two-year engineering technician (ET) programs are still structured using a narrow, discipline-specific educational model. What is more, most courses are taught in static lecture discussion format with accompanying routine laboratory experiences. As the field has gone through several transformations, instructional methods have remained stagnant, unchanged for decades.

From Old Methods to New

We believe that to meet the challenges of the present and future, instructors who teach engineering technicians should change their approach in two fundamental and overlapping ways. First, they need to move from a discipline-specific model to a holistic, "systems-based" method of teaching that places more emphasis on the relationships and common ground between the various branches of engineering technology. Second, they should develop this systems-based approach while incorporating experiential learning strategies into their lesson plans, strategies that have been proven effective by decades of educational research.

The old lecture-and-lab format works well for transmitting a body of knowledge from an instructor to a student. But the goal of engineering technician education should not be such transmission *per se*, but rather the development of proficient engineering technicians—technicians who can skillfully apply that knowledge in a variety of settings.

The difference between these two goals is subtle but real, and at heart it is a question of flexibility. Students can absorb every drop of knowledge offered in a lecture course, and reproduce it perfectly under testing conditions. But to be truly proficient engineering technicians, they have to be able to take that theoretical knowledge and apply it in a variety of unpredictable real-world contexts. For that to happen, students have to move from being dependent learners for whom the instructor is the sole source for information, toward being independent, flexible, active learners who can identify gaps in their knowledge and skills and take action to fill those gaps on their own.

An added complication is the fact that many of the students in two-year engineering technician programs are non-traditional adult learners who pose specific challenges for ET educators. Adult learners differ from traditional 18-24 year-old college students in that they are often between jobs, looking to increase their skills and return to the labor market as quickly as possible. If they are not unemployed, they may work full-time, and/or have family obligations—creating a different kind of time pressure. They also have a lifetime of educational and on-the-job experiences that shape their responses to the classroom.

ET faculty have to provide these students with an optimal balance of core academic knowledge that will satisfy general education requirements and allow transferability, and discipline-specific technical skills needed to be marketable upon graduation.

Technicians at work at Coherent/DEOS in Connecticut. Engineering technicians are the "hands-on" people who run experiments, monitor procedures, troubleshoot systems and otherwise make engineering labs work.

Researchers have identified several key principles for successful adult learning. Learners should be presented with clear learning goals and objectives, as well as a clear path to attaining those goals; they should develop a rich body of experience centered on solving genuine real-world problems. They should also reflect on their learning both individually and with peers, receive timely and constructive feedback, and learn in an environment that supports and encourages inquiry.

Other researchers have shown that adult learners perform best when a course instructor actively engages their preconceptions on a topic. When adult learners' preconceptions are acknowledged and valued in the coursework, even if done so in a critical way, the students can then work with and build on those experiences so that the new knowledge they learn in class is based solidly on what they already know.

A Systems-Level Approach

Taking this research as a starting point, we have developed a new framework for engineering technician education that we believe meets many of the challenges educators now face. It combines a systemic, interdisciplinary approach to curriculum design with an emphasis on more active, experience-based learning strategies.

Embracing and implementing change can be difficult for faculty already overloaded by their many academic and professional activities. Also, the complex nature of the curriculum approval process at many institutions means that change will face administrative hurdles. With this in mind, we focus our model on strategies that can be applied within existing curriculum frameworks. These methods have been shown to produce real results in improving learner skills, knowledge, attitudes, and taken as a whole, learner proficiency.

As a first step in re-engineering engineering technician education, we recommend that ET faculty break away from the traditional model of teaching courses focused on a single topic and taught in isolation from other courses, and adopt a more "holistic," interdisciplinary systems-level approach to technician education.

We recommend that Engineering Technology faculty adopt a more "holistic," interdisciplinary systems-level approach to technician education.

Education research indicates that students are better able to make connections to other courses and other disciplines when they view the material they are learning in the context of a complete system. Moreover, solving genuine real-world problems serves as a catalyst for learning and not only accelerates learning, but also increases learner motivation.

In contrast, many electrical engineering technology curricula begin with a first semester of stand-alone introductory courses (e.g., DC electric circuits, computer applications, CAD, etc.). These courses are often taught by individual instructors, isolated from other instructors, other courses, and even the labs in which the course content is to be applied.

Upon successful completion of these courses, students are allowed to continue on to more advanced courses, again taught in isolation. Each new course builds on the prerequisite knowledge and skills presumably acquired in a previous set of courses, in a predetermined sequence intended to provide students with the knowledge and skills needed to complete a capstone project in their last semester.

Lecture-style instruction has its strengths, but as a method of training engineering technicians it often fails to instill independence and critical thinking skills.

The problem with this approach is that the bulk of material is taught without an understanding of the context in which it will ultimately be applied. As a result, students learn technical content in small chunks, using a 'bottom-up' or 'component-level' approach without the benefit of seeing the 'big picture'—how all of the pieces fit together to form a complete system.

Four-year institutions like Drexel University have developed solutions to this problem. Drexel's E^4 (for "Enhanced Educational Experience for Engineering Students) program took an integrated approach to engineering instruction. Faculty of mathematics, science, engineering and the humanities worked together to create a coordi-nated curriculum that emphasizes experiential learning, teamwork and an "engineering upfront" philosophy. The result: Drexel reported a 50 percent increase in student retention for the first graduating class that completed the experimental program, as well as improved problem solving, negotiation, and critical integration skills.

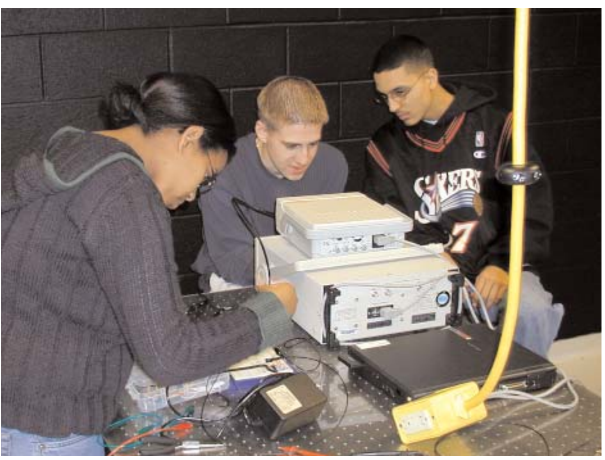
We believe that subject matter at the two-year engineering technician level should be introduced to students as an integral piece of a larger system, as in the E^4 approach developed at Drexel.

The key here is to provide students up front with a "bird's eye view" of where, how, and why the topic they are studying fits into the grand scheme of things. They can then put the current topic into perspective, seeing its the impact and interrelation within the context of the complete system. This line of "systems" thinking can be applied not only to a particular topic within a course, but also to the course itself, as well as an entire curriculum or program.

When applying a systems approach to education, it is especially important to provide students with clear learning objectives, goals and a path to their attainment. The clearer the connections are between the work at hand and the overall system, the better the students will draw their own such connections with future material. Instructors can help students hone and adapt those skills by requiring frequent demonstrations of core competencies in the context of a real-world application and by providing timely and constructive feedback.

Course syllabi typically include a list of learning objectives upon which students' performance will be based. However, students often find the rationale behind these learning objectives unclear. They may wonder why the material is important to know, how it applies in the real world or how their progress will be evaluated. In many cases students simply go through the motions: they complete their homework, take tests, demonstrate the skills required to pass the course and then move on to the next level without ever knowing the context in which their skills are to be applied.

By taking a systems-level approach, on the other hand, students are given the same learning objectives at the beginning of the course, but in the context of a real-world application, such as the design of a simple power supply or electronic control system. As a result they better understand the importance of those learning objectives in relation to a larger system. The learning will take on real meaning, and the students will be better able to apply their knowledge to similar future real-world applications.



ET students will benefit from an approach that puts hands-on problem solving in the context of complete systems.

A systems-level approach to engineering technician education is a natural catalyst for helping faculty move towards a more interdisciplinary curriculum. For example, an electric circuits course based around the real-world task of building a working industrial robot can introduce other aspects of the system and lead to topics outside the head instructor's expertise. Other instructors or guest lecturers with the needed background can team-teach related subjects such as mechanical actuators and sensors, motor control software, printed circuit-board fabrication or even the societal and economic ramifications of the technology.

Industry has an integral role to play in developing the curriculum content, learning objectives, real-world problems scenarios and assessment criteria for systems-level technician education. Industry involvement adds credibility to the curriculum by ensuring that the content is relevant to real-world needs and applications. Industry field trips early on in a curriculum, for example, can provide a simple yet powerful and motivating learning experience for students and faculty alike by providing a glimpse of the context in which specific skills, knowledge and attitudes will be applied.

Theories of active learning

For a systems-level approach to ET education to yield the best possible results, instructors need to actively engage their students in the learning process. Researchers agree that active learning—that is, learning that involves hands-on experience, problem-solving, applying knowledge to new situations and providing students with ongoing critical feedback—enhances learner proficiency. When students are actively involved in their own learning, they understand concepts and retain information more successfully, which in turn makes them more flexible and adaptable in the workplace.

We focus on three primary components of active learning: experiential learning, active reflection and metacognition. Experiential learning is the process of learning by way of direct experience, as opposed to "book learning" or theoretical study. Research shows that experiential methods not only improve academic performance, but also enhance students' ability to apply their knowledge to in new situations. Research also shows that in traditional lecture-based classroom instruction, only 10 to 20 percent of what is learned in the classroom is ever applied outside the classroom. In contrast, over 70 percent of what is learned using experiential methods is likely to be applied outside the classroom. Given that engineering technicians are the "hands-on" side of an engineering team, ET students need sufficient real-world experiences to transform classroom content into practical knowledge that can be applied in the field.

One of the misconceptions about experiential learning is that students must be provided with theoretical instruction prior to engaging in hands-on activities. Instructors will often start a supposedly experiential course with abstract lectures and derivations to "introduce the topic." In stark contrast, proponents of experiential learning maintain that "doing precedes understanding," arguing that hands-on experience should precede theoretical instruction for deep learning to occur.

Experiential learning is neither complete nor effective without another component of active learning, i.e., active reflection. Students need time to digest and assimilate new information through discussion, exploring alternative solutions to problems, and case analysis. Research has shown that allowing students time for such reflection will improve their performance on skill assessments.

Active reflection is useful for revealing and correcting misconceptions. By eliciting students' prejudices about the topic at hand and encouraging them to reflect together on those ideas, an instructor can help students process the new information more thoroughly.

Finally, metacognition, or "thinking about thinking," is a third key factor that influences an individual's ability to engage in lifelong learning. Metacognition is the ability to consider, control and understand one's own learning and cognition. It has been described as an "internal dialog" with oneself regarding knowledge about a particular subject to be learned or atask at hand; the strategies and resources needed to accomplish the learning objective or task; and the process of planning, monitoring and evaluating progress en route to accomplishing the learning objective or completing the task at hand.

Researchers agree that metacognitive learners are more strategic in their learning and perform better than learners who do not employ metacognitive processes. Moreover, students who use metacognitive strategies have been shown to be more flexible and adaptive in how they apply their knowledge in different situations. In today's ever-changing high tech world, those who are capable of learning new things and adapting to change will be much better positioned to excel as productive members of the 21st century workforce.

Feedback is critical to the process of metacognitive development among learners. While metacognitive ability may be inherent in some individuals, the good news is that it can be developed through the process of scaffolding, whereby instructors provide specific cues and feedback designed to help students focus on regulating their own learning. In sum, as learners develop the metacognitive skills needed to plan, monitor and evaluate their own learning, they will acquire the crucial skills needed to engage in lifelong learning.
The implications of active learning on engineering technician education are clear. If our efforts to achieve proficiency among graduates are to be realized, we must embrace an active learning approach. Within the constructs of the interdisciplinary systems approach presented here to engineering technician education, engineering technology faculty can facilitate active learning in a variety of ways. While some instructors may be initially reluctant to change the way they teach, minor adjustments in classroom strategy can yield substantial results.

Putting it all together

The purpose of this paper was to develop a pedagogical framework, grounded in research, for re-engineering engineering technician education. We have established a theoretical basis for an interdisciplinary systems-engineering approach to engineering technician education, one aimed at developing learner proficiency through active learning, real-world problem solving, and metacognitive development. Numerous strategies for improving learner proficiency were presented, all with the intent of improving learning outcomes for engineering technicians faced with the challenge of learning a complex body of knowledge over a relatively short period of time, and more importantly, being able to skillfully apply that knowledge in real-world situations.

Original paper with citations and bibliography available upon request from Chuck O'Toole, cotoole@nebhe.org. For information about the American Society for Engineering Education (ASEE) and about the ASEE 2005 Annual Conference and Exposition, visit their web site at www.asee.org.

Cohort 2 Workshops, continued from page 1

one each in Nashville, Tenn.; Portsmouth, New Hampshire; Pomona, California; and Kauai—convened those faculty and counselors to introduce the course and give them practice with the WebCT online environment.

Each two-day workshop introduced participants to the study of photonics. On the first day, the project team gave a presentation about the history and goals of PHOTON2 and led teachers through a demonstration of the web-based course software. Also, at most workshops the first day ended with a field trip to a nearby photonics-related company or lab.

The second day of each workshop was devoted to hands-on work with the photonics lab kit. Participants learned about laser safety and practiced setting up the equipment, to prepare for the coursework to come.

The first workshop took place in late October at Nashville State Community College. It was hosted by NSCC professor Innocent Usoh and attended by Williamson County High School science teacher Joyce Maddox and Professor Akshaya Kumar of the physics department at Tuskegee University. Also in the Nashville-Tuskegee alliance but unable to attend the workshop were Carol Harrison and Chris Pettibone of Tuskegee's Booker T. Washington High School.

Professor Frank Smith of Californa State Polytechnic University at Pomona leads a tour of CSU's CLEAR illumination laboratory.

NSCC comes to the project with some fiber optics and optics instruction already offered through their electronics and physics programs. Professor Usoh joined PHOTON2 in order to further develop those offerings and to establish connections with local high schools and industry.

At Tuskegee University, the physics department wants to upgrade their laboratory facility and introduce new experiments to their optics courses. Professor Kumar is also exploring the possibility of offering advanced courses in optics and photonics. Meanwhile, Booker T. Washington High School had no optics-related offerings prior to joining the project. They hope to develop a partnership with Tuskegee University and encourage B.T.W. students to look at optics as a career path.

PHOTON2 Co-PI Judy Donnelly and Orange Coast College professor Robert Castano at the Pomona Alliance workshop.

A few weeks later, PHOTON2 met with members of the New England alliance at New Hampshire Community-Technical College at Pease.

The New England Alliance is spread out across the six-state region, with clusters of schools in Connecticut, Maine, New Hampshire and Vermont. In Connecticut, Anthony DeRosa of Grasso Regional Technical School and Anne Paris of Lyman Memorial High School are both working to incorporate photonics education into their curriculum. Both schools send many graduates to nearby Three Rivers Community College, where PHOTON2 instructor Judy Donnelly has built a photonics degree program. The high schools hope to get their students interested in the field early so that they can take advantage of TRCC's offerings.

In Maine, professors at two community colleges—Rick Reardon at Eastern Maine Community College in Bangor and Bill Dolan at Kennebec Valley Community College in Fairfield—are working with Ralph Chapman of United Technology Center MVR #4, a technical high school in Bangor. Reardon applied to PHOTON2 "because of the phenomenal potential of photonics in the area of telecommunications, medicine, defense, security and computer technologies." Dolan, meanwhile, was a participant in NEBHE's earlier fiber optics project, FOTEP. He sees PHOTON2 as an opportunity to add optics material to KVCC's two-semester Semiconductor Fundamentals course.

New Hampshire and Vermont together bring three schools to the Alliance. In Portsmouth, NH, Dave Miller, a professor at the NHCTC Pease campus and a veteran of both Projects PHOTON and FOTEP, is using PHOTON2 to further build up an already extensive photonics and fiber optics program. Miller and teacher Ken Franson, of Kingswood Regional High School in Wolfsboro, are interested in creating a "Running Start" pathway program to introduce photonics to students early on. At the Southwest Vermont Career Development Center in Bennington, teacher Adrian Sebborn sees PHOTON2 as a means to help the school meet the needs of new and growing mircotech industries in the area.

At the workshop at NHCTC in November, the par-

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Cohort 2 Workshops,, continued from previous page

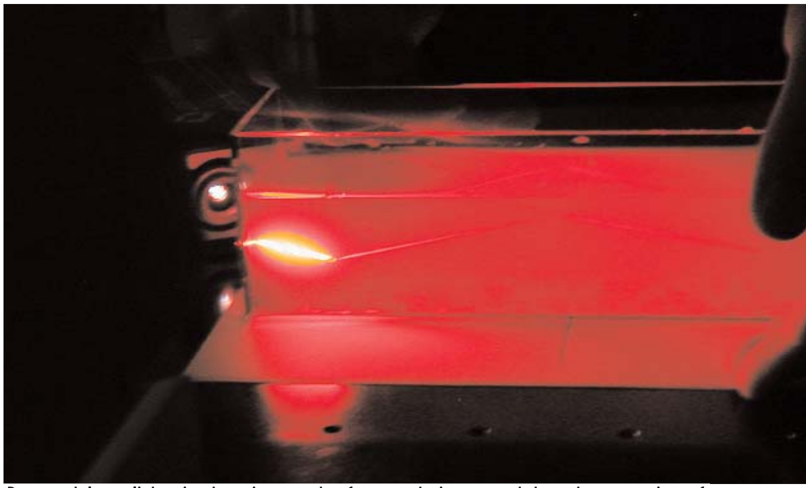
ticipants took a tour of Photomachining, Inc., a company based in Pelham, NH. After an introduction to high precision laser materials processing, Photomachining CEO Dr. Ronald Schaeffer took the group on a tour of the shop floor and demonstrated a variety of lasers used in micromachining, including CO2, frequency doubled and tripled Nd:YAG, and excimer lasers.

After New Hampshire, it was time to head out to the Los Angeles area to visit California State Polytechnic University at Pomona. There, Professors Gerald Herder and Massoud Moussavi hosted participants from three local institutions, as well as the two teachers from Booker T. Washington High School in Tuskegee.

Herder and Moussavi joined the project in order to better integrate optics and photonics technology into CSU Pomona's already extensive engineering offerings, and to establish stronger ties with high schools and two-year colleges in the area. They already have strong ties with the International Polytechnic High School, which is located on the CSU Pomona campus. Dee Ann Matthews and Susanna Wann both teach at the small, project-based, experimental high school, and felt that PHOTON2 was a good way to create new hands-on activities for their students.

Also in the Pomona alliance are Professor Robert Castaño of Orange Coast College and David Susuras of Vista del Lago High School. Castaño sees optics playing a role in the college's courses in communication systems and computer repair, with emphasis on sensor systems used in medicine and telecomm. Susuras, who teaches physics at the newly opened Vista Del Lago, wants to use the PHOTON2 equipment to further build the school's physics offerings.

The group paid a visit to Cal Poly's College of Engineering Center for Lighting Education and Applied Research (CLEAR). The Center's facilities include a modeling studio lab with a moveable ceiling that can accommodate various test fixtures, as well as a computer simulation laboratory with



Deep red laser light ricochets in a tank of water during a workshop demonstration of total internal reflection.

forty computers, all equipped with lighting simulation software that utilizes data from the modeling studio to design lighting systems. The participants also made a site visit to Southern California Edison's Customer Technology Application Center (CTAC). The Center is a source of information, training and support needed to make important energy management and energy efficiency choices.

The final workshop took PHOTON2 to Kauai, the westernmost island in the Hawaiian chain. Kauai, like Hawaii in general, has a strong military presence. As a result the local optics industry is beginning to grow quickly. Francis Takahashi, a professor at Kauai Community College, applied to PHOTON2 so the island's schools could prepare their students for the opportunities in this growing field.

Joining Takahashi and KCC are Al Carbonel, a teacher at Kauai High School, and Garret Dacay, Val Nitta, and Wendi Russell, all teachers at Waimea High School. Carbonel has a background in engineering and is eager to use optics technology in his lessons. Dacay and Nitta are both career technology educators and hope to include units on optics in their tech courses, while Russell, a math teacher, feels that photonics will be a good "real-world" application that she can use to teach match concepts.

The Kauai alliance took their field trip at Trex Enterprises, a small materials manufacturer that produces a composite that can be shaped into super-smooth mirrors for optical and astronomical research. Trex manager Dave Kane took the group on a tour, showing them a variety of mirrors and other products made with the Trex material.

On February 2, the second cohort officially began the online course, and at this writing they are nearly halfway finished. ■

National Visiting Board Spotlight — Ronald E. Scotti

Ronald E. Scotti is a Science and Technology Strategist for SPIE—The International Society for Optical Engineering. He came to SPIE after retiring from Lucent Technologies Bell Laboratories, where he spent many years involved in Optical Technologies for Telecommunications. Scotti holds a Ph.D. from the Optical Sciences Center of the University of Arizona.

PHOTON2 News *spoke with Scotti recently about his work with SPIE and the PHOTON2 National Visiting Board (NVB).*

What is the mission of SPIE?

SPIE is a not-for-profit organization with a primary mission to serve our members and the international engineering and science communities by providing high quality information and educational products and services. Our complete vision and mission statements can be found on our website at www.spie.org.

SPIE Science and Technology Strategist and PHOTON2 National Visiting Board member Ronald E. Scotti.

What do you do at SPIE?

My responsibilities in this position involve monitoring the status of the technologies associated with optical engineering and provide the staff with information on the latest trends in these fields. I work with the staff and the volunteer leadership to make sure our programs reflect the newest information and latest topics.

How do you see your role as a member of the PHOTON2 NVB?

I help provide oversight to ensure that the Photon 2 project goals are achieved. This involves monitoring and reporting on the progress of the educational programs and providing insights that may help or facilitate these programs.

What aspects of your previous work experience and work at the SPIE can help bring a special expertise to the Advisory Board?

Well, my background and experience in the field of optics provide technical expertise to assure the programs are current and relevant. In addition, through mentoring and training a number of students and employees I have an understanding of what works in a learning environment. Finally, my network of technical and business contacts are an important asset in helping to introduce the PHOTON2 program to different geographical areas and find supporting agents in those areas.

How do you think PHOTON2 can best serve the needs of students and employers in the optics/photonics industry?

An educated workforce is the key to the success of the future of any technical industry. The optics and photonics industry touches our daily lives in many ways and yet it is a relatively new industry from a commercial and industrial viewpoint. I believe this technology will continue to grow in its importance as it provides the means to understand processes that impact the quality and cost of many future products. An example is the pharmaceutical industry where fluorescent spectroscopy is a mainstay of high throughput screening in drug discovery and infrared imaging spectroscopy is just beginning to provide critical information on the uniformity and quality of their products that they are not able to obtain by other means.

I believe the PHOTON series of projects provides a previously missing introduction to the optics and photonics technologies for educators at several levels. These programs are also an excellent avenue to present the future career opportunities in optics and photonics to a broad audience. ■

Lonnie LeClair

Lonnie LeClair of New Hampshire has had a long career working in fiber optics cabling and research and development. He has done coursework with Dave Miller of New Hampshire Community Technical College at Pease, who is currently a participant in Project PHOTON2.

PHOTON2 News *spoke with Mr. LeClair about his experiences in the fiber optics field, his background, and his views on career paths in the industry.*

Describe your current work.

Currently I work for Integrisys Communications doing networking cable installation. I've done several large jobs for Integrisys, including work for Liberty Mutual Portsmouth building a fiber optic backbone for their offices. Typically I'm installing 50-micron multi-mode fiber.

How did you become interested in fiber optics?

I started out in the military. From 1980 to 1983 I was a computer maintenance technician with the Air Force.

My introduction to fiber was as a cable TV technician in Florida. That got me interested in learning about fiber. For Christmas my parents said I could have anything I wanted. I asked them to pay for a week-long course in fiber at Corning Cable.

When I moved back to New Hampshire (that's where I grew up) I got a job with White Mountain Cable Construction and worked there for five years.

After White Mountain, I was with JCI Communications in Boston. There I implemented a program of fiber documentation to provide customers with test results. JCI is now NetVersant.

> "For Christmas my parents said I could have anything I wanted. I asked them to pay for a week-long course in fiber."

After JCI I worked at Eigenlight in Somersworth, NH. I worked in the R&D lab under Dr. Craig Poole, sculpting fiber with a CO2 laser. But Eigenlight was hit hard by the tech crash, and I was laid off. I did some small cabling work until I got the Integrisys job.

What is your educational background?

I did a lot of learning on the job, and I've taken several small classes along the way to pick up nuances and little techniques. I've done classroom demos for Dave Miller [at New Hampshire Community Technical College].

I've been working toward my Associate's degree at NHCTC, with the goal of becoming a network administrator, but my current position has me working very far out of town, so I haven't had time to finish the general ed classes.

I'm currently certified as A+, Network+, Server+, CCNA, and Certified Fiber Optics Tech. I have also completed an Information Systems Technology certificate at NHCTC.

What do you enjoy most about your work in the optics industry?

In my current work doing installation and testing, I'd say the travel. I get to go to a different job site every day, and see different cities.

> "[In fiber optics,] on-the-job training will be a major factor in your career."

My favorite experience over my career was the time at Eigenlight. It was my first experience in a laboratory setting, where I was mentored by a Ph.D., Dr. Craig Poole, who is a former Bell Labs scientist. I was working with lasers, the polarization of laser light, how it behaves within fiber.

Can you describe that work in more detail?

We sculpted fiber with the lasers. We would use a CO2 laser, a cutting laser, to put a kink in the glass, and downstream we would cut reflective surfaces. That would tap off a portion of light and reflect to the detectors that monitored the amount of power in the fiber.

Would you change anything about your career in fiber?

I would have gotten my degree sooner. It's better to do that right after high school or the military, especially to get a strong background in physics.

What advice do you have for anyone interested in entering this field?

Study math and physics. Both of them apply greatly to engineering. Also, taking the classes offered by vendors is a big plus-they can give you the little tricks and things that you won't learn in traditional schools.

Experience is most important though. On the job training will be a major factor in your career. Most companies, if you just show up, won't let you take care of their fragile fiber until they know you have the experience to do it right. So maybe do side-alongs with technicians or job shadowing to get over that hump. ■

PHOTON2 Participant Gives Talk on Teacher Collaboration

Adrian Sebborn and Carl DeCesare of the Southwest Vermont Career Development Center in Bennington, Vermont, work with two students.

Adrian Sebborn recently realized unexpected benefits from his participation in the PHOTON2 project. Sebborn, a teacher at the Southwest Vermont Career Development Center in Bennington, Vermont, ran a workshop for his Center colleagues about teachers using each other as resources. The workshop was part of an Innovation grant funded by the Vermont State Department of Education.

Sebborn used PHOTON2 as an example of how individual teachers acquire specialized skills. He explained that although he was out of school for a couple of days to attend the initial photonics workshop, his colleagues would largely be unaware of what he was doing if it were not for announcing it now. Most people seemed surprised that a programming and networking teacher would be taking a photonics course. Equally they would probably not expect that his majors in college had been Education, Biology and Art and Design.

Frequently teachers have specialized skills and expertise of which their colleagues are unaware. As a result, often teachers do not know of the wealth of resources that are available to them from the people with whom they work. The purpose of the workshop was to open up channels of communication between teachers and allow them to discover the
hidden resources possessed by their colleagues.

As a result of the workshop, Sebborn, who teaches Networking and Artificial Intelligence in a technical school, has been invited to teach a photonics unit to students taking AP Physics at nearby Mount Anthony Union High School. Meanwhile his students will do some mechanics with the school's AP Physics teacher. He will also do similar projects with Earth science students from Mount Anthony and machine trades students from his own school.

The next step will be to bring in teachers from other area middle and high schools. Sebborn plans on using more examples from photonics. He describes the response to the workshops as very positive, with high school math students visiting machine trades classes to see practical applications of coordinate geometry with CAD and the CNC machines, for example.

"Even I was amazed at the diversity of skills available amongst this group," he said. "It ranged from violin making to work experience at Los Alamos [National Laboratory]." ■

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