PHOTON PBL NEWS

A Project of the New England Board of Higher Education (NEBHE)

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PHOTON PBL 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).

Please visit our website:
www.photonprojects.org.

Program Staff:

Fenna Hanes
Sr. Director, Professional & Resource Development
617/357-9620 x129
fhanes@nebhe.org

Lisa M. Goldstein
Newsletter Editor & Program Coordinator
617/357-9620 x113
lgoldstein@nebhe.org

45 Temple Place ■ Boston, MA 02111

PHOTON PBL Develops Four New Challenges

Lighting Efficiency Challenge

In today's world, energy conservation is critical. Lighting alone costs billions of dollars worldwide each year. Unfortunately, much of this energy is wasted; the output of an incandescent light is about 95% heat; only 5% is usable light.

At research laboratories such as the California State Polytechnic University (CSPU) Center for Lighting Education and Applied Research in Pomona, CA, the next generation of lighting sources and fixtures is being developed and tested. Co-PIs Judy Donnelly and Nicholas Massa traveled to CSPU in November 2007 to film Professor Massoud Moussavi's engineering students test the truth of a statement on the package for a 26-watt fluorescent bulb that claims the bulb's output is the same as a 100-watt incandescent.

Moussavi began by explaining the challenge. He then split his students into groups and had them list what facts they knew and what they needed to research. After conducting research in the state-of-the-art lighting lab and holding several brainstorming discussions, students were able to describe their solutions. As a result of this active learning activity, the students now have a tangible understanding of the benefits of each type of lighting and how and why scientific research can determine which choice is superior in terms of energy savings.

CSPU students (from left) Erick de Guzman, Joseph Hu, Deborah Mueller, Randy Gomez, and Benjamin Garcia.

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PHOTON PBL Instructors Field-test the Challenges

PBL thrusts students into uncertain learning situations, where problem parameters are not well defined and the task at hand may be ambiguous – just like the real world. To ease this transition, the PHOTON PBL Challenges are designed with three levels of structure: Level 1 (Instructor Led - Highly Structured), Level 2 (Instructor Guided - Moderately Structured) and Level 3 (Instructor as Consultant - Open-Ended). The level used depends on the technical nature of the problem and ability level of the students. This format allows students (and faculty) to progress through the PBL Challenges along a continuum, from a low student autonomy mode (highly structured) to high student autonomy mode (open-ended) over time, improving the likelihood that both students and faculty will adopt and embrace this new mode of instruction.

Gary Beasley is the lead instructor of the two-year associate degree Laser and Photonics Technology program at Central Carolina Community College in Lillington, NC. He used the Photomachining Challenge with his second year students. The students were presented with the Challenge and given seven hours to complete it.

Beasley's students were very engaged in the learning process.

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Creating the PBL Challenges

By Judith Donnelly, PhD

For the PHOTON PBL Principal Investigator (PI) team, the process of developing multimedia industry-based Challenges has itself been an exercise in problem-based learning.

The first step was to identify potential industry and research university partners who could provide challenges that would be engaging, preferably interdisciplinary across science, technology, engineering and mathematics (STEM) subject areas and involve optical principles common to a physics or technology course.

An initial workshop with industry and university partners was held in January 2007 after the partners were identified. First, the PIs introduced PBL as an instructional method. Participants discussed problem solving in their own organizations and offered possible PBL Challenge problems typical of their own company or institution. Workshop discussions revealed that a Challenge and its solution must be clearly defined before the on-site visit to avoid confusion later during production.

So far, the PHOTON PBL team has held on-site workshops at six of the eight partner organizations, typically over a one and a half day period. On the first afternoon, the PBL team meets with the host participants to explain problem-based learning as a teaching method, as well as the process of creating a PBL Challenge. The PBL team then tours the facility, views the problem and its solution, and plans the following day's recording sessions.

The next day, events are staged for videotaping. First, the technical team recreates the introduction of the Challenge problem such as a manager speaking at a staff meeting or a customer requesting a new manufacturing process. The next step is to conduct a brainstorming discussion of possible methods to solve the problem. The final session reveals the organization's solution to the problem. The outcome of each workshop is four to six hours of video and 500 to 950 still photos.

The goal of the PHOTON PBL video production team is to create a short two or three minute long video presentation of each session. The raw video is first edited to 60-90 minutes and a written transcription is produced. Three scripts are developed using the transcription as a guide: problem statement, discussion and solution. Each final Challenge video is assembled using voice-overs and still photos with a few frames of video. Two background video segments are also produced—a general introduction to the Challenge context and an overview of the company or university.

While the videos are being developed, the PI team is also working on instructional resources to supplement the multi-media presentation, such as web links, PDF documents and short video segments on related topics. To guide students in the problem solving process, the challenges also include an innovative "white board" screen projected directly onto a classroom's white board. This graphic allows students to organize their thoughts and plan the next stage of learning and problem analysis.

Teachers are often reluctant to use a teaching method that they do not feel comfortable with, and students with little or no problem solving experience are unlikely to succeed if thrown into an open-ended problem situation. The PHOTON PBL model is flexible enough to handle different levels of users. Teachers of beginning problem solvers can show all three video sessions—problem statement, brainstorming discussion and solution—just pausing to allow time for student discussion or teacher explanation. More experienced problem solvers may view the problem statement with a brainstorm session used as needed in order to guide students toward a solution. Expert problem solvers may simply view the problem statement and are then left to devise their own path to a solution.

In each case, after students have presented their own solution to the challenge, they are shown the organization's solution to compare and contrast with their own. The fact that the students may arrive at a different solution than the organization's reinforces the importance of creativity and innovation and demonstrates that most problems have more than one possible solution.

The first three Challenges were completed in time for the July 2007 professional development workshop held at Roger Williams University in Bristol, RI. These summer workshop participants have been field-testing the Challenges in their own classrooms this year.

One student commented, "The video made it more exciting because it made you feel like you were in a real world environment, with many people working on a common goal." One community college instructor remarked, "The level of enjoyment shown by the students was demonstrated by the quality of the work that they prepared for the second class session. They were all active participants in the development and presentation of their designs." Another instructor commented, "There were a lot of high fives all around when they saw that their solution was much like the company solution." ■

Judith Donnelly is professor of physics at Three Rivers Community College in Norwich, CT. She can be reached at jdonnelly@lasertechonline.org.

Field-testing, continued from page 1

They used problem solving skills, teamwork and research to analyze the problem and develop solutions. Students did not seem to be stressed and in fact were very motivated to research and solve the problem using the PBL format. The students believed they learned a great deal more by solving a real world problem than just by listening to a lecture or reading about it.

Comments included: "It was good that you could think outside the box for a solution, without having to have only one way to solve it." And "Enjoyed collaborating with teammates, which made it feel like you were working with fellow coworkers on a real problem."

PHOTON PBL teachers are finding that their students are more engaged in problem-based learning than in traditional lecture type classes. They are beginning to understand that learning and retention is not so much about getting the right answer as it is about *how* to arrive at the answer. Educators are also learning that successful teaching is not about knowing all the answers yourself, as much as knowing how to guide students to find the answers themselves.

JoAnn Flejszar, a science teacher at Oakridge High School in Muskegon, MI, field-tested the Photomachining Challenge in her physics class for 10th to 12th grade students. Seventy percent of Oakridge High students receive reduced lunch subsidies and only 14 percent of parents have some postsecondary education.

Flejszar knew that she wanted to include optics and photonics in her physics class but she herself lacked the content knowledge. In spring 2007 she participated in NEBHE's PHOTON2 "Introduction to Photonics" professional development course delivered by Co-PI Judy Donnelly through Three Rivers Community College's distance learning program. This led to her participation in the summer 2007 PHOTON PBL professional development workshop held at Roger Williams University. She returned home ready to field-test the Challenges.

Flejszar was eager to obtain a PHOTON2 lab kit to complement the Challenges, but her school could not afford to buy it. She successfully wrote a grant proposal to SPIE to purchase the kit, lab exercises and lab videos. She also used the Optical Society of America's Optics Discovery Kit.

She began by introducing the Photomachining Challenge, somewhere between a guided and open-ended exercise. She first gave her students a set of questions they should answer and showed them the discussion segment of the Challenge before they began their research.

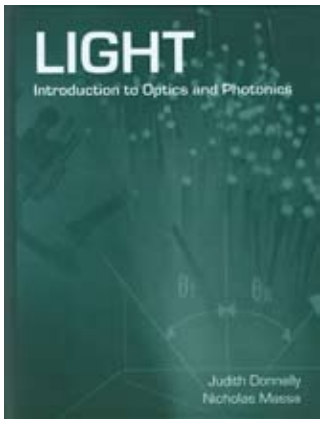
The students enjoyed the videos and the fact that the Challenge addresses a real question from a real company. At first, the students were somewhat frustrated because she did not give them the answer and allowed them to struggle a bit. However, "The kids blew me away with what they can come up with," she said.

For their work on the Challenges, Flejszar's students are graded on the process of finding the answers. Consequently, they are at a point where they realize that learning is about solving problems and they can accept not knowing the answer right away.

Now in her second year of teaching physics, the high demand for Flejszar's hands-on physics class resulted in the school adding a second Physics section next year. The school administration also increased the graduation requirement from two to three science courses.

Committed to the PBL model, Flejszar will attend the PHOTON PBL summer 2008 workshop at Boston University's Photonics Center so she can work on the four new challenges that will be ready for field-testing during the next academic year. ■

For information on the July 27-August 1, 2008 professional development workshop, visit www.photonicsprojects.org.



LIGHT–Introduction to Optics and Photonics

By Judith Donnelly, Three Rivers Community College, and Nicholas Massa, Springfield Technical Community College.

This 15-chapter text provides an introductory overview of optics principles and photonics applications suitable for beginning college students, high school juniors and seniors, technicians, managers, or anyone who wants to learn about optical science and photonics technology at the algebra/trigonometry level.

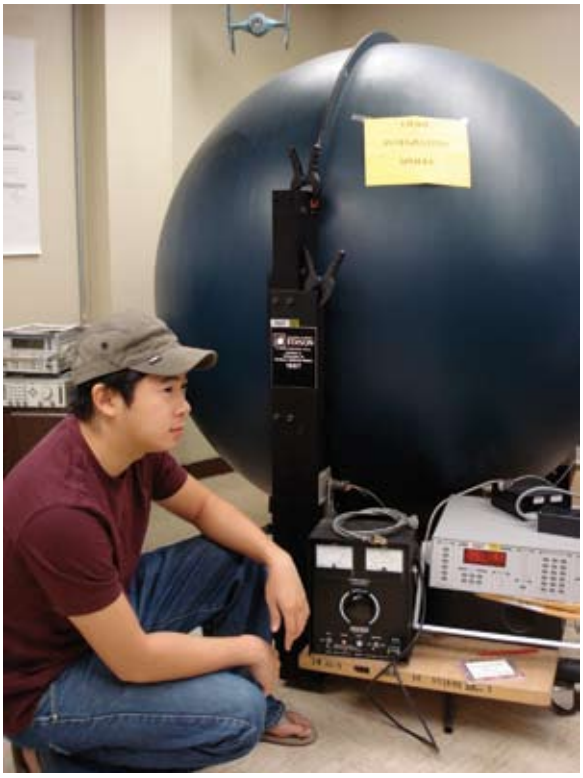
Written with the student in mind, the text features:

- plentiful illustrations
- a wide variety of optics/photonic applications in nature and technology
- three chapters on industrial applications written by industry experts
- questions and problems after each chapter

The book is available in full color (both hard cover and paperback), as a black & white paperback or as a download.

For sale at:
http://stores.lulu.com/PHOTON2

Workshop, continued from page 1



Joe Hsu and integrating sphere measure light bulb's output.

Blue Blanket Challenge

Photodigm, Inc., a specialist in photonics technology for communications, digital imaging, defense and medical device applications is located in Richardson, Texas. Founder, VP and CTO Gary Evans has worked with many university researchers over his 30-year career to remain on the cutting edge of technology.

One medical problem he and his colleagues at Southern Methodist University in Dallas and at Drexel University in Philadelphia are working on is how to best treat infant jaundice. About half of newborns develop jaundice due to an inability to clear bilirubin, an orange-yellowish chemical that results from the breakdown of the hemoglobin found in red blood cells.

For centuries, physicians have known about the healing power of light. A possible new form of phototherapy was discovered by accident when a doctor working in a nursery noticed that newborns whose cribs were near windows recovered from jaundice sooner than those babies near the center of the room.

Three different types of lighting systems have been developed to mimic the effects of natural sunlight. One type shines regular fluorescent or halogen lamps on the newborn. A second system uses a bright halogen bulb with fiber optic cable linking it to a flat panel. The baby lies on the panel, which has embedded optical fibers that shine light from below. The two systems are sometimes used together. The third form of phototherapy uses light-emitting diodes (LEDs) designed to operate at bilirubin's absorption wavelengths.

The Challenge is determining the best type of light to use. Can researchers devise a safe and effective way to expose a baby to this light in a home setting by creating a portable device that does not restrict the baby to a hospital isolette?

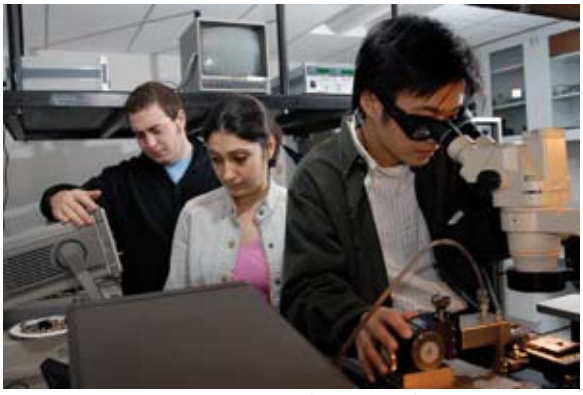
In December 2007, PI Hanes and Co-PI Donnelly visited Drexel University and met with Dr. Evans, SMU's Professor Gemunu Happawana, Drexel's Professor Arye Rosen and Dr. Har'el Rosen, a neonatologist with Onsite Neonatal Partners. They reconstructed the light problem so science and technology students can work through it as a Challenge.

Like other PHOTON PBL Challenges, students go through a problem solving cycle of analyzing the problem statement, conducting research and brainstorming sessions, and reaching one or more viable solutions. As described in Donnelly's article "Creating the Challenges," teachers decide the appropriate level of difficulty for their students.

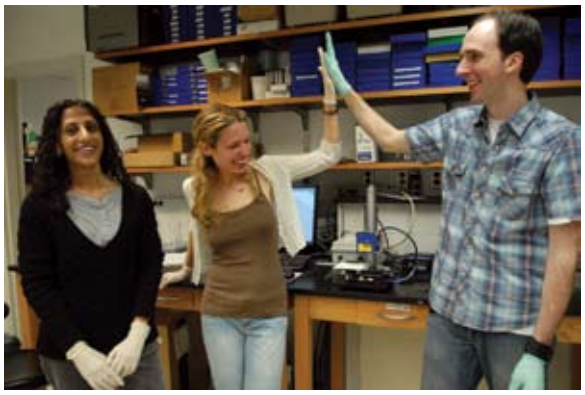
Two Other Challenges

In March, PI Hanes & Co-PI Massa joined multimedia consultant Michele Dischino at the University of Pennsylvania Medical School's McKay Orthopaedic Laboratory. They tested alumna Dischino's thesis of using lasers to measure the impact of tendon injury on the overall joint mechanism.

In April, Co-PIs Audet and Massa visited Pennsylvania State University's Electro-Optics Center in Freeport, PA, to create a Challenge about searching for a lost hiker in the woods. The students must determine which kind of Infra-Red (IR) camera is best to locate the hiker. One final challenge will be developed later this summer. ■



Drexel Universty students (from left) Nicholas Vacirca, Usmah Kawoos and Guanghai Ding work on a Challege.



From left, Nelly Andarawis, Michele Dischino, and David Beason celebrate the successfull filming of their Challenge at the University of Pennsylvannia Medical School McKay Orthopaedic Laboratory.

PHOTON PBL Dissemination Activities

The PHOTON PBL Principal Investigators, project consultants, collaborators and PHOTON2 participants have been busy spreading the word about the project at conferences and workshops across the country.

June 2007
International Bi-annual Education and Training in Optics and Photonics (ETOP) Conference sponsored by SPIE in Ottawa, Canada

- "PHOTON PBL: Problem-Based Learning in Photonics Technology Education" - Massa
- "International Photonics Training: A Case Study" - Hanes and Sporea
- "Development of an Industry Based Laser Manufacturing Degree Program" - Donnelly
- "Associate Degree in Optical System Technology at Pima Community College" - Han

ASEE Annual Conference and Exhibition in Honolulu, HI

- "LIGHT MAGIC: Optics and Vision" - Donnelly
- "Using Basic Computer-Aided Drafting and Design Courses at the Freshman Level to Improve Technology Students Competitiveness in Obtaining Early Academic Career Internships" - Moussavi

August 2007
SPIE Annual Meeting, San Diego, CA

- "Professional Development in Photonics: The Advanced Technology Education Project of the New England Board of Higher Education" - Donnelly

October 2007
NSF/ATE Annual Conference in Washington, DC

- "Problem-based Learning – One Foundation, Two Perspectives"- Hanes, Massa and Dischino in collaborations with the ATE/NSF Case Files Project's Loring and Jeanetta

January 2008
ASTE International Conference in St. Louis, MO

- "Integrating Engineering Concepts in Science Education" - Dischino

March 2008
NSTA Annual Conference in Boston, MA

- "Focusing Like a Laser Beam" - Audet, Dischino, Donnelly, Hanes, Massa and Magnani ■

Laser Institute of America Hosts College Grad Speakers

Industry representatives nd college students listen at LIA meeting.

The Northeast Regional Chapter of the Laser Institute of America (LIA) hosted a dinner meeting on February 26, 2008 at Springfield Technical Community College (STCC) in Springfield, MA. Many representatives of the region's laser industry attended. Chapter President Bill Shiner, VP of Marketing at IPG Photonics, organized the meeting to stimulate communications between educators and employers and focus on the critical need for skilled technicians who can work with new and emerging technologies driving this rapidly growing industry.

The meeting focused on regional photonics education. STCC Professor Nicholas Massa began the program with a tour of STCC's state-of-the-art laser electro-optics laboratory. After dinner, Professor Massa was joined by Professor Judy Donnelly who directs the Three Rivers Community College's Laser and Fiber Optics associate degree programs in Norwich, CT.

LIA generously provided funding for a large group of current STCC and TRCC students to attend the meeting and learn more about outstanding career opportunities. Several graduates of both schools' programs also spoke about how their classes had prepared them for careers in the laser industry.

STCC graduate speakers included Gary Mansfield, currently an intern in the Research and Development Lab at IPG Photonics in Oxford, MA, and Gina Ferrara, a manufacturing engineer at ITT Power Solutions in West Springfield, MA. TRCC college grads included Robert Bernier a field service technician at Heuttinger in Farmington, CT, and Ray Brohinsky a laser technician at IPG Photonics.

To learn more about LIA, visit http://www.laserinstitute.org/. ■

Melissa and Michelle Redish – A Family Affair

Career Spotlight

Melissa Redish learned about the laser program at Central Carolina Community College (CCCC) in Sanford, NC, through a one-day Saturday workshop program for middle school students that she attended with her youngest daughter, Bonnie. At the time, Melissa was an assistant teacher in the public school system; however she was so impressed by the laser program that she enrolled the following fall.

Melissa raved about her classes to her older daughter, Michelle, a sophmore studying accounting. The following year Michelle transferred to CCCC to join the laser program herself. She graduated just one year after her mother, and both now work at Northrop Grumman Corp. (NGC) building lasers.

Melissa Redish (left) and Michelle Redish at work.

Attracted to Lasers

Melissa
The many types of lasers and job opportunities all over the country caught my attention. I also saw the need for more women in this growing field. That and a NdYag laser burning a hole through a brick and a really cool laser light show redirected my career goals. [While teaching] I saw a lot of girls that were great in math and science not even considering going into those fields. But, "Do as I say, not as I do" doesn't work. So, I decided to set the bar higher for my daughters and maybe inspire other young women.

Michelle
I had been switching majors a lot at the college I previously went to. I started out a chemistry major but moved on to psychology and then accounting. I knew I was good at math and science but didn't know of a lot of options that appealed to me. My mom had shown me some of her coursework and looking at it I just thought to myself, "I can do that." I went on a tour of her program and was hooked after seeing some of the applications of lasers, in particular the Argon-Krypton laser set up to direct the beam with mirrors around the room and a sample of a hologram. The day of the tour I started the paperwork to transfer to CCCC.

Getting Started

Melissa
The staff at CCCC provided exactly the training and education needed here at NGC Laser Systems. Their example and expectations of professionalism and teamwork were very important in transitioning from school to workforce. Everything we do here relates back to the lab and classroom experiences we received. Now my youngest daughter is considering going to CCCC and studying Lasers and Photonics to receive hands-on experience before going into engineering.

Michelle
CCCC provided me with hands-on experience working with electrical and optical equipment. I was one of those people who started the program not even knowing what a multi-meter was except that it was one of those tools my dad used occasionally, so I could have easily been overwhelmed. The class sizes were small so I was able to receive help if needed. It also allowed me to get used to working in a team-oriented environment, as well as figuring things out logically myself.

Current Work

Melissa
I miss the kids and the many wonderful creative things I learned from them [but] I love doing something different everyday around people who enjoy sharing their knowledge and experience. This is definitely a career field that allows you to think and share ideas. The potential growth for this industry now and in the future is amazing.

I have just been promoted to Laser Tech II. I currently work on the Mark VIIE program as well as continue to support the Common Resonator lab. I have the privilege to work with many talented people. On a daily basis I align, troubleshoot, provide engineering support and test the Mark VIIE from chassis to finished product. The products we build go directly to our ground forces in Iraq and Afghanistan, and giving them the best is always first priority.

Michelle
At the moment I am an entry-level laser technician, working toward a Laser Technician II hopefully in the next year. I work on the Viper program where my team builds, troubleshoots and repairs reliable lasers to move on the next level of assembly. The quality of our units is critically important since its purpose is to protect our soldiers from the air.

I love learning something different each day at work either from the people I work with or from the unit itself. This is a field where the people you meet today will help you out both now and in the future, especially since this is a growing field with endless possibilities. ■

CCSU Tech Ed Students Participate in Challenge Development

Students in Central Connecticut State University's Technology and Engineering Education program are preparing to teach in technology education programs in Connecticut middle and high schools.

One requirement of the 15-week Communications Systems course is that students develop their own multi-media educational tool using Adobe Premier, Photoshop and Flash. Professor Michele Dischino, multi-media consultant to the PHOTON PBL project, proposed a contest: creating a one- to two-minute video introduction for one of the PHOTON PBL Challenges currently in development.

Students were shown two different PBL Challenges, the Lighting Efficiency and the Blue Blanket Chllenges. They were also supplied with written and audio scripts, and a list of resources including weblinks, photos and videos about the Challenge topics. Students could choose which Challenge to use, and either work individually or in a small team of two or three. Dischino provided guidance as needed.

After five weeks, students and project PHOTON PBL leaders gathered to judge the completed introductions. Judges used a field-tested rubric for evaluating oral presentations in many areas: coherence, video quality, audio quality and copyright issues. First, second and third place cash prizes were awarded to the top introductions. Additionally, each participant was awarded a $25 gift certificate to Amazon.com. "We wanted to recognize each student's effort and contribution to the development of new "real-world" instructional materials," said Professor Dischino. A pizza party and lively discussion followed the brief ceremony. ■

Professor Michele Dischino (fifth from left) with her students and Professor Nicholas Massa (far right).

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45 Temple Place
Boston, MA 02111
617/357-9620

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