PROGRAM GUIDE

the accelerating universe of PHYSICS EDUCATION

AAPT 2007 SUMMER MEETING

JULY 28 - AUGUST 1

AAPT GREENSBORO 2007

Welcome to Greensboro

Welcome to beautiful Greensboro and **The Accelerating Universe of Physics Education:** the biggest and best AAPT meeting ever. With more than 500 papers and posters and 132 sessions and workshops, you are sure to find quality physics information, custom designed for your every interest. Kick back and immerse yourself in exciting physics and physics education from NASCAR to the Vatican Observatory, Nanotechnology to the Milky Way, AP Physics to Graduate Research, Art Museums to String Bands—whatever your heart desires. In addition to all of the informative and inspiring presentations, don't miss any of the special events: cutting-edge exhibits; world-famous plenary speakers; solar viewing; the High School Day and Historically Black Colleges and Universities (HBCU) Day activities; Physics Apparatus, Photo, and Video Contests; High School Share-A-Thon;the uniquely North Carolina "egg"citing Picnic and Physics Demonstration Show; and all of the committee meetings and crackerbarrels. I promise you will have the opportunity to experience Southern hospitality at its finest and learning at its best.

Thanks to our wonderful local hosts, Steve Danford (UNCG) and the North Carolina section of AAPT; AAPT Programs and Awards Committees; the paper sorters; the AAPT Executive Board and Central Office staff, and all of the many dedicated people who made this meeting possible. Special thanks to Mary Creason of Duke University, who dreamed of this meeting many years ago but was killed in a traffic accident in May. We are dedicating this meeting to Mary—in her honor in memory—for all the hard work and insight she gave. (See also page 2.)

It has been my pleasure to serve as AAPT Program Chair for Seattle and Greensboro, and I'm now pleased to pass the torch to Vice President Alex Dickison, who will serve as Program Chair for Baltimore and Edmonton. Best of luck, Alex.

Lila Adair, AAPT President-Elect and Program Chair
Piedmont College, Athens, GA

In Honor and Memory

Dr. Mary Alice Putnam Creason was the inspiration for this meeting—Mary proposed many years ago that an AAPT Summer Meeting be held in North Carolina, and then she worked hard to make it happen. Unfortunately Mary and her husband Jim were killed in a car accident May 12, 2007. Mary was known for her dedication to AAPT on both the local and national levels. Bill McNairy, President of the NC section of AAPT, said, "Mary was never as happy and fulfilled as when she attended an AAPT meeting." Her smile was contagious and yet she never seemed to tire in her efforts to share her love of science teaching in the classroom, at AAPT workshops on forensic science and laboratories, and during PIRA activities at summer meetings. One student said, "She was so nice, supportive and caring; one of the people who really stuck in my mind and who made that my best meeting ever by far."

Mary was a Lecturer and the Director of Introductory Laboratories at Duke University, and had served several years as Secretary/Treasurer of the North Carolina Section of AAPT. In her honor, the local planning team continued diligently with the many plans and arrangements that Mary had started. We are certain they have put together a meeting that would have made Mary proud.

Lila Adair, Program Chair, said, "Mary, we will miss you, and all of your friends and colleagues dedicate this program to you. Thank you for all you did to make this the biggest and best AAPT meeting ever."

The Accelerating Universe of Physics Education

2007 AAPT Summer Meeting–Greensboro, NC

July 28–August 1, 2007

Joseph F. Koury Center &
University of North Carolina (UNCG)

Featuring

- Plenaries
- Workshops and Exhibits
- Invited and Contributed Sessions
- Award Lectures by Leading Educators
- AAPT's Semiannual Business Meeting

AAPT

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Thank you to local organizing committee

Mario Belloni, Davidson College, Davidson, NC
Mary Creason, Duke University, Durham, NC
Steve Danford, University of North Carolina–Greensboro
Jose D'Arruda, University of North Carolina–Pembroke
Ed Hellen, Davidson College, Davidson, NC
John Hubisz, North Carolina State University, Raleigh, NC
William McNairy, Duke University, Durham, NC
Promod Pratap, Davidson College, Davidson, NC

Thank you to our paper sorters

Lila Adair, Piedmont College, Demorest, GA
Mary Creason, Duke University, Durham, NC
Alex Dickison, Seminole Community College, Sandford, FL
Wayne Fisher, Myers Park High School, Charlotte, NC
Floyd James, North Carolina A&T State University, Greensboro, NC
Rachel Scherr, University of Maryland, College Park

With Appreciation

The AAPT Meetings Committee thanks Shodor Education Foundation and UNCG Reynolds for their generous contributions toward scholarships for local teachers to attend this meeting.

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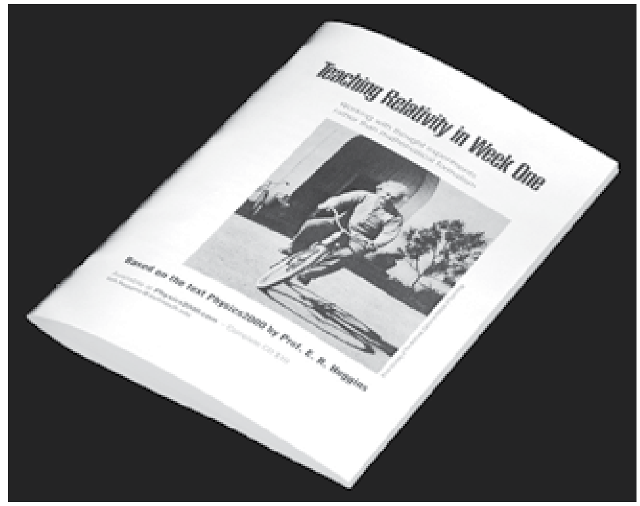
AAPT Executive Officer

TEACHING RELATIVITY IN WEEK 1

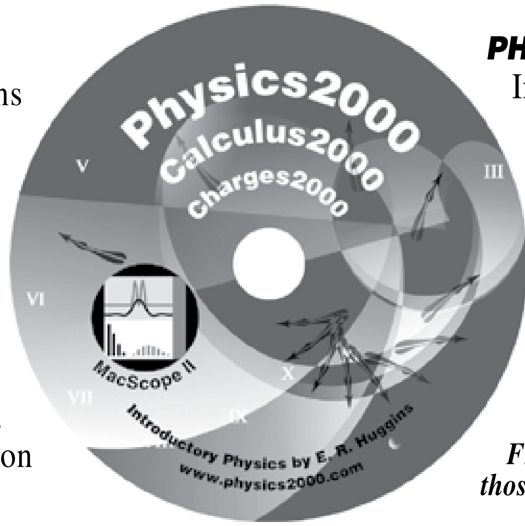
The ***Physics2000 textbook*** introduces a way to teach a comfortably paced one-year introductory physics course that ***integrates modern physics***. That is done by ***starting with Special Relativity in week one*** and then incorporating 20th century concepts as you go along. For example, after you finish discussing light waves, you go right to photons and the particle-wave nature of matter.



To see how this is done, come to the Physics2000 workshop on Tuesday, 1:30 to 3:30.

PHYSICS2000 CD

This $10 CD contains everything: the complete Physics2000 text, 20 movies, the Calculus2000 text, and the shareware program MacScope II. The 2 volume paperback version of the text is $25. Hardcover version $40.

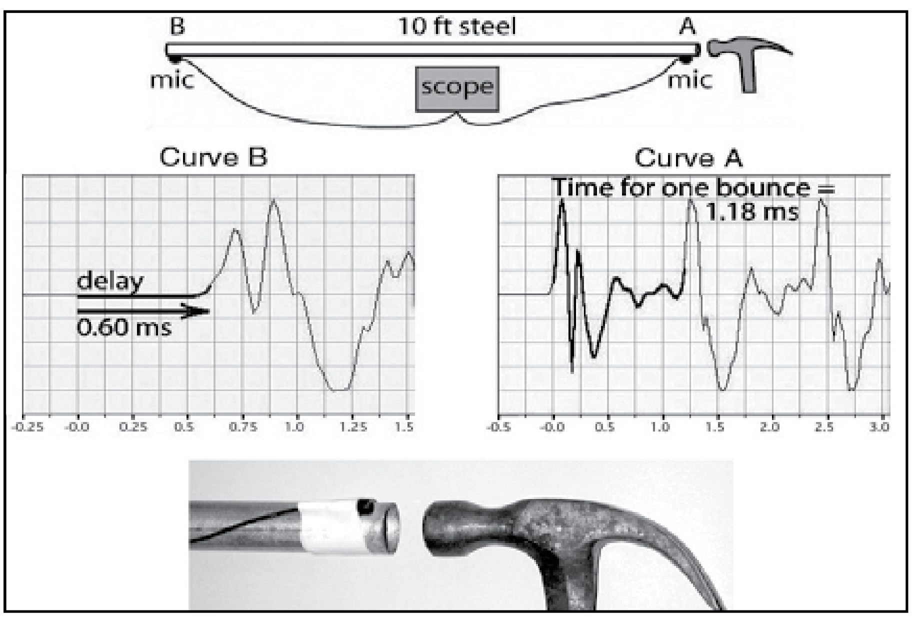


PHYSICS2000 WORKSHOP

In the workshop we show you how to start with special relativity in the first week, and fit 20th century topics in as you go along. As examples, we discuss introducing magnetism from Coulomb's law and the Lorentz contraction, and then how to teach the time-energy form of the uncertainty principle using the ***Fourier analysis*** capability of MacScope II.

Free Physics2000 CD and printed texts for those who attend the workshop.

www.physics2000.com



MACSCOPE II AS AN EASY TO USE, INEXPENSIVE, LAB SCOPE

We taped 2 microphones to the ends of a steel pipe, plugged them into the stereo input and used MacScope to measure the time it took the sound pulse to travel down the pipe. We can also see the pulse bouncing back and forth. Total equipment cost, under $100 plus a USB equipped computer.

Cyber Cafe

The AAPT Cyber Cafe will be available daily for checking email.

Speaker-Ready Room

There will be a speaker-ready room in the McCormick room where all presentations (invited and contributed) must be taken in advance.

The Speaker Ready room will be open during the following hours:

Sunday, July 29: 4–9 PM.

Monday, July 30: 12 noon–2 PM

Tuesday, July 31: 12 noon–2 PM

Wednesday, Aug. 1: 12 noon–2 PM

Audiovisual Equipment

Audiovisual Equipment other than a computer and computer projector must be ordered 24 hours in advance by contacting Amanda King with A&V Company: aking@avcompany.com

New Session for Graduate Students!

Title: **Cutting-Edge Physics Research in Simple English**

When: **Tuesday, July 31, 2007**
9-11 am and 3-5 pm

Where: **Koury Center–Imperial E**

For the first time ever, this new session will be for graduate students to practice presenting their research. They will receive feedback from an expert on their presentation skills.

Contact Information

AAPT Programs and Conferences Department

Staff: 301-209-3344 or 301-209-3040

Warren Hein, Chief Academic Officer, whein@aapt.org

Maria Elena Khoury, Director, mkhoury@aapt.org

Tiffany Hayes, Associate Director, thayes@aapt.org

Natasha Randall, Meetings Assistant, nrandall@aapt.org

Jacqueline Determan, Corporate Accounts Manager, jdeterma@aapt.org

Annette Coleman, Programs Manager, acoleman@aapt.org

Janet Lane, Programs Coordinator, jlane@aapt.org

Onsite Registration Desk

336-292-9161 x 5164 (from outside hotel); ext. 5164 (from inside Hotel)

Shuttle Bus Schedule

Workshop AM & PM Shuttle Schedule

Workshop Shuttle Service for JKCC & UNCG-McIver Physics Bldg. (MPB)

Saturday & Sunday July 28 & 29

Departs UNCG at 7:15 AM for JKCC AM & Full Day Workshops
Departs JKCC at 7:30 AM for UNCG-MPB AM & Full Day Workshops
Departs UNCG-MPB at 12:15 PM for JKCC PM Workshop
Departs JKCC at 12:30 PM for UNCG-MPB PM Workshops
Departs UNCG-MPB at 5:15 PM for JKCC PM & Full Day Workshops
Departs JKCC at 5:30 PM for UNCG-MPB PM Workshop

Event PM Shuttle Schedule

Sunday, July 29, 2007—Welcome Reception Shuttle Service

1. Pick up at 6:00 PM from UNCG-Dorms to JKCC (Committee Meetings)
2. Pick up at 7:00 PM from UNCG-Dorms to JKCC (Welcome Reception)
3. Pick up at 9:00 PM from JKCC to UNCG-MPB
4. Pick up at 9:30 PM from JKCC to UNCG-MPB
5. Pick up at 10:00 PM from JKCC to UNCG-MPB
6. Pick up at 10:30 PM from JKCC to UNCG-MPB

Tuesday, July 31, 2007—Picnic Shuttle Service

1. Pick up at 5:00 PM from JKCC to UNCG (Evening Event: Picnic—4 buses)
2. Pick up at 5:30 PM from JKCC to UNCG-MPB
3. Pick up at 7:30 PM from UNCG to JKCC
4. Pick up at 8:30 PM from UNCG to JKCC
5. Pick up at 9:00 PM from UNCG to JKCC
6. Pick up at 9:30 PM from UNCG to JKCC

Daily AM & PM Shuttle

Monday, July 30, 2007—AM Shuttle Service

1. Pick up at 7:00 AM from UNCG-MPB to JKCC
2. Pick up at 8:00 AM from UNCG-MPB to JKCC

Monday, July 30, 2007—PM Shuttle Service

1. Pick up at 6:00 PM from UNCG-MPB to JKCC
2. Pick up at 8:15 PM from JKCC to UNCG-MPB
3. Pick-up at 10:15 PM from JKCC to UNCG-MPB

Tuesday, July 31, 2007—AM Shuttle Service

1. Pick up at 7:00 AM from UNCG-MPB to JKCC
2. Pick up at 8:00 AM from UNCG-MPB to JKCC

Tuesday, July 31, 2007—PM Shuttle Service

1. Pick up at 10:30 PM from JKCC to UNCG-MPB

Wednesday, August 1, 2007—AM Shuttle Service

1. Pick up at 7:00 AM from UNCG-MPB to JKCC
2. Pick up at 8:00 AM from UNCG-MPB to JKCC

Wednesday, August 1, 2007—PM Shuttle Service

1. Pick up at 5:30 PM from JKCC to UNCG-MPB

KEY

JKCC: Joseph S. Koury Convention Center
UNCG-MPB: University of North Carolina Greensboro–McIver Physics Building

Greensboro — A City of Connections

The lunch counter where the first civil rights sit-in occurred.

Beautiful parks and recreation areas, historical sites, educational institutions, dining, and nighttime entertainment will greet you in Greensboro, NC. Nestled in the Piedmont Triad area along with Winston-Salem and High Point, Greensboro is host to AAPT's 2007 Summer Meeting.

History of Greensboro

Saura and Keyauwee Indians were the earliest inhabitants of Piedmont North Carolina. Permanent settlement of the area by Europeans began around 1740.

The city is named after Maj. Gen. Nathanael Greene, who led 4,400 American rebels in three battle lines at Guilford Courthouse on March 15, 1781. Gen. Cornwallis held the field after an intense, two-hour fight, but lost one-quarter of his army, which hastened his eventual defeat at Yorktown seven months later.

The Blandwood mansion, open as a museum.

The town was officially formed in 1807. By the mid-1800s the seeds for its future as a textile, insurance, and transportation center had been planted. In 1828 the first textile mill opened, and in 1850 the first insurance company opened. The first coeducational institution in North Carolina was established here in 1837 by Quakers. Called the New Garden Boarding School, it continues as Guilford College today. Quakers here also established the first Underground Railroad in the 1830s. North Carolina was the last state to secede from the union during the Civil War.

The textile industry and the railroad contributed to progress into the 20th century.

In 1960, Greensboro was the site of the first Civil Rights era sit-in, when four African American students from N.C. A&T University refused to accept a lunch counter color bar. Today they are memorialized with a statue on the campus of N.C. A&T. The original lunch counter at the Woolworth Building is to be the centerpiece for the International Civil Rights Center and Museum, currently under construction.

Education

The University of North Carolina at Greensboro is part of the University of North Carolina system, which was the first public university to open in the nation. The city is home to several other universities and colleges, including: Bennett College for Women, Elon University School of Law, Greensboro College, Guilford College, Guilford Technical Community College, and North Carolina Agricultural & Technical University.

The Natural History Museum.

Photos courtesy Greensboro Area CVB / Dan Routh Photography

Things to Do in Greensboro

- ***Blandwood Mansion:*** The former home of Governor John Motley Morehead, this mansion is surrounded by four acres of beautiful gardens. The main structure, an example of Italianate architecture, was built onto an original four-room farmhouse that was constructed on the site in the 1790s. (447 West Washington St., Greensboro.)

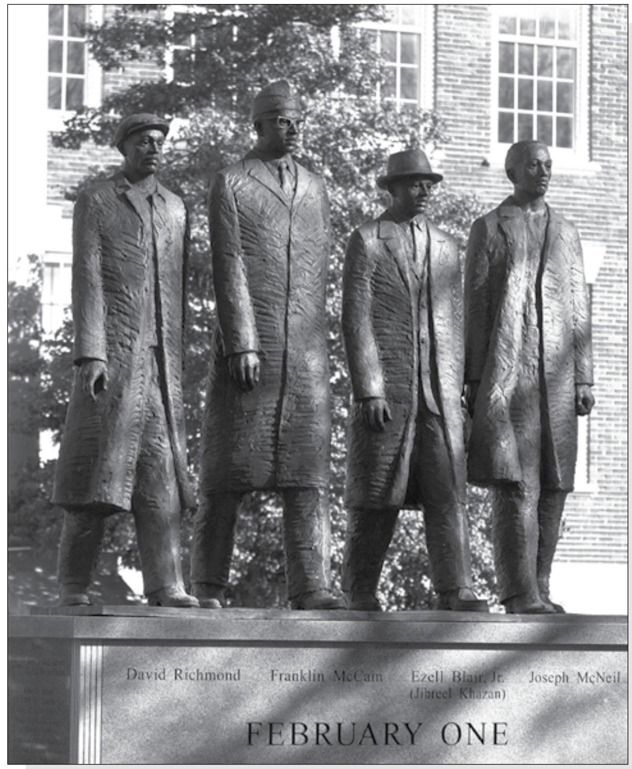
- ***Natural Science Center:*** This hands-on museum features a zoo, an aquarium, a planetarium, educational programs, and an educational gift shop. Visitors can roam through a Dinosaur Gallery, see snakes and amphibians in the Jaycee Herpetarium, learn about gems and minerals, and enjoy a petting zoo while at this center. (4301 Lawndale Drive, Greensboro.)
- ***Greensboro Historical Museum:*** Discover American history through the stories of Piedmont people and events in 12 galleries and two restored houses. (130 Summit Ave., Greensboro.)
- ***The Guilford Courthouse National Military Park*** is a memorial to the March 15, 1781 Revolutionary War Battle. Located off U.S. Highway 220 at 2332 New Garden Road.
- ***Greensboro Children's Museum***—real cockpit, police car with sirens, kid-sized grocery store and more. (220 N Church St., Greensboro.)
- ***Wet 'n Wild Emerald Pointe***—water park located on S. Holden Road. (www.emeraldpointe.com)
- North Carolina is home to 61 ***wineries,*** including wine tasting vineyards. Guilford County has Grove Winery and Stonefield Cellars Winery, where tours and tastings, along with sales, are available. See www.ncwine.org for details.
- ***Greensboro Scenic Tours***: History comes alive through costumed interpreters who reveal the city's past through the eyes of the people who lived it. (301 S. Greene St., Suite 12; 336-697-7275.)

Shopping

- *The Shops at Friendly Center*—includes Macy's, Banana Republic, Old Navy, Ben and Jerry's, and more.
- *State Street Station*—35 specialty shops, restaurants, and boutiques housed in elegant refurbished 1920s vintage buildings.
- *Four Seasons Town Centre*— recently renovated mega mall with Dillard's, Belk, Ann Taylor, more.
- *Replacements Ltd.* —tour showrooms, museum, warehouse, and restoration facility of the world's largest retailer of old and new china, crystal, flatware and collectibles.

Transportation

Piedmont Triad International Airport is served by six major carriers. Amtrak and Greyhound Bus also serve the area. And Interstates 40, 85, and 73/74 all intersect in Greensboro.



The A&T Four statue.

Weather

The warmest month of the year is July with an average maximum temperature of 88.20 degrees F. Temperature variations between night and day tend to be moderate during the summer with a difference that can reach 22 degrees. The annual average precipitation at Greensboro is 46.92 inches. Rainfall is fairly evenly distributed throughout the year. The wettest month of the year is July, with an average rainfall of 4.73 inches.

More Information

- Sheraton Greensboro/Koury Center: http://www.kourycenter.com/default.shtml
- Greensboro Convention and Visitors Bureau: www.greensboronc.org/
- Greensboro Chamber of Commerce: www.greensboro.org.

Special Events

SUNDAY, JULY 29

H.S. Share-a-thon	4:30–6:30 PM	Imperial D
SPS/AAPT Poster Reception	6:30–8 PM	Colony B-C
Welcome Reception	8–10 PM	Imperial D

MONDAY, JULY 30

First-Timers Gathering	7–8 AM	Auditorium I
TYC Breakfast (ticket)	7–8 AM	Heritage
Retirees' Breakfast (ticket)	7–8 AM	Meadowbrook
Photo Contest Viewing & Voting	7:30 AM–10 PM	Exhibit H.
Exhibit Show	8 AM–2 PM and 4–6 PM	Exhibit H.
Poster Session I	8–9 AM and 5–6 AM	Exhibit H.
Spouses Gathering	9–9:30 AM	Augusta B
Apparatus Competition Viewing / PIRA	9 AM–4 PM	Colony A
TYC Resource Room	9 AM–4 PM	Imperial H
Plenary Speech Gerry Wheeler	11 AM–Noon	Imperial D
Solar Viewing	11 AM–9 PM	Koury Parking Lot
HBCU Luncheon (ticket)	12:15–1:45 PM	Guilford E
Klopsteg Award Neil Tyson	2–3 PM	Imperial D

TUESDAY, JULY 31

Photo Contest Viewing & Voting	7:30 AM–6 PM	Exhibit H.
Exhibit Show	8 AM–2 PM and 4-6 PM	Exhibit H.
Poster Session II	8–9 AM and 5–5:30 PM	Exhibit H.
TYC Resource Room	9 AM–4 PM	Imperial H
Apparatus Competition Viewing / PIRA	9 AM–4 PM	Colony A
Millikan Award David Sokoloff	11 AM–Noon	Imperial D
Plenary Speech Janet Guthrie	2–3 PM	Imperial D
Summer Picnic (ticket)	5:30–7:15 PM	UNCG–The Quad
Evening Demo Show	7:15–8:15 PM	UNCG–Taylor Theater
Evening Demo Show (open to public)	8:30–9:30 PM	UNCG–Taylor Theater

WEDNESDAY, AUGUST 1

Great Book Giveaway	8–9 AM	Exhibit H.
Apparatus Competition Viewing / PIRA	11 AM–2 PM	Colony A
TYC Resource Room	8 AM–4:30 PM	Imperial H
Teaching Awards Pre-College, Jan Mader Undergrad, Steven Manly	11 AM–Noon	Imperial D
Plenary Speech George Coyne	2–3 PM	Imperial D
PERC Banquet (ticket)	6–8 PM	Victoria
PERC Poster Reception	8–10 PM	

Exhibitors

AAPT
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Visit the AAPT booth and be one of the first to buy classic AAPT titles at slashed prices. The books will be available in the booth. Also, find our new logo on backpacks for sale, plus pick up your copy of Cliff Swartz's book *Cliff's Nodes* autographed by the author! Find out about the AAPT Online Career Center. Also see some fun online physics demos and lessons from ComPADRE.

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Physics Teacher Education Coalition
Booth 19

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503-649-0790
www.ptec.org

PTEC—Physics Teacher Education Coalition—a joint effort of APS, AAPT, and AIP that addresses the critical need for producing more and better prepared physics and physical science teachers. The Coalition disseminates and promotes elements of successful teacher education programs.

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Since 1986 Ztek has developed, published and distributed physics software and videos appropriate for middle schools, high schools, technical schools, junior colleges and universities. The majority of Ztek's products have been produced in cooperation with the AAPT. Currently offers over 400 videos and simulations in 15 individual physics products.

Neil Tyson

Klopsteg Memorial Award—"Adventures in Science Illiteracy," Neil deGrasse Tyson, Astrophysicist, American Museum of Natural History & Director, Hayden Planetarium, NYC, *Monday, July 30, 2–3 PM* – Koury Center, Imperial D

Neil deGrasse Tyson earned his BA in physics from Harvard and his PhD in Astrophysics from Columbia. Tyson's professional research interests are broad, but include star formation, exploding stars, dwarf galaxies, and the structure of our Milky Way. Tyson obtains his data from the Hubble Space Telescope, as well as from telescopes in California, New Mexico, Arizona, and the Andes Mountains of Chile. In addition to dozens of professional publications, Tyson has written, and continues to write, for the public. He is a monthly essayist for Natural History magazine under the title "Universe." And among Tyson's seven books are his memoir The Sky Is Not the Limit: Adventures of an Urban Astrophysicist and Origins: Fourteen Billion Years of Cosmic Evolution, co-written with Donald Goldsmith. Origins is the companion book to the PBS-NOVA four-part mini-series "Origins," in which Tyson serves as on-camera host. Tyson is the recipient of seven honorary doctorates and the NASA Distinguished Public Service Medal. His contributions to the public appreciation of the cosmos have been recognized by the International Astronomical Union in their official naming of asteroid "13123 Tyson." Tyson is the first occupant of the Frederick P. Rose Directorship of the Hayden Planetarium, where he also teaches.

David Sokoloff

Robert A. Millikan Award— "Building a New, More Exciting Mouse Trap Is Not Enough!" David R. Sokoloff, Professor of Physics, University of Oregon, Eugene, OR, *Tuesday, July 31*, *11 AM–Noon* – Koury Center, Imperial D

David Sokoloff is Professor of Physics at the University of Oregon. He began his studies of physics at Queens College of the City University of New York, and went on to earn his PhD in AMO physics from the Massachusetts Institute of Technology in 1972 under Ali Javan. Prior to his current position, he was a faculty member at Western Illinois University and the University of Michigan, Dearborn. He has held visiting positions at California Polytechnic State University, San Luis Obispo, and Tufts University, and spent a year as Science Director of WISTEC, the hands-on science center in Eugene, OR.

His physics curriculum development work and extensive dissemination efforts are nationally and internationally recognized. For over two decades, he has conducted research into students' understandings of physics and used the results of this research to develop active learning approaches to enhance student understanding in introductory physics courses. These new curricula—which were developed with longtime colleagues Ronald Thornton and Priscilla Laws—include the four modules of RealTime Physics: Active Learning Laboratories (RTP) and Interactive Lecture Demonstrations (ILDs), both of which are published by John Wiley & Sons. Since 1999, he has been part of a UNESCO team presenting active learning workshops in Australia, Vietnam, Korea, Sri Lanka, Ghana, Tunisia, Morocco, India, Tanzania, and Brazil. Sokoloff is the editor of Active Learning in Optics and Photonics, the training manual published by UNESCO for use in the most recent series of these workshops in developing countries. He was awarded the Distinguished Service Citation by AAPT in 1997.

Jan Mader

Excellence in Pre-College Physics Teaching Award—
"Those Who Can Teach," Jan Mader, Great Falls High School, Great Falls, MT, *Wednesday, Aug. 1, 11:05 AM* – Koury Center, Imperial D

When Jan Mader was in the second grade she came home to inform her mother that she was going to be a nuclear physicist. She attended Montana State University on a physics scholarship, graduating with a BS in physics with an education endorsement. In 1988 as a National Diffusion Network Teacher Trainer in PRISMS and the Mechanical Universe, Mader began providing physics in-service to physics and physical science teachers throughout the U.S. She was awarded a NASA Fellowship in 1990 and received an MS from the University of Northern Iowa with an emphasis in Physics Education. She was director of the Space Science Activities Workshop for the University of Northern Iowa—Summers 1991-1994, and director of the Dwight D. Eisenhower funded Mathematics and Science Team Spring Workshops and Summer Institute for 1998. Mader's affiliation with AAPT and the PTRA program began in 1987 when she attended the AAPT/PTRA program in Bozeman, MT. She was the "dorm mom" for the meeting under the direction of Larry Kirkpatrick. From that summer forward she became an AAPT groupie, attending both Winter and Summer meetings, serving on assorted committees, providing paper sessions and workshops, and becoming an official PTRA in 1992. Mader has authored or coauthored curriculum for Waves, Optics, and Holography for MSU's STIR Program; S.P.A.S.E: Space Science Projects and Activities for Secondary Education; for the Iowa Space Consortium; and more. Mader is currently a physics and holography instructor. Her motto is: Those Who Can Teach, and her students will tell you that a day without physics does not exist.

Steven Manly

Excellence in Undergraduate Physics Teaching Award— "Experiences in Collaborative Learning at the University of Rochester—It's All in the Shoes," Steven Manly, Professor of Physics, University of Rochester, Rochester, NY
Wednesday, Aug. 1, 11:35 AM – Koury Center, Imperial D

Born and bred in rural North Carolina, Steve Manly graduated from Pfeiffer College with a triple major (mathematics/physics/chemistry) in 1982. Looking for a change, he moved to New York City and earned a PhD in experimental high-energy physics from Columbia University in 1989. Manly joined the Yale faculty from 1990-1998 and then moved to the University of Rochester. His research interests are primarily in the areas of high energy, nuclear, and gravitational physics, focusing on the nature of matter and the fundamental forces of nature and how they evolved in the early stages of the universe. Most of his work has been with large, international, scientific collaborations running experiments at accelerators sited at Fermi National Accelerator Laboratory, the Stanford Linear Accelerator Center, and Brookhaven National Laboratory. Manly has published more than 150 articles in scientific journals. His efforts in the classroom have focused on large introductory physics courses for both physics and nonphysics majors and the conveyance of physics concepts to nonscientists. He was named NY State Professor of the Year in 2003 by the Carnegie Foundation for the Advancement of Teaching, and was the Mercer Brugler Distinguished Teaching Professor at the University of Rochester from 2002 to 2005.

Gerry Wheeler

Plenary I— "Max Dresden 2nd Memorial Lecture," Gerry Wheeler, Executive Director, National Science Teachers Association, *Monday, July 30, 11 AM–Noon* – Koury Center, Imperial D

As the Executive Director of the National Science Teachers Association (NSTA), Gerry Wheeler heads the world's largest professional organization representing science educators of all grade levels. Prior to joining NSTA, Wheeler was Director of the Science/Math Resource Center and Professor of Physics at Montana State University. He also headed the Public Understanding of Science and Technology Division at the American Association for the Advancement of Science (AAAS) and has served as President of AAPT. Wheeler received an undergraduate degree in science education from Boston University and a Master's degree in physics and a PhD in experimental nuclear physics, both from the State University of New York at Stony Brook. Between undergraduate and graduate school, he taught high school physics, chemistry, and physical science. For much of his career Wheeler has played a key role in the development of mass media projects that showcase science for students. He was involved in the creation of 3-2-1 Contact for the Children's Television Workshop, served on advisory boards for the Voyage of the Mimi and the PBS children's series CRO, and created and hosted Sidewalk Science. Wheeler is the recipient of numerous awards for his teaching and mass media work, including outstanding teaching awards from Temple University, the University of Hartford, and Montana State University, as well as the AAPT Millikan Award.

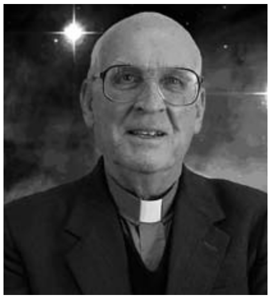
Janet Guthrie

Plenary II— "Racing As Metaphor," Janet Guthrie, President, Guthrie Racing LLC, Aspen, CO, *Tuesday, July 31, 2–3 PM* – Koury Center, Imperial D

Before becoming the first woman ever to compete in the Indianapolis 500 and the Daytona 500, Janet Guthrie had a diversified background. She was a pilot and flight instructor, an aerospace engineer, a technical editor, and a public representative for major U.S. corporations. She had 13 years of experience on sports car road-racing circuits, building and maintaining her own race cars, before being invited to test a car for Indianapolis. She graduated from the University of Michigan with a BSc in physics, then joined Republic Aviation in Farmingdale, NY, as a research and development engineer, working on aerospace programs. Meanwhile, she purchased a Jaguar XK 120 coupe and began competing in gymkhanas, field trials, and hill climbs. This led to the purchase of a Jaguar XK 140 for competition in Sports Car Club of America races.

In 1977 she became the first woman to qualify for and compete in the Indianapolis 500; she was also the first woman and Top Rookie at the Daytona 500 in the same year. She finished ninth in the Indianapolis 500 in 1978, with a team she formed and managed herself. Her 2005 autobiography, Janet Guthrie: A Life at Full Throttle, was described by Sports Illustrated as "an uplifting work that is one of the best books ever written about racing."

Drawing on her difficult and sometimes hilarious experiences as the first woman ever to compete in this country's major oval-track auto races, Guthrie speaks of the qualities necessary for anyone to be successful on a fast track.



George Coyne

Plenary III— "Dance of the Fertile Universe: Cosmic and Human Evolution," George Coyne, Adjunct Professor of Astronomy, University of Arizona, Tucson, AZ (Director Emeritus of the Vatican Observatory, Vatican City, Rome)
Wednesday, Aug. 1, 2–3 PM – Koury Center, Imperial D

George Coyne obtained his PhD in Astronomy from Georgetown University (Washington, DC) in 1962 and the Licentiate in Theology from Woodstock College (Maryland) in 1966. In addition he has received PhD degrees honoris causa from St. Peter's University (New Jersey), Loyola University (Chicago), The University of Padua (Italy), the Jagellonian University (Krakow, Poland) and Marquette University (Milwaukee). Since 1966 he has been associated with astronomy programs at the University of Arizona (Tucson) and from 1976 to 1980 he served in various capacities in the administration of the astronomical observatories at that university.

From 1978 until 2006 he was Director of the Vatican Observatory (Specola Vaticana), which has its headquarters at Castel Gandolfo (Rome, Italy) and a research branch at the University of Arizona in Tucson. His research interests have ranged from the study of the lunar surface to the birth of stars, and he pioneered a special technique, polarimetry, as a powerful tool in astronomical research. Currently he is studying cataclysmic variable stars, the interstellar dust in the Magellanic Clouds, and the detection of protoplanetary disks. Parallel to his scientific research, he has developed an interest in the history and philosophy of science and in the relationship between science and religion.

Committee Meetings

SUNDAY, JULY 29

Meetings Committee	8–11 AM	Links
Publications Committee	8–11 AM	Imperial A
Programs Committee I	4:30–6:30 PM	Imperial B
Nominating Committee	4–6 PM	Links
Section Officers’ Exchange	5–6 PM	Imperial C
Section Representatives	6:30–8 PM	Imperial C
Teacher Preparation Committee	6:30–8 PM	Imperial B
Graduate Education Committee	6:30–8 PM	Imperial A
International Education Committee	6:30–8 PM	Oak B-C
Apparatus Committee	6:30–8 PM	Colony A

MONDAY, JULY 30

Pre-High School Committee	7–8 AM	Imperial A
Membership & Benefits Committee	9–10:30 AM	Imperial E
Two-Year College Committee	12–1:30 PM	Cedar ABC
Interest of Senior Physicists Committee	12–1:30 PM	Oak A
History & Philosophy Committee	12–1:30 PM	Imperial A
Bauder Fund Committee	12:30–2 PM	Links
Nominating Committee I	12:30–2 PM	Heritage
Minorities in Physics Committee	6–8 PM	Maple
High School Committee	6–8 PM	Imperial F

TUESDAY, JULY 31

Investment Advisory Committee	9:30–10:30 AM	Links
Laboratories Committee	12:30–2 PM	Imperial A
Professional Concerns Committee	12:30–2 PM	Imperial E
Undergraduate Education Committee	12:30–2 PM	Imperial B
SI Units & Metric Ed. Committee	1–3 PM	Links
RQEHSPT	1–2 PM	Colony C
Awards Committee	1–3 PM	Oak A
Nominating Committee II	1–3 PM	Maple
Educational Technologies Committee	8:30–10:30 PM	Cedar ABC
Research in Physics Ed Committee	8:30–10:30 PM	Colony B-C
Science Ed. for the Public Committee	8:30–10:30 PM	Imperial A
Women in Physics Committee	8:30–10:30 PM	Imperial B
PIRA Business Meeting	8:30–10:30 PM	Colony A
Space Science & Astronomy Committee	8:30–10:30 PM	Imperial C

WEDNESDAY, AUGUST 1

Programs II	7–9 AM	Heritage A
Venture Fund	7:30–8:30 AM	Links

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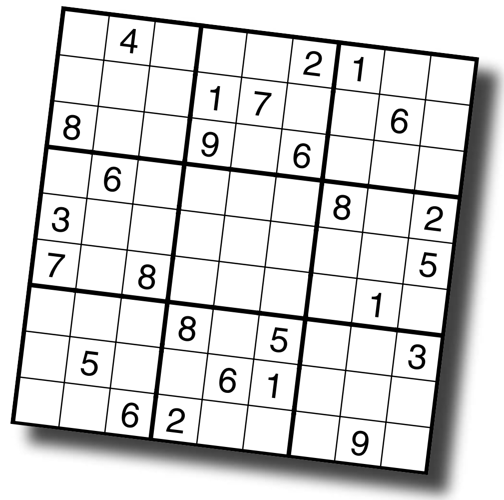
Collect all of the stamps and correctly complete the puzzle for your chance to win one of our top prizes!



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Meeting-at-a-Glance

Meeting-at-a-Glance includes committee meetings and other events, including snack breaks, Plenary Sessions, and receptions. Unless the room says UNCG, all meeting rooms are in the Joseph S. Koury Center.

Friday, July 27

6–8 PM		Pre-Registration Pick-up	Sheraton-Greensboro Hotel Registration Desk I, off lobby

Saturday, July 28

7 AM–4:30 PM		Registration	Sheraton-Greensboro, off lobby
8 AM–12 PM	W01	Video-Based Motion Analysis	UNCG-Stone 127
8 AM –12 PM	W02	Physics from the Junk Drawer	UNCG-McIver 331
8 AM–12 PM	W03	Reaching, Keeping, Teaching Under-represented Minorities	UNCG-EUC Cone C
8 AM–12 PM	W04	InterActions in Physical Science	UNCG-McIver 140
8 AM–12 PM	W05	TELS: Technology Enhanced Learning of Science	UNCG-McIver 254
8 AM–5 PM	W06	Learning Physics While Practicing Science	UNCG-McIver 230A
8 AM–5 PM	W07	Simulating the Nature of Science	UNCG-EUC Claxton
8 AM–5 PM	W08	Reseach-Based Alternatives to Problem Solving	UNCG-EUC Alexander
8 AM–5 PM	W09	Incorporating Critical Thinking into Intro. Astronomy	UNCG-EUC Kirkland
8 AM–5 PM	W10	Lecture Demonstrations I	UNCG-Taylor Theater
1–5 PM	W11	Introductory Labs	UNCG-McIver 225 & 228
1–5 PM	W12	Activity-Based Physics Learning Using ABP H.S. CD	UNCG-Graham 202
1–5 PM	W13	Hands-On Units for All Ages	UNCG-McIver 331
1–5 PM	W14	Physics and Everyday Thinking (PET) and PSET	UNCG-McIver 140
1–5 PM	W16	WebTOP	UNCG-McIver 256
5:30–9:30 PM		Executive Board I	Edgewood
6–7:30 PM	T01	Mining the Hidden Web	Cedar B-C

Sunday, July 29

7 AM–4:30 PM		Registration	Sheraton-Greensboro, off lobby
8–11 AM		Meetings Committee	Links
8–11 AM		Publications Committee	Imperial A
8 AM–12 PM	W17	P-CSI-Greensboro: The Role of Physics in Forensic Science	UNCG-McIver 230A
8 AM–12 PM	W18	Learning the "Game" of Science	UNCG-McIver 331
8 AM–12 PM	W19	Preparing Pre-College Teachers to Teach Physics by Inquiry	UNCG-McIver 140
8 AM–12 PM	W20	TIPERS with Physlets	UNCG-Stone 127
8 AM–12 PM	W21	VPhython: 3D Programming for Ordinary Mortals	UNCG-HHRA 1305
8 AM–12 PM	W22	NASCAR R&D	UNCG-McIver 254
8 AM–5 PM	W23	Lecture Demos II	UNCG-Taylor Theater
8 AM–5 PM	W24	Using Research-Based Curricula and Tools	UNCG-McIver 256
8 AM–5 PM	W25	Physics on the Road	UNCG-EUC Claxton
8 AM–5 PM	W26	Teaching Astronomy with Technology	UNCG-EUC Alexander
8 AM–5 PM	W27	Doing Real Science Projects with Small Telescopes	Oak B-C
8 AM–5 PM	W28	Using RTOP to Improve Physics and Physical Science Teaching	Cedar B-C
8 AM–5 PM	W29	Piaget Beyond "Piaget" for Physics Learning	Colony C
10 AM–12 PM	T02	Creating Java Simulations for Physics Teaching	UNCG–EUC Cone C
12:30–4:30 PM		Executive Board II	Edgewood
1–3 PM	T03	Tutorial on the LANGURE Collaboration in Research Ethics	Imperial B
1–5 PM	W30	Improving Student Learning in Physics	UNCG–EUC Cone C
1–5 PM	W15	Building Physics Teacher Pedagogical Content Knowledge	UNCG-EUC Kirkland
1–5 PM	W31	Advanced and Intermediate Instructional Laboratories	UNCG-McIver 225 & 228
1–5 PM	W32	21st Century Teaching and Learning	UNCG-McIver 331
1–5 PM	W33	What Every Physics Teacher Should Know About Cog. Research	UNCG-McIver 140
1–5 PM	W34	Energy in the 21st Century	UNCG-McIver 230A
1–5 PM	W35	Physics Teaching Web Advisory (Pathway)	UNCG-HHRA 1305
1–5 PM	W36	Ways to Use PhET's Web-based Interactive Simulations	UNCG-Stone 127
1–5 PM	W37	Phenomenal Physics: A Guided Inquiry Curriculum	Colony B
1–5 PM	W38	Physics and Toys I: Force, Motion, Light and Sound	Imperial C
1–5 PM	W39	Implementing the Learning Assistant Model	Imperial A
4–6 PM		Nominating Committee	Links
4:30–6:30 PM		Programs Committee I	Imperial B

4:30–6:30 PM		High School Share-a-Thon	Imperial D
5–6 PM		Section Officers' Exchange	Imperial C
6:30–8 PM		SPS/AAPT Poster Reception	Colony B-C
6:30–8 PM		Section Representatives	Imperial C
6:30–8 PM		Teacher Preparation Committee	Imperial B
6:30–8 PM		Graduate Education Committee	Imperial A
6:30–8 PM		International Education Committee	Oak B-C
6:30–8 PM		Apparatus Committee	Colony A
7–9 PM		Registration	Sheraton-Greensboro, off lobby
8–10 PM		Welcome Reception	Imperial D

Monday, July 30

7–8 AM		First Timers Gathering	Auditorium I
7–8 AM		Pre-High School Committee	Imperial A
7–8 AM		Retirees' Breakfast (ticket)	Meadowbrook
7–8 AM		TYC Breakfast (ticket)	Heritage
7:30 AM–5 PM		Registration	Sheraton-Greensboro, off lobby
7:30 AM–10 PM		Photo Contest Viewing & Voting	Exhibit Hall
8–9 AM and 5–6 PM		Poster Session I	Exhibit Hall
8 AM–2 PM and 4–6 PM		Exhibit Show	Exhibit Hall
9–9:30 AM		Spouses Gathering	Augusta B
9–10 AM	AA	Tutorial: Interactive LECTURE DEMONSTRATIONS	Auditorium I
9–10:10 AM	AN	Mentoring Students in Undergraduate Research	Meadowbrook
9–10:30 AM		Membership and Benefits Committee	Imperial E
9–10:30 AM	AI	Physics Education at HBCUs and MSIs	Maple
9–11 AM	AB	Tutorial in Intermediate Mechanics	Imperial A
9–11 AM	AC	Contributions of Carolina Educators	Imperial C
9–11 AM	AD	Innovations in TYC Curriculum	Imperial G
9–11 AM	AE	Problem Solving	Colony B-C
9–11 AM	AF	K-12 Teachers on Campus Supporting Teachers	Imperial B
9–11 AM	AG	PER: Instructional Reform	Cedar
9–11 AM	AH	AP Physics: Present and Future	Imperial F
9–11 AM	AJ	Energy and the Environment	Oak B-C
9–11 AM	AK	Favorite Activities/Lessons in the TYC Physics Classroom	Imperial H
9 AM–4 PM		Apparatus Competition Viewing/ PIRA Resource Rm	Colony A
9 AM–4 PM		Two-Year College Resource Room	Imperial H
9 AM–5 PM	AL	The Physics Bazaar	Oak A
11 AM–9 PM		Solar Viewing	Koury Center Parking Lot
11 AM–12 PM	AM	Plenary: Dresden Lecture	Imperial D
12:15–1:45 PM		HBCU Luncheon (ticket)	Guilford E
12–1:30 PM		PTRA Rural Regional Coordinators Mtg.	Meadowbrook
12–1:30 PM		Two-Year College Committee	Cedar ABC
12–1:30 PM		Interest of Senior Physicists Committee	Oak A
12–1:30 PM		History & Philosophy Committee	Imperial A
12–2 PM		Lunch Break	
12–2 PM		Exhibit Show (Open to Public)	Exhibit Hall
12:30–2 PM		Nominating Committee I	Heritage
12:30–2 PM		Bauder Fund Committee	Links
2–3 PM	BA	Klopsteg Award	Imperial D
3–4:10 PM	BF	Computational Physics in the Two-Year College Curricula	Imperial G
3–4:30 PM	BC	PIRA Crackerbarrel on Instructional Apparatus	Imperial A
3–4:40 PM	BD	Connecting Curriculum and Content Through Digital Libraries	Auditorium 1
3–5 PM	BE	PER: Observing and Modeling Cognition	Cedar
3–5 PM	BG	Physics Research at HBCUs and MSIs	Maple
3–5:20 PM	BB	H.S. Physics: Laboratories, Curriculum, Concepts, Competition	Imperial F
4–6 PM		Exhibit Show	Exhibit Hall
4–5 PM		Exhibit Show – Snacks, Cash Bar	Exhibit Hall
6–6:40 PM	BM	Introductory Undergraduate Physics Textbooks	Imperial E
6–7:30 PM	BJ	Crackerbarrel on Physics and Society Education	Imperial A
6–8 PM		Minorities in Physics Committee	Maple
6–8 PM		H.S. Committee	Imperial F
6–8 PM	BH	Educational Technology Demonstrations	Oak B-C
6–8 PM	BI	Q&A with the AAPT Executive Officer	Colony B-C
6–8 PM	BK	Professional Concerns of Two-Year College Physics Faculty	Imperial G
6–8 PM	BL	New Technologies for Teaching and Learning	Imperial C

6–8 PM	BN	PER: Surveys and Other Assessments	Cedar
8–8:40 PM	BT	Outline Courseware: Learning Outcomes, Marginal Costs...	Imperial C
8–9 PM	BO	Crackerbarrel on Retention of Minority Students	Maple
8–9 PM	BR	Crackerbarrel on Physics on the Road Handbook	Imperial A
8–9:30 PM	BP	Professional Concerns of High School Physics Faculty	Imperial F
8–9:30 PM	BQ	Criteria for Textual Material for a First Course in Physics	Imperial G
8–10 PM	BS	Professional Concerns of Instructional Resource Specialists	Imperial B
8–10 PM	BU	AAPT Planning	Colony B-C
8–10 PM	BV	Integrating Computation into the Curriculum	Oak B-C
8–10 PM	BX	More Exciting High School Physics	Imperial E
8–10:10 PM	BW	PER: Student Understanding of Topics in Physics & Tas	Cedar

Tuesday, July 31

7:30–10 AM		Photo Contest Voting	Exhibit Hall
7:30 AM–5 PM		Registration	Sheraton Hotel, off lobby
7:30 AM–10 PM		Photo Contest Viewing	Exhibit Hall
8–9 AM and 5–5:30 PM		Poster Session II	Exhibit Hall
8 AM–2 PM and 4–6 PM		Exhibit Show	Exhibit Hall
9–10 AM	CA	Blogs, Wikis and Forums	Imperial C
9–10 AM	CF	PIRA Session: Data Acquisition and Analysis Software	Imperial B
9–10 AM	CH	Early Field Experiences: The Impact on Potential Teachers	Imperial F
9–11 AM	CB	Conceptual Understanding: Models & Measurement I	Cedar
9–11 AM	CC	Physics and Art	Meadowbrook
9–11 AM	CD	Need for Speed	Colony B-C
9–11 AM	CE	Historical Apparatus	Auditorium I
9–11 AM	CG	Institutional Family Friendly Policies	Maple
9–11 AM	CI	Successful Implementation of PER-based Strategies	Oak B-C
9–11 AM		Cutting-Edge Physics Research in Simple English	Imperial E
9 AM–4 PM		TYC Resource Room	Imperial H
9 AM–4 PM		Apparatus Competition Viewing/ PIRA Resource Rm	Colony A
9:30–10:30 AM		Investment Advisory Committee	Links
11–12 PM	CJ	Robert A. Millikan Award	Imperial D
12–1 PM	DA	Space Science and Astronomy Missions	Oak B-C
12–1 PM	DB	PER: Topical Group Town Hall	Cedar
12 PM–2 PM		Exhibit Show (Open to Public)	Exhibit Hall
12 PM–2 PM		Lunch Break	
12:30–2 PM		Laboratories Committee	Imperial A
12:30–2 PM		Professional Concerns Committee	Imperial E
12:30–2 PM		Undergraduate Education Committee	Imperial B
1–2 PM		RQEHSPT	Colony C
1–2 PM		SI Units & Metric Education Committee	Links
1–2 PM	DC	Professional Concerns in the Teaching of Astronomy	Oak B-C
1–2 PM	DD	Professional Concerns of Minorities in Physics	Maple
1–2 PM	DP	PER: Leadership Organizing Council Meeting (Closed)	Cedar
1–3 PM		Awards Committee	Oak A
1–3 PM		Nominating Committee II	Maple
2–3 PM	DE	Plenary: Racing as Metaphor	Imperial D
3–5 PM	DF	Conceptual Understanding: Models and Measurement II	Cedar
3–5 PM	DG	Women on the Biophysics Frontier	Maple
3–5 PM	DH	The Art and Science of Teaching	Colony B-C
3–5 PM	DI	Demonstration of Mastery: The Future of the Exams	Imperial G
3–5 PM	DJ	Teacher Preparation and Professional Development	Imperial F
3–5 PM	DK	Undergraduates' Roles in Improving Education	Imperial A
3–5 PM	DL	Physics Teaching Around the World	Imperial B
3–3:40 PM	DM	Laboratory Improvement: NSF-CCLI Projects	Auditorium I
3–5 PM	DN	Physics Olympics as Student Outreach	Oak B-C
3–5 PM	DO	Best Practices in Teaching with Technology	Imperial C
4–5 PM		Exhibit Show – Snacks and Cash Bar	Exhibit Hall
5:30–7:15 PM		Summer Picnic	UNCG, The Quad (near Jamison, Coit, Bailey residence halls)
7:15–9:15 PM		Evening Demo Show & Announcement of Contest Winners	UNCG–Taylor Theater
8:30–9:30 PM		Evening Demo Show (Open to Public)	UNCG–Taylor Theater
8:30–10:30 PM		Educational Technologies Committee	Cedar ABC
8:30–10:30 PM		Research in Physics Ed. Committee	Colony B-C
8:30–10:30 PM		Science Ed. for the Public Committee	Imperial A
8:30–10:30 PM		Women in Physics Committee	Imperial B

8:30–10:30 PM		PIRA Business Meeting	Colony A
8:30–10:30 PM		Space Science & Astronomy Committee	Imperial C

Wednesday, Aug. 1

7–9 AM		Programs II	Heritage A-B
7:30–8:30 AM		Venture Fund	Links
7:30 AM–2 PM		Photo Contest Viewing	Exhibit Hall
7:30 AM–3:30 PM		Registration	Registration
8–9 AM		Great Book Giveaway	Exhibit Hall
8–9 AM		Prize Drawing	Exhibit Hall
8–9 AM		Poster Session III	Exhibit Hall
8 AM–4:30 PM		TYC Resource Room	Imperial H
9–10:10 AM	EG	Physics Teacher Preparation Around the World	Imperial B
9–10:30 AM	EF	Mathematics in Physics	Colony B-C
9–11 AM	EA	A Road Less Traveled: Exploring Teaching Assistant Training Programs	Cedar
9–11 AM	EB	Professional Concerns of Solo PER Faculty	Maple
9–11 AM	ED	Panel Discussion: Introductory College Physics Textbooks	Imperial F
9–11 AM	EE	Physics and Society Education	Auditorium I
9–11 AM	EH	The Advanced Physics Laboratory I	Oak B-C
9–11:10 AM	EC	Introductory College Physics Courses	Imperial A
11 AM–12 PM	EI	Excellence in Physics Teaching Awards	Imperial D
11 AM–2 PM		Apparatus Competition Viewing/ PIRA Resource Rm	Colony A
12–1 PM	FA	Professional Concerns of PER Graduate Students and Residents	Cedar
12–1:30 PM	FB	Professional Concerns of 4-Year College and University Physics Faculty	Imperial B
12–2 PM		Lunch Break	
1–2 PM	FC	Professional Concerns of PER Faculty	Cedar
2–3 PM	FD	Plenary: The Dance of the Fertile Universe: Cosmic and Human Evolution	Imperial D
3–4:20 PM	FF	Scientific Reasoning	Auditorium I
3–4:20 PM	FG	Laboratories	Imperial A
3–5 PM	FE	Bridging Session: Cognitive Science and Physics Education Research	Cedar
3–5 PM	FH	The Advanced Physics Laboratory II	Maple
3–5 PM	FI	Report on IACPE Meeting In Costa Rica, 2006 Posters	Oak B-C
5:30–8:30 PM		Executive Board III	Edgewood
6–8 PM		PERC Banquet (ticket)	Victoria
8–10 PM		PERC Reception	

Thursday, Aug. 2

8:30 AM–5 PM		Physics Education Research Conference	

Monday, July 30 – Session Schedule

Time	Audito-rium I	Imperial A	Imperial C	Imperial G	Colony B-C	Imperial B	Cedar	Imperial F	Maple	Oak B-C	Imperial H	Oak A	Imperial E	Imperial D	Meadow-brook
7:00 a.m. – 8:30															
9:00	AA: Tutorial: Interactive Lecture Demos	AB: Tutorial: Intermediate Mechanics	AC: Contributions of Carolina Educators	AD: Innova-tions in TYC Curriculum	AE: Problem Solving	AF: K-12 Teachers on Campus Sup-porting Teach-ers Across the Curriculum	AG: PER: Instructional Reform	AH: Advanced Placement Physics: Present and Future	AI: Physics Education at HBCUs and MSIs	AJ: Energy and the Environment	AK: Favorite Activities/Les-sons in the TYC Physics Classroom	AL: The Physics Bazaar			AN: Mentoring Students in Undergrad. Research
11:00														AM: Dresden Lecture, Gerry Wheeler	
2:00														BA: Klopsteg Award: Neil deGrasse Tyson	
3:00	BD: Connecting Curriculum Through Digital Libraries	BC: PIRA Crackerbarrel on Instructional Apparatus		BF: Computa-tional Physics in TYC Curricula			BE: PER: Observing and Modeling Cognition	BB: H.S. Physics: Laboratories, Curriculum, Concepts ...	BG: Physics Research at HBCUs and MSIs						
5:30 – 6:30		BJ: Ckrrbarrel on Physics and Society Educ.	BL: New Technologies for Teaching and Learning	BK: Concerns of TYC Physics Faculty	BI: Q&A with the AAPT Exec. Officer		BN: PER: Surveys and Other Assessments			BH: Education-al Technology Demos			BM: Intro-ductory Undergraguate Physics Texts		
7:30 – 8:30		BR: Crkrbarrel: Physics on the Road	BT: Outline Courseware	BQ: Texts for First Physics Course	BU: AAPT Planning	BS: Concerns of Instruct. Resource Specialists	BW: PER Student Understanding of Topics in Physics & Tas	BP: Concerns of H.S. Phys. Faculty	BO: Crkbarrel Minority Students	BV: Integrating Computation in Curriculum			BX: More Exciting H.S. Physics		
9:30															

Tuesday, July 31 – Session Schedule

	Auditorium I	Imperial A	Imperial C	Imperial G	Colony B-C	Imperial B	Cedar	Imperial F	Maple	Oak B-C	Imperial H	Oak A	Imperial D	Meadow-brook
7:00 a.m.														
7:30														
8:00														
8:30														
9:00	CE: Historical Apparatus		CA: Blogs, Wikis and Forums		CD: Need for Speed	CF: PIRA Session	CB: Conceptual Understanding: Models and Measurement I	CH: Early Field Experiences	CG: Institutional Family Friendly Policies	CI: Imple-mentation of PER-based Strategies Around the World				CC: Physics and Art
9:30														
10:00														
10:30														
11:00													CJ: Robert Millikan Award: David Sokoloff	
11:30														
Noon							DB: PER: Topi-cal Group Town Hall			DA: Space Science and Astronomy Mission				
12:30 p.m.														
1:00									DD: Prof. Concerns of Minorities in Physics	DC: Prof. Concerns in Astronomy Teaching				
1:30														
2:00													DE: Plenary, *Racing as Metaphor,* Janet Guthrie	
2:30														
3:00	DM: Laboratory Improvement	DK: Under-graduates' Roles in Improving Education	DO: Best Practices in Teaching with Technology	DI: Demonstra-tion of Mastery: The Future of Exams	DH: The Art and Science of Teaching	DL: Physics Teaching Around the World	DF: Conceptual Understanding	DJ: Teacher Preparation and Professional Development	DG: Women on the Biophysics Frontier	DN: Physics Olympics as Student Outreach				
3:30														
4:30														
5:30														
6:30														
7:30														
8:30														
9:30														

Wednesday, Aug. 1 – Session Schedule

	Auditorium I	Imperial A	Imperial C	Imperial G	Colony B-C	Imperial B	Cedar	Imperial F	Maple	Oak B-C	Imperial H	Oak A	Imperial D	Meadow-brook
7:00 a.m.														
7:30														
8:00														
8:30														
9:00	EE: Physics and Society Education	EC: Introductory College Physics Courses			EF: Mathematics in Physics	EG: Physics Teacher Prep. Around the World	EA: A Road Less Traveled: Exploring Teaching Assistant Training Programs	ED: Panel: Introductory College Physics Textbooks	EB: Professional Concerns of Solo PER Faculty	EH: The Advanced Physics Laboratory I				
9:30														
10:00														
10:30														
11:00													EI: Excellence in Physics Teaching Awards	
11:30														
Noon						FB: Prof. Concerns of 4-Yr College and Univ. Physics Faculty	FA: Prof. Concerns of PER Grad. Students and Residents							
12:30 p.m.														
1:00							FC: Professional Concerns of PER Faculty							
1:30														
2:00													FD: Plenary, George Coyne	
2:30														
3:00	FF: Scientific Reasoning	FG: Laboratories					FE: Bridging Session: Cog. Science and Phys. Educ. Research		FH: The Advanced Physics Laboratory II	FI: Report on IACPE Meeting in Costa Rica, 2006 Posters				
3:30														
4:30														
5:30														
6:30														
7:30														
8:30														
9:30														

Workshop Abstracts

Saturday, July 28, 2007

W01: Video-Based Motion Analysis

Sponsor: Committee on Educational Technologies
Date: July 28
Time: 8 AM–Noon
Location: UNCG–Stone Bldg. Rm 127

Robert Teese, Rochester Inst. of Technology, Physics Dept., Rochester, NY 14623; rbtsps@rit.edu

Patrick J. Cooney, Priscilla W. Laws, Maxine Willis

This workshop is for physics teachers who wish to explore the use of video-based motion analysis in a wide range of applications including the teaching laboratory, projects, and homework. Participants will learn how to make digital video clips for analysis, as well as how to use video analysis for homework problems and in the classroom. We will discuss educationally effective uses of video analysis being developed in the LivePhoto Physics project, the Workshop Physics project and in other settings. Evaluation copies of analysis software, selected digital video clips, and homework assignments will be provided to the participants for their use after the workshop. The software used in this workshop is available for both Mac and Windows computers. Participants may find that some prior, hands-on experience with basic video analysis using software such as VideoPoint or VideoGraph will be helpful but is not required. (Format: Mac/PC)

W02: Physics from the Junk Drawer

Sponsor: Committee on Physics in High Schools
Date: July 28
TIme: 8 AM-Noon
Location: UNCG-McIver Physics Bldg. Rm 331

Scott Ragan, North Carolina State Univ., Raleigh, NC 27695; scott_ragan@ncsu.edu

David Haase, Keith Warren

The title describes it best! Physics from the Junk Drawer was developed for K-12 science teachers who are interested in doing fun and eye-catching physical science demonstrations and activities in their classroom in order to engage the students. This hands-on workshop emphasizes simple activities, inquiry, and fa.m.iliar materials. It covers activities from our "Physics From the Junk Drawer & Counter Top Chemistry" publication that has been shared with thousands of teachers across the country. Participants will receive hands-on experiences with many of the 46 different activities in the book. Topics covered include motion and forces, electrostatics and magnetism, sound, light, and others. You don't want to miss it!

W03: Reaching, Keeping and Teaching Under-Represented Minorities

Co-Sponsors: Committee on Minorities in Physics, Committee on Women in Physics
Date: July 28
Time: 8 AM-Noon
Location: UNCG-Elliott Univ. Center, Cone C Rm

Juan Burciaga, Whitman Coll., Physics Dept., Walla Walla, WA 99362; burciaj@whitman.edu

The purpose of the workshop is to increase the effectiveness of teachers (K-12) and college faculty in constructing inclusive learning environments in their classrooms and beyond. Workshop participants, using guided discussions and collaborative exercises, will explore pedagogical philosophies, outreach paradigms, and assessment strategies that can be adapted to individual uses. Participants will also investigate the factors that can help (or hinder) widespread, permanent change. Though focused particularly on under-represented groups, the workshop is actually geared to making the learning of physics more effective for all students. The pedagogical exercises are built on physics at the senior high school and introductory college level, but teachers in the K-20 educational enterprise may find the workshop useful.

W04: InterActions in Physical Science: A Research-Based Middle School Curriculum

Sponsor: Committee on Physics in Pre-High School Education
Date: July 28
Time: 8 AM-Noon
Location: UNCG-McIver Physics Bldg. Rm 140

Robert Poel, Western Michigan Univ., Center for Science Educ., Kalamazoo, MI 49008; bob.poel@wmich.edu

What is middle-school physical science? What content is needed to meet state and national standards for physical science content and the nature of scientific inquiry? How can we help middle-school science teachers who are ready or need to implement an inquiry-based physical science curriculum based on learning research and national standards? These are some of the questions that this workshop addresses as it introduces InterAction in Physical Science, a new middle-school physical science curriculum. The aim of InterActions is to promote both a deep understanding of funda.m.ental physical science concepts and the nature of scientific inquiry. The curriculum actively engages students in doing science by conducting interesting investigations and participating in small and whole group discussions that help middle-grade students make sense of their observations and construct important scientific ideas and skills. In this workshop, participants will also learn how this curriculum supports a classroom environment that engages students in doing science, learning how to make evidence-based claims, and then persuading themselves and their peers that these claims are valid and useful ways of understanding the world.

W05: TELS: Technology Enhanced Learning of Science

Sponsor: Committee on Educational Technologies
Date: July 28
Time: 8 AM-Noon
Location: UNCG-McIver Physics Bldg. Rm 254

S. Raj Chaudhury, Norfolk State Univ., Dept of Physics and CSE, Newport News,VA 23606; schaudhury@cnu.edu

The Technology Enhanced Learning of Science Center has designed inquiry-based, technology-enhanced online learning modules based on extensive research on how students learn hard-to-visualize topics in science. This workshop will introduce participants to TELS projects in physics and chemistry at both high school and middle-school levels. Powerful computational models are embedded within a guided inquiry framework that helps students learn through prediction, observation, and reflective writings. Extensive support for teacher practice is built into the TELS approach to monitor student work and facilitate easy feedback. Browse sa.m.ple activities at http://wise.berkeley.edu/ prior to the workshop.

W06: Learning Physics While Practicing Science

Co-Sponsors: Committee on Physics in Undergraduate Education, Committee on Physics in Two-Year Colleges
Date: July 28
Time: 8 AM-5 PM
Location: UNCG-McIver Physics Bldg. Rm 230A

Eugenia Etkina, State Univ. of New Jersey Rutgers, Graduate School of Education, New Brunswick, NJ 08901; etkina@rci.rutgers.edu

Participants will learn how to modify introductory physics courses to help students acquire a good conceptual foundation, apply this knowledge effectively in problem solving, and develop the science process abilities needed for real life work. We provide tested curriculum materials including: The Physics Active Learning Guide with 30 or more activities per textbook chapter for use with any textbook in lectures, recitations, and homework; (b) a CD with over 200 videotaped experiments and associated questions for use in lectures, recitations, laboratories, and homework; and (c) a set of labs with inexpensive equip.m.ent that can be used to construct, test, and apply concepts to solve practical problems. During the workshop we will illustrate how to use the materials not only in college and high school physics courses but also in courses for future physics teachers to have an explicit emphasis on using the processes of science and various cognitive strategies.

W07: Simulating the Nature of Science

Sponsor: Committee on Educational Technologies
Date: July 28
Time: 8 AM-5 PM
Location: UNCG-Elliott Univ. Center, Claxton Rm

Tim Erickson, Eeps Media, Oakland, CA 94618-1044; customer@eeps.com

How can we teach about the nature of science? We'll use a new web-based simulation. Participants will work in small groups as research tea.m.s opening up a new area of knowledge, generating and demolishing hypotheses, and building up a common understanding and body of research. You will design and perform experiments, analyze your data, and publish your results, communicating through journals and symposia. You will even worry about funding. Supported by NSF.

W08: Research-Based Alternatives to Problem Solving in General Physics

Sponsor: Committee on Research in Physics Education
Date: July 28
Time: 8 AM–5 PM
Location: UNCG-Elliott Univ. Center, Alexander Rm

Kathleen Harper, Western Michigan Univ., Center for Science Educ., Columbus, OH 43210; harper.217@osu.edu

Thomas M. Foster, David P. Maloney

Accumulating research on problem solving in physics clearly indicates that traditional, end-of-chapter exercises in physics texts are not useful and may actually hinder students' learning of important physics concepts. The research also raises questions about the efficacy of such tasks for helping students develop "problem solving skills." In light of these results the question is: What alternative tasks can we use to help students develop problem solving skills and a conceptual understanding? This workshop will review the research and then provide exa.m.ples of several alternative tasks and their use.

W09: Incorporating Critical Thinking into Introductory Astronomy

Sponsor: Committee on Space Science and Astronomy
Date: July 28
Time: 8 AM–5 PM
Location: UNCG-Elliott Univ. Center, Kirkland Rm

Joe Heafner, Catawba Valley Comm. Coll., Physics Dept., Hickory, NC 28602; heafnerj@sticksandshadows.com

Incorporating critical thinking into an otherwise traditional introductory astronomy course requires both revision of content and use of inquiry-based activities. This workshop will demonstrate one way to implement these changes. The first part will directly address science and critical thinking through small interactive mini labs. The second part will address application of critical thinking to astronomical concepts that are frequently omitted from traditional courses. Suggestions for assessment will be given. Participants will receive activity kits and course materials, all free.

W10: Lecture Demonstrations I

Sponsor: Committee on Apparatus
Date: July 28
Time: 8 AM–5 PM
Location: UNCG-Taylor Bldg, Theater

Dale Stille, Univ. of Iowa, Physics and Astronomy Dept., Iowa City, IA 52242; dale-stille@uiowa.edu

Sam Sampere (co-leader)

Topics in this workshop cover the standard first semester of physics instruction, from mechanics to thermal. It is taught by an experienced team of lecture demonstrators. The format allows for and encourages interplay between instructors and participants. It is recommended that both Lecture Demonstrations I and II be taken, as this will cover the complete year of demonstrations needed for a typical course. The demonstrations used and exhibited will be based on, but not limited to, the PIRA top 200 list of demonstrations. See http://www.pira-online.org for more info on this list.

W11: Introductory Laboratories

Sponsor: Committee on Apparatus
Date: July 28
Time: 1–5 PM
Location: UNCG-McIver Physics Bldg. Rm 225 & 228

Van Bistrow, Univ. of Chicago, Physics Dept., Chicago, IL 60637; vanb@uchicago.edu

Eric Ayars, Brian Jones, Mary Ann Klassen, Anthony Papirio, Joshua Socolar, Andrew Tomasch

In this workshop several introductory-level instructional laboratory setups will be presented by Gabe Alba (Rutgers University), Van Bistrow (University of Chicago), David Gerdes (University of Michigan), Brian Jones (Colorado State University), and others. Attendees will break into small groups and move from setup to setup in 25-minute intervals, getting an overview of technical aspects of each experiment. Student instructions, expected results, common problems, pros and cons of apparatus, and obtaining/constructing equip.m.ent will be discussed. Handouts for each activity will be provided. This workshop is appropriate for secondary and post-secondary educators.

HBCU
luncheon

Discussing the ***successes*** and ***challenges*** of physics faculty in Historically Black Colleges and Universities.

Monday, July 30

12:15–1:45 PM

Room: Guilford E
(ticket)

W12: Activity-Based Physics Learning Using the ABP High School CD

Sponsor: Committee on Physics in High Schools
Date: July 28
Time: 1–5 PM
Location: UNCG-Graham Bldg. Rm 202

Maxine Willis, 1130 Old Harrisburg Rd., Gettysburg, PA 17325; maxinewillis@earthlink.net

Martin Bauberger, Priscilla Laws

This workshop is designed for teachers interested in using active-learning materials in their physics classes. Participants will work with curricular materials in kinematics, dynamics, energy, and optics from the updated Activity-Based Physics High School CD (ABP HSCD). The curricula on the ABP HSCD are RealTime Physics, Tools for Scientific Thinking, Workshop Physics, and Interactive Lecture Demonstrations. These student-centered curricular modules are based on the outcomes of physics education research and are linked to the national standards. They make extensive use of computers for data collection and analysis. Attendees will gain hands-on experience with the materials. The equip.m.ent and software used in this workshop are compatible with both Mac and Windows computers and use interface equip.m.ent from Vernier Software and PASCO. (Format: Mac/PC)

W13: Hands-On Units for All Ages

Co-Sponsors: Committee on Science Education for the Public
Committee on Apparatus
Date: July 28
Time: 1–5 PM
Location: UNCG-McIver Physics Bldg. Rm 331

Richard Flarend, Penn State Altoona, Physics Dept., Altoona, PA 16601; ref7@psu.edu

Alice Flarend

Looking for more activities with a solid educational content for your classroom or an outreach program? In this workshop, participants will work through sequences of hands-on connected activities covering each of the following topics: heat, sound, and electro-magnetism. Presenters have used these activities in a variety of settings, including outreach programs with elementary and middle-school students, high school physics classes, college physics courses for nonscientists and teacher in-services. Presenters strive to use inexpensive materials. Participants will receive sample materials for most activities and a resource CD.

W14: Physics and Everyday Thinking (PET) and Physical Science and Everyday Thinking (PSET): Two New Curricula

Co-Sponsors: Committee on Teacher Preparation
Committee on Physics in Pre-High School Education
Date: July 28
Time: 1-5 PM
Location: UNCG-McIver Physics Bldg. Rm 140

Fred Goldberg, San Diego State Univ., Physics Dept., San Diego, CA 92120; fgoldberg@sciences.sdsu.edu

Steve Robinson, Valerie Otero

"Physics and Everyday Thinking" and "Physical Science and Everyday Thinking" are one-semester general education science courses for undergraduate students. They are particularly appropriate for prospective and practicing elementary teachers. Both courses engage students in activities that promote learning of: (1) physics or physical science content, (2) nature of science, (3) students' own science learning, and (4) children's science learning. PET focuses on the themes of interactions, energy, forces, and fields. PSET also focuses on both macro and micro descriptions of the properties of matter. After students develop their own understanding of ideas in the class, they then analyze video of children discussing similar ideas in elementary classrooms. During this workshop participants will be introduced to both the PET and PSET curricula, and will view and discuss video from both the college PET/PSET classrooms and elementary classrooms.

*Supported by NSF Grant ESI-0096856. PET is published by, and PSET will be published by, It's About Time, Herff Jones Education Div.

W15: *Moved to Sunday*

W16: WebTOP: Web-Based Interactive Activities for Teaching and Learning Waves and Optics

Sponsor: Committee on Educational Technologies
Date: July 28
Time: 1-5 PM
Location: UNCG-McIver Physics Bldg. Rm 256

Taha Mzoughi, Kennesaw State Univ., Dept. of Biological and Physics, Kennesaw, GA 30144-5591; tmzoughi@kennesaw.edu

John T. Foley

WebTOP is a 3D interactive computer graphics system developed to help instructors teach and students learn about waves and optics. It is made up of 19 modules spanning eight different subject areas: waves, geometrical optics, reflection and refraction, polarization, interference, diffraction, lasers, and scattering. Each module has an interactive simulation, a theory section, sets of examples and exercises, and a scripting feature for recording and initializing sessions. In addition, WebTOP includes several highly interactive guided tutorials. WebTOP can be run from our website, http://webtop.msstate.edu or be downloaded. Topics range from high school level to upper undergraduates. During the workshop, participants will learn how to use WebTOP, and how to develop their own WebTOP-based web pages. The participants will be given a CD that contains the WebTOP software and instructions, and a printed tutorial. WebTOP is sponsored in part by NSF (DUE 0231217).

T01: Mining the Hidden Web

Sponsor: Committee on Graduate Education in Physics
Date: July 28
Time: 6-7:30 PM
Location: Koury Center–Cedar B-C

Pat Viele, Cornell Univ., Physics Dept., Ithaca, NY 14853-2501; ptv1@cornell.edu

Millions of excellent websites designed to support the teaching and learning of science content are available in the "hidden web." Unfortunately, they are relatively unknown and untapped because information searchers do not know they exist. These key sites are not indexed by the usual search engines such as Yahoo and Google. This workshop will explore the location and access of information sources and search tools, useful in supporting science learning.

Sunday, July 29, 2007

W17: P-CSI-Greensboro: The Role of Physics in Forensic Science

Sponsor: Committee on Physics in High Schools
Date: July 29
Time: 8 AM–Noon
Location: UNCG-McIver Physics Bldg. Rm 230A

Kathy Mirakovits, Portage Northern H.S., Portage, MI 49024; kmirakovits@portageps.org

Forensic science, the application of science to matters of law, uses all science disciplines to problem solve a criminal act. Physics plays an integral part in this interdisciplinary meld of crime-scene reconstruction. Some of the areas that use the concepts of physics will be briefly explored in this workshop. The workshop presenter is a high school physics teacher who has been integrating criminalistics into physics and physical sciences classes for over 12 years (pre-CSI). She has completed law enforcement training in the required 40-hour bloodstain pattern analysis course for police officers. Participants will be introduced to how forensic scientists use physics in the study of bloodstain-pattern analysis, forensic analysis of glass (fractures and identification), firearms identification and ballistics, and an introduction to vehicular-accident reconstruction. Suggestions for inclusion of crime scene investigation principles into physics or physical science curricula will be discussed. At the end of the workshop, participants have the opportunity to test their skills in a "mini" mock crime scene (very brief due to time limitations).

W18: Learning the "Game" of Science: Introducing Students to the Nature and Philosophy of Science

Sponsor: Committee on History & Philosophy of Physics
Date: July 29
Time: 8 AM–Noon
Location: UNCG-McIver Physics Bldg. Rm 331

David Maloney, Indiana Univ Purdue Univ. - Fort Wayne, Physics Dept., Fort Wayne, IN 46805; maloney@ipfw.edu

One dilemma that is experienced in science classes is helping students understand how science works, what makes an activity scientific, and the characteristics of scientific reasoning. In an activity inspired by a quote from The Feynman Lectures on Physics, participants will use a strategy game-based analog of scientific method to examine the nature of scientific reasoning. In the activity, information is provided about the playing pieces, game board, and the moves for several games. Based on this information, the participants are to determine the rules of the game. Through the activity and by using a variety of games, students can experience facets of scientific methodology. The workshop will explore three or four different games that feature different aspects of scientific reasoning. We will also discuss the strengths and weaknesses of the activity as well as ideas for additional variations.

W19: Preparing Pre-College Teachers to Teach Physics by Inquiry

Co-Sponsors: Committee on Research in Physics Education, Committee on Teacher Preparation
Date: July 29
Time: 8 AM–Noon
Location: UNCG-McIver Physics Bldg. Rm 140

Lillian McDermott, Univ. of Washington - Seattle, Physics Dept., Seattle, WA 98195-1560; peg@phys.washington.edu

Designed primarily for college and university faculty, this workshop focuses on preparing pre-college teachers (K-12) to teach physics and physical science. Participants will work through portions of *Physics by Inquiry*.[1] Excerpts from a video[2] will illustrate the types of interactions that take place as teachers work through exercises and experiments. There will be a focus on how physics education research has guided the design of the modules. In addition, there will be a discussion of various aspects involved in designing a course to prepare K-12 teachers to teach by inquiry. Copies of *Physics by Inquiry* will be provided to participants.

1. L.C. McDermott and the Physics Education Group at the University of Washington, *Physics by Inquiry: An Introduction to Physics and Physical Science*, Volumes I and II (Wiley, New York, 1996). Supported by the National Science Foundation.
2. Physics by Inquiry: A Video Resource (WGBH, Boston, 2000). Supported by the National Science Foundation.

W20: TIPERs with Physlets

Co-Sponsors: Committee on Educational Technologies, Committee on Physics in Two-Year Colleges
Date: July 29
Time: 8 AM–Noon
Location: UNCG-Stone Bldg. Rm 127

Anne Cox, Eckerd Coll., Collegium of Natural Sciences, St. Petersburg, FL 33711; coxaj@eckerd.edu

Tom O'Kuma

TIPERs (Tasks Inspired by Physics Education Research) are a type of problem that is designed to probe student conceptual understanding and help students build their problem-solving skills. Physlets (physics applets) are animations that instructors can customize (by scripting). These two pedagogical tools fit together to provide enhanced interactive engagement for students in the classroom. Participants in this workshop will learn how to use and design Physlet-based TIPER exercises for their own students.

W21: VPython: 3D Programming for Ordinary Mortals

Sponsor: Committee on Educational Technologies
Date: July 29
Time: 8 AM–Noon
Location: UNCG-Moore Humanities Hall, (corner of Forest St. and Spring Garden) Rm 1305

Bruce Sherwood, North Carolina State Univ., Physics Dept., Raleigh, NC 27694; bruce_sherwood@ncsu.edu

Ruth Chabay, Joe Heafner

VPython is a programming environment that enables users with minimal programming skills to write programs that produce navigable real-time 3D animations. Students in our introductory physics courses use VPython to write programs to model physical systems and to visualize electric and magnetic fields. VPython produces real-time 3D animations as a side effect of computations. One to two hours of carefully crafted instruction is sufficient to bring novice students to the point of being able to do serious computer modeling. VPython is suitable for use in both introductory and advanced courses. VPython is based on the Python programming language (http://python.org) which has a large user community; Python textbooks are available in most large bookstores. Like Python,VPython is open-source freeware available for Windows, Linux, and Macintosh (http://vpython.org). Workshop participants will learn to write 3D programs and can sample existing physics applications.

W22: NASCAR Research & Development

Sponsor: Committee on Laboratories
Date: July 29
Time: 8 AM–Noon
Location: UNCG-McIver Physics Bldg. Rm 254

Van Bistrow, Univ. of Chicago, Physics Dept., Chicago, IL 60637; vanb@uchicago.edu

Participants will analyze performance and safety of vehicles using NASCAR's Research and Development Facility's data of car performance under race conditions. Participants are encouraged to develop new modes of analysis of the data. Special thanks to Michael Fisher, Managing Director of NASCAR's Research and Development Facility.

W23: Lecture Demonstrations II

Sponsor: Committee on Apparatus
Date: July 29
Time: 8 AM–5 PM
Location: UNCG-Taylor Bldg., Theater

Dale Stille, Univ. of Iowa, Physics and Astronomy Dept., Iowa City, IA 52242; dale-stille@uiowa.edu

Sam Sampere (co-leader)

Topics in this workshop cover the standard second semester of physics instruction, from E&M to astronomy. It is taught by an experienced team of lecture demonstrators. The format allows for and encourages interplay between instructors and participants. It is recommended that both Lecture Demonstrations I and II be taken as this will cover the complete year of demonstration needed for a typical course. The demonstrations used and exhibited will be based on, but not limited to, the PIRA top 200 list of demonstrations. See http://www.pira-online.org for more info on this list.

W24: Using Research-Based Curricula and Tools to Revitalize Your Intro Course

Co-Sponsors: Committee on Research in Physics Education, Committee on Educational Technologies
Date: July 29
Time: 8 AM–5 PM
Location: UNCG-McIver Physics Bldg. Rm 256

David Sokoloff, Univ. of Oregon, Physics Dept., Eugene, OR 97403-1274; sokoloff@uoregon.edu

Ronald Thornton, Priscilla Laws

This hands-on workshop is designed for those interested in making learning in their introductory courses more active within the context of lectures, labs, and recitation hours. Participants will be introduced to physics education research-based strategies for each of these components: Interactive Lecture Demonstration (ILDs), Web-Based ILDs, RealTime Physics labs, Activity-Based Tutorials and Collaborative Problem-Solving Tutorials, as well as modeling and video analysis tools. The tools and software used in this workshop are available for Macintosh and Windows computers.

W25: Physics on the Road

Sponsor: Committee on Science Education for the Public
Date: July 29
Time: 8 AM–5 PM
Location: UNCG-Elliott Univ. Center, Claxton Rm

Brian Jones, Colorado State Univ., Physics Dept., Fort Collins, CO 80523-1875; bjones@lamar.colostate.edu

Steve Shropshire, Chris Chiaverina

Interested in taking physics on the road? The presenters of this workshop will give you a taste of their programs, which range from programs consisting of one person and a few boxes of equipment to a van with 80 different experiments in the back, from science shows to hands-on experiences, from straight demo shows to more theatrical events. We will show you our stuff and share some advice: how to put together a traveling science show, other components of the outreach programs, tips and tricks for doing a great presentation, and, of course, lots and lots of ideas for great physics experiments and demonstrations. This workshop is intended for folks who want to learn more about how to do outreach, old hands who want to learn (and share!) some new ideas, and folks who just want to see some cool physics in action.

W26: Teaching Astronomy with Technology

Sponsor: Committee on Space Science and Astronomy
Date: July 29
Time: 8 AM–5 PM
Location: UNCG-Elliott Univ. Center, Alexander Rm

Kevin M. Lee, Univ. of Nebraska - Lincoln, Physics and Astronomy Dept., Lincoln, NE 68588-0111; klee6@unl.edu

Dave Kriegler, Tim Slater

This workshop will survey a variety of educational technologies useful for engaging students in both high school and introductory college classrooms. Special emphasis will be placed on simulation usage and peer instruction. Participants will work on computers gaining familiarity with the astrophysical simulations of the Nebraska Astronomy Applet Project (NAAP) and its web-based assessment capabilities. Participants will also design peer instruction sequences to be used in the classroom using the computer-based modules of the ClassAction Project. A lighter emphasis will be placed on using computerized ranking tasks and on comparing available options for online homework, astronomy laboratories, and desktop planetariums. All participants will receive NAAP, ClassAction, and computerized ranking task materials on CD.

W27: Doing Real Science Projects with Small Telescopes

Sponsor: Committee on Space Science and Astronomy
Date: July 29
Time: 8 AM–5 PM
Location: Koury Center–Oak B-C Rm

Pamela Gay, Southern Univ. of Illinois-Edwardsville, Physics Dept., Edwardsville, IL 62026-1654; pgay@siue.edu

In this workshop participants will get resources on how they can get involved in real science using off-the-shelf telescopes to tour the skies. Divided into three parts, this workshop will overview current opportunities for professional-amateur-educational astronomy collaborations and then go into the practical skills needed to do science through both visual observing and CCD observing. Participants will receive CD-ROMs containing practice activities, FAQs, and the basics on getting started. Particular emphasis will be given to variable star observing. Variable stars are part of the current Science Olympiad Division C program, and this workshop will go over the skills needed to understand observing these stars and contributing data to the International Database of Variable Stars at the American Association of Variable Stars. Methods for observing planetary transits, microlensing events, and minor bodies (for instance, asteroids) will also be discussed.

W28: Using RTOP to Improve Physics and Physical Science Teaching

Co-Sponsors: Committee on Teacher Preparation, Committee on Physics in Undergraduate Education
Date: July 29
Time: 8 AM–5 PM
Location: Koury Center–Cedar B-C Rm

Kathleen Falconer, Buffalo State Coll., Physics Dept., Buffalo, NY 14222; falconka@buffalostate.edu

Paul Hickman

The Reformed Teaching Observation Protocol (RTOP)[1] is a 25-item rubric that provides a percentile score describing the degree and kind of student-centered constructivist inquiry present in an instructional situation. RTOP scores correlate very highly with student conceptual score gains.[2] In this workshop we will score video vignettes of teaching to learn to use RTOP for guiding personal reflection and improvement on our own teaching;[3] for mentoring peers, novice teachers and student teachers; and to establish a vocabulary for discussing reformed teacher practices.[4]

1. M. Piburn, D. Sawada, K. Falconer, J. Turley, R. Benford, and I. Bloom. "Reformed Teaching Observation Protocol (RTOP)." ACEPT IN-003. (ACEPT, 2000). The RTOP rubric form, training, and statistical reference manuals, are available from <http://PhysicsEd.BuffaloState.EduAZTEC/

rtop/> under RESOURCES.

2. A.E. Lawson et al., "Reforming and evaluating college science and mathematics instruction: Reformed teaching improves student achievement," *J. Coll. Sci. Teach.* **31**, 388–393 (March/April 2002).

3. D.L. MacIsaac and K. A. Falconer. "Reforming physics instruction via RTOP," *Phys. Teach.* **40** (8), 479-485 (Nov. 2002).

4. D.L. MacIsaac, D. Sawada, K.A. Falconer, "Using the reform teacher observation protocol (RTOP) as a catalyst for self-reflective change in secondary science teaching," Peer-reviewed paper. American Education Research Association Division K. (2001) (ERIC Document Reproduction Service No. ED 452 070).

W29: Piaget Beyond "Piaget" for Physics Learning

Co-Sponsors: Committee on Teacher Preparation
Committee on Research in Physics Education
Committee on Physics in Pre-High School Education

Date: July 29

Time: 8 AM–5 PM

Location: Koury Center–Colony C Rm

Dewey Dykstra, Boise State Univ., Physics Dept., Boise, ID 83725-1570; ddykstra@boisestate.edu

While early work of the Swiss Genetic Epistemologist, Jean Piaget, and co-workers in Geneva was being "rediscovered" in the 1970s in physics education, Piaget and his co-workers were advancing understanding of origins and development of human understanding of the world several decades beyond the works we were studying at the time. We were just grappling with Piaget's notion of developmental "stages," while Piaget and his co-workers moved beyond "stages," explaining how, why, and under what circumstances human understanding changes. Physics educators realized Piaget's method of evidence collection, the individual interview, revealed the nature of interviewee understanding. Such interviews became the origins of physics education research (PER) in student conceptions. Work of the Geneva group on understanding change in human understanding has not been extensively studied in physics education and PER. This later work, with significant implications for physics learning and teaching, will be the subject of the workshop.

T02: Creating Java Simulations for Physics Teaching with Easy Java Simulations

Co-Sponsors: Committee on Undergraduate Education in Physics
Committee on Educational Technologies

Date: July 29

Time: 10 AM–Noon

Location: UNCG-Elliott Univ. Center, Cone C Rm

Wolfgang Christian, Davidson Coll., Physics Dept., Davidson, NC 28035-6926; wochristian@davidson.edu

Francisco Esquembre

The tutorial shows how to use the Easy Java Simulations (EJS) modeling and authoring tool to create dynamical simulations of physical phenomena for teaching. These simulations can be used for computer demonstrations or virtual laboratories, or serve as programming examples and tasks for computational physics. Simulations created with EJS are ready to be distributed on a CD or published on a web page as Java applets. This tutorial is intended for programmers and nonprogrammers alike. Participants are encouraged to bring laptops as they will receive a CD with documentation and step-by-step examples of simulations of several levels of difficulty. Paper documentation will also be provided. Additional information, including a web-based forum that provides examples and facilities for exchanging simulation and related pedagogical experiences is available on the EJS website: http://www.um.es/fem/Ejs/.

T03: Tutorial on the LANGURE Collaboration in Research Ethics

Sponsor: Committee on Graduate Education in Physics

Date: July 29

Time: 1–3 PM

Location: Koury Center–Imperial B Rm

Michael Paesler, North Carolina State Univ., Physics Dept., Raleigh, NC 27695-8202; Paesler@ncsu.edu

This two-hour tutorial will describe the LANGURE research collaboration that focuses on instruction in research ethics for graduate students. We will describe different aspects of the academic program and show how one can incorporate formalized research ethics training into a graduate curriculum. LANGURE (Land Grant University Research Ethics) is a national collaboration of land grant universities; historically black universities; a private corporation; a national consortium for education in responsible conduct of research; and an open source software group. LANGURE involves more than 130 faculty and graduate students dedicated to developing a model curriculum in research ethics for doctoral candidates in engineering and the physical, social, and life sciences. North Carolina State University is the head institution of the program which is sponsored by a major grant from the National Science Foundation for 2005-2008 called "A Model Curriculum for Land Grant Universities in Research Ethics." Information can be found at www.chass.ncsu.edu/langure/index.html

W30: Improving Student Learning in Physics: Tutorials in Introductory Physics

Sponsor: Committee on Research in Physics Education

Date: July 29

Time: 1–5 PM

Location: UNCG-Elliott Univ. Center, Cone C Rm

Lillian McDermott, Univ. of Washington - Seattle, Physics Dept., Seattle, WA 98195-1560; peg@phys.washington.edu

Designed primarily for college and university faculty, this workshop illustrates how research can help improve student learning in introductory calculus and algebra-based physics courses. Tutorials in Introductory Physics[1] is a set of instructional materials intended to supplement the lecture, textbook, and laboratory of a standard calculus-based or algebra-based introductory course. The tutorials address specific conceptual and reasoning difficulties that have been identified through research. In addition to providing hands-on experience with the curriculum, the workshop will include discussions of instructional strategies incorporated into the materials and results from assessments of student learning. Important aspects related to implementation of the tutorials will be covered, including preparation of graduate teaching assistants, undergraduate peer instructors, and post-docs. Copies of *Tutorials in Introductory Physics* will be provided to participants.

1. L.C. McDermott, P.S. Shaffer, and the Physics Education Group at the University of Washington, Tutorials in Introductory Physics, First Ed. (Prentice Hall, 2002). Developed with support from the National Science Foundation.

W15: Building Physics Teacher Pedagogical Content Knowledge

Sponsor: Committee on Teacher Preparation

Date: July 29

Time: 1-5 PM

Location: UNCG-Elliott Univ. Center, Kirkland Rm

Eugenia Etkina, State Univ. of New Jersey Rutgers, Graduate School of Education, New Brunswick, NJ 08901; etkina@rci.rutgers.edu

Lee Shulman identified pedagogical content knowledge (PCK) as a necessary component of teacher knowledge—a blend of content and pedagogy that distinguishes the understanding of a content specialist from that of the novice. PCK involves knowing students' original ideas and potential difficulties, alternative ways to represent those ideas, and the various effective instructional methods within a particular discipline. What constitutes physics PCK and how can prospective and practicing physics teachers construct and improve theirs? What elements of a teacher preparation program and what specific activities help physics teachers to develop their PCK? Where should we work to develop students' PCK: in the undergraduate physics courses, in the methods courses, during student teaching or through novice teacher mentoring? In this interactive workshop participants will tackle the above questions and develop some strategies for incorporating the building of teacher PCK into their physics courses, methods courses, and teacher preparation programs.

W31: Advanced & Intermediate Instructional Laboratories

Sponsor: Committee on Apparatus
Date: July 29
Time: 1–5 PM
Location: UNCG-McIver Physics Bldg. Rm 225 & 228

Van Bistrow, Univ. of Chicago, Physics Dept., Chicago, IL 60637; vanb@uchicago.edu

Gabe Alba, Steve Wonnell, Dean Hudek, Ramon Torres-Isea

Several advanced and intermediate instructional laboratory setups will be presented and discussed. The attendees will break into small groups and move from setup to setup in 25-minute intervals. At each setup a presenter will perform the laboratory exercise and discuss its technical aspects including expected results, common problems, pros and cons of this apparatus, etc. They will also explain what is involved in obtaining the setup (i.e., where to buy parts and how to build it or where to buy a complete setup). Handouts will be provided. This workshop is appropriate for post-secondary educators developing laboratories for sophomore, junior, and senior-level physics courses.

W32: 21st Century Teaching & Learning: Middle Grades Science and Mathematics

Co-Sponsors: Committee on Physics in Pre-High School Education, Committee on Educational Technologies
Date: July 29
Time: 1–5 PM
Location: UNCG-McIver Physics Bldg. Rm 331

Lisa Grable, North Carolina State Univ., Physics Dept., Raleigh, NC 27606; grable@ncsu.edu

Eric Wiebe, Bethany Smith, Bethany Hudnutt, Beckey Reed

Participants will learn to use 21st-century skills as a framework for science and math integration in the middle school curriculum. The Partnership for 21st Century Skills has developed a definition of 21st century skills that can be mapped to curriculum standards for science and mathematics in 6th, 7th, and 8th grades. Participants will receive hands-on experience with professional development materials designed for middle grades teachers. Activities are based on science education and instructional technology research and are focused on data collection and visualization. Topics include the use of Vernier probeware, graphing calculators, TinkerPlots, and video tools.

W33: What Every Physics Teacher Should Know About Cognitive Research

Sponsor: Committee on Research in Physics Education
Date: July 29
Time: 1–5 PM
Location: UNCG-McIver Physics Bldg. Rm 140

Chandralekha Singh, Univ. of Pittsburgh, Physics Dept., Pittsburgh, PA 15260; clsingh@pitt.edu

In the past few decades, cognitive research has made major progress in understanding how people learn. The understanding of cognition that has emerged from this research can be particularly useful for physics instruction. We will discuss and explore, in a language accessible to everybody, how the main findings of cognitive research can be applied to physics teaching and assessment. This workshop is guaranteed to be useful for all physics teachers. Those involved in physics education research are particularly encouraged to attend.

W34: Energy in the 21st Century

Sponsor: Committee on Science Education for the Public
Date: July 29
Time: 1–5 PM
Location: UNCG-McIver Physics Bldg. Rm 230A

Patrick Keefe, Clatsop Comm. Coll., Physics Dept., Astoria, OR 971030; pkeefe@clatsopcc.edu

Greg Mulder

We have found that engaging students in predictions of what form and how much energy will be used in the future is a very successful way to generate enthusiasm and further investigation of physics. Participants of this workshop will be introduced by way of experience to two different group projects that involve designing energy systems. These modeling exercises look at past energy-consumption patterns and develop a plan for energy usage in the 21st century. Other considerations such as population, costs, and efficiencies are also used to further expand the discussion and decision making that takes place.

W35: Physics Teaching Web Advisory (Pathway)

Co-Sponsors: Committee on Educational Technologies, Committee on Physics in High Schools
Date: July 29
Time: 1–5 PM
Location: UNCG-Moore Humanities Hall, (corner of Forest St. and Spring Garden) Rm 1305

Brian Adrian, Kansas State Univ., Physics Dept., Manhattan, KS 66506; badrian@phys.ksu.edu

Dean Zollman, Scott Stevens

The Physics Teaching Web Advisory (Pathway) is a new type of digital library. Based on state-of-the-art digital video technology, Pathway is a free online resource that provides assistance and expertise for teachers of physics. Participants will be introduced to the two primary components of Pathway—the Synthetic Interview and the searchable digital video library. The Synthetic Interview enables any teacher to have a virtual conversation with experienced physics teachers while the digital library provides access to a variety of video resources. We will show how Synthetic Interview responses are tied to the National Science Education Standards and to current literature in physics teaching. Participants will learn how both features can be valuable in their physics teaching.

W36: Ways to Use PhET's Interactive Simulations

Co-Sponsors: Committee on Educational Technologies, Committee on Research in Physics Education
Date: July 29
Time: 1–5 PM
Location: UNCG-Stone Bldg. Rm 127

Katherine Perkins, Univ. of Colorado, Physics Dept., Boulder, CO 80309; Katherine.Perkins@colorado.edu

Wendy Adams, Sam McKagan, Carl Wieman

The Physics Education Technology (PhET) Project has developed more than 60 simulations for teaching and learning introductory physics at the high school and college levels. These research-based simulations create animated, interactive, game-like environments that are designed to engage students in active thinking, encourage experimentation, and help develop visual and conceptual models of physical phenomena, emphasizing their connections to everyDate life. The simulations are free, and can be run from the PhET website (http://phet.colorado.edu) or downloaded to a local computer for off-line use. In this workshop, participants will work with these simulations and explore how they can be used effectively in lecture, lab, and as part of homework assignments to improve both student learning and engagement.

W37: Phenomenal Physics—A Guided Inquiry Curriculum for Conceptual Physics Instruction

Co-Sponsors: Committee on Physics in High Schools, Committee on Physics in Undergraduate Education
Date: July 29
Time: 1–5 PM
Location: Koury Center–Colony B Rm

Russ Harkay, Keene State Coll., Keene, NH 103435-2001; rharkay@keene.edu

The word inquiry has become a buzzword of late, and we might ask what IS guided inquiry and how can we implement it effectively? Are there limitations imposed by this methodology and how might we minimize those? Is there evidence of effectiveness? Can inquiry "turn on" unmotivated students? Using exercises gleaned from a textbook authored by the presenter and developed under NSF grant Project INSPIRE, participants explore a hands-on mode of learning that can lead to remarkable levels of retention and interest in the subject while eliminating apprehension. The curriculum lends itself to conceptual physics courses at the secondary and college level and some are substituting them for labs. The curriculum utilizes inexpensive materials, a sense of humor, and informality to increase motivation and participation. Relevance, involvement, and active learning are the mainstays of this robust, inquiry-based curriculum, and studies using CLASS and FCI have demonstrated effectiveness in producing gains.

W38: Physics and Toys I: Force, Motion, Light and Sound

Co-Sponsors: Committee on Physics in Pre-High School Education
Committee on Science Education for the Public
Date: July 29
Time: 1–5 PM
Location: Koury Center–Imperial C Rm

Raymond Turner, Clemson Univ., Clemson, SC 29634-0978; traymon@clemson.edu

Beverley A.P. Taylor

This hands-on workshop is designed for teachers at all levels in search of fun physics demonstrations, lab experiments, and interactive materials through the use of ordinary children's toys. More than 50 toys will be demonstrated, and the physical principles related to these toys will be discussed. This workshop will concentrate on toys that illustrate the concepts of force, equilibrium, linear and rotational motion, optics and light, sound, and waves. You will have the opportunity to participate in both qualitative and quantitative investigations using some of these toys. The workshop leaders have found that toys can be utilized at all grade levels from kindergarten through college by varying the sophistication of the analysis. These same toys can also be used for informal presentations to public groups of all ages, whether children or adults. Participants will be given a small assortment of toys to help start their own toy collection.

W39: Implementing the Learning Assistant Model at Your University

Sponsor: Committee on Research in Physics Education
Date: July 29
Time: 1–5 PM
Location: Koury Center–Imperial A Rm

Valerie Otero, Univ. of Colorado, Boulder, CO 80309-0249; Valerie.Otero@Colorado.edu

Steve Iona, Steve Pollock, Noah Finkelstein

Interested in transforming your course to be more interactive? Looking to increase the pool of talented science students who go into teaching? The Colorado Learning Assistant Program can help. Learning Assistants (LAs) are talented undergraduate students who are hired to help transform large-enrollment courses to be collaborative, student-centered, and interactive. Meanwhile, these LAs make up the pool from which K-12 teachers are recruited. The LA model has demonstrated effectiveness in improving undergraduate education, in facilitating multi-disciplinary collaboration among faculty, and in recruiting talented science majors to teaching careers. In this workshop we will introduce two- and four-year college faculty to the Learning Assistant Model and discuss issues involved in implementation in a variety of university contexts. In addition to engaging in hands-on analysis of data, participants will evaluate several different approaches to implementing and funding an LA program. Materials to assist faculty in implementing the program will be provided.

Commercial Workshop Abstracts

CW01: Experience Digital Physics Curriculum

Sponsor: Kinetic Books
Date: Mon., July 30
Time: 9–11:30 AM
Room: Tidewater A

Leaders: Mark Bretl, Glenn Brooks

View and experiment with a digital physics textbook and virtual physics labs. Learn how fully integrated digital physics curriculum can aid in your instruction. Application of multi-learning styles and inquiry-based learning in a self-paced package provide students with the opportunity to experiment and explore.

CW02: Active Physics: Bridging Research & Practice

Sponsor: It's About Time
Date: Mon., July 30
Time: 9–11:30 AM
Room: Tidewater B

Leader: Arthur Eisenkraft

Research from cognitive sciences, motivational research and instructional models can inform the way in which we present physics content to students. Alongside the need for good instructional models that take into account results from research, physics instructors face the persistent issue of the need for differentiated instruction – challenging all students while not "dummying down the course" nor "driving the students from the course."

Teaching ALL students in our classes and avoiding attrition yet maintaining rigor, while be the focus of this workshop. The 7E instructional model will be presented with its link to research to how people learn. In addition, strategies for differentiating instruction will be presented. Finally, a "proof of concept" will be presented to demonstrate that this approach to designing lessons and courses can satisfy our needs for students to learn physics content, physics problem solving and the larger organizing principles of our discipline.

CW03: Inquiry-based investigations in Physics: Inertia and the Energy Car

Sponsor: CPO Science
Date: Mon., July 30
Time: 9–11:30 AM
Room: Augusta A

Leader: Alen Brown

In this workshop, participants use technology to record real time data to explain the abstract concept of inertia and discover Newton's First Law. Newton's first law states that an object at rest will remain at rest and an object in motion will stay in motion unless acted on by a force. Participants will use hands-on activities to discover that inertia is the property of an object that resists changes in motion and that inertia comes from mass. Through data collection and graphing students will see how objects with more mass have proportionately more inertia than objects with less mass.

Research based? YES! The teaching strategies utilized are aligned with the latest research in the cognitive learning sciences. An emphasis on exploring concepts through hands-on, inquiry-based approach combined with group learning makes physics "friendly" and accessible for all students. The complete teaching and learning system being demonstrated integrates the student text, lab manual, teacher materials and lab equipment, saving you valuable time. This program provides an excellent combination of physics concepts and algebra. If a textbook is adopted, full equipment kits are supplied at no additional expense. Come see how a fully integrated hands-on curriculum makes a difference in student comprehension!

CW04: Ordinary Experiments Performed with Extraordinary Apparatus

Sponsor: PASCO scientific
Date: Mon., July 30
Time: 1:30–3:30 PM
Room: Tidewater A

Leaders: Ann Hanks, Jon Hanks

Join two of PASCO's physics teachers, 20-year veterans of the classroom, to experience new ways of performing 12 classic experiments: Impulse and Momentum, Ballistic Pendulum, Conservation of Energy, Hooke's Law, Vibrating Strings, Conservation of Angular Momentum, Interference of Sound Waves, Resistivity, Ohm's Law, LRC Circuits, Electrical Equivalent of Heat, and Diffraction of Light. By combining the Xplorer GLX (a special-purpose Physics computer) with physics apparatus specifically designed to work with sensors, PASCO has optimized sensor-based experiments so that students can concentrate on the physical phenomena instead of spending valuable time on tedious setups. Participants will receive experiment write-ups and a chance to win an Xplorer GLX.

CW05: Teaching Relativity in Week One

Workshop Cancelled

Sponsor: Physics2000.Com
Date: Mon., July 30
Time: 1:30–3:30 PM
Room: Tidewater B

Leader: Elisha Huggins

The Physics2000 textbook introduces a way to teach a comfortably paced one-year introductory physics course that integrates modern physics. That is done by starting with Special Relativity in week one and then incorporating 20th century concepts as you go along. For example, after you finish discussing light waves, you go right to photons and the particle-wave nature of matter. In the seminar we show you how to teach relativity in five-45 minute lectures, developing the intuitive concepts used throughout the course. We then discuss examples such as deriving the magnetic force law from Coulomb's law and the Lorentz contraction. We will then use the Fourier analysis capability of the MacScope II program to teach the time-energy form of the uncertainty principle and introduce Fourier Optics. MacScope II is a freely downloadable shareware audio oscilloscope that uses the computer's (Macintosh and Windows) audio input for acquiring data. Workshop attendees will receive a free copy of the Physics 2000 CD and printed texts.

CW06: MasteringPhysics Workshop

Sponsor: Addison Wesley
Date: Mon., July 30
Time: 1:30–3:30 PM
Room: Augusta A

Leaders: Claire Masson

With more than 100,000 daily users MasteringPhysics is the most widely used physics homework and tutorial system in the world. Its unprecedented popularity is due to two unique advantages. Firstly, MasteringPhysics is the most sophisticated homework system available allowing for multi-part, multi-step free-response problems, an unmatched variety of wrong-answer feedback, individualized help (comprising hints or simpler sub-problems upon request), all driven by the largest metadatabase of student problem-solving in the world. Secondly, MasteringPhysics is the most educationally proven system —eight years in development and testing, NSF-sponsored published research (and subsequent studies) shows that the system has dramatic educational results with correlated gains in class finals of up to eight times that from traditional hand-graded homework, and gains in conceptual understanding (as measured using the FCI) higher than that from group problems.

Our workshop will explain how to introduce MasteringPhysics into your course quickly and easily, the benefits to you and your students, the latest physics education research using the system, even guidelines for authoring your own problems and possible research techniques. We welcome anyone who is interested in new ways to offer more effective tutoring and testing in their calculus- and algebra/trig-based physics courses.

CW07: Online Homework Management with SmartWork

Sponsor: W. W. Norton & Company
Date: Tues., July 31
Time: 9–11:30 AM
Room: Tidewater B

Leader: Leo Wiegman

SmartWork, W. W. Norton's innovative online homework-management system, makes it easy for instructors to assign, edit, and administer physics homework assignments. SmartWork supports a wide range of question types, to include vector diagramming, equation entry, and numeric answer. End-of-chapter problems adapted for use within SmartWork offer instant scoring, algorithmic variables, specific answer feedback, and hinting. Tutorial Problems provide additional help by breaking challenging problems into a series of logical sub-steps. A fully integrated ebook makes it easy for students to consult the text when working through problems.
SmartWork offers ready-made assignments for each chapter of Ohanian and Markert's Physics for Engineers and Scientists, plus a bank of additional questions, all drawn from the textbook's end of chapter problems and review problems. Instructors may use these assignments as is, select alternate questions from the question bank, or use the full range of SmartWork's "WYSIWYG" (What You See is What You Get) authoring tools to develop new content. No other system gives instructors such easy editorial control over publisher-provided content. www.wwnorton.com/college

CW08: Experience Digital Physics Curriculum

Sponsor: Kinetic Books
Date: Tues., July 31
Time: 11:00 AM–1:00 PM
Room: Tidewater A

Leaders: Mark Bretl, Glenn Brooks

View and experiment with a digital physics textbook and virtual physics labs. Learn how fully integrated digital physics curriculum can aid in your instruction. Application of multi-learning styles and inquiry-based learning in a self-paced package provide students with the opportunity to experiment and explore.

CW09: Teaching Relativity in Week One

Sponsor: Physics2000.Com
Date: Tues., July 31
Time: 1:30– 3:30 PM
Room: Tidewater B

Leader: Elisha Huggins

The Physics2000 textbook introduces a way to teach a comfortably paced one-year introductory physics course that integrates modern physics. That is done by starting with Special Relativity in week one and then incorporating 20th century concepts as you go along. For example, after you finish discussing light waves, you go right to photons and the particle-wave nature of matter. In the seminar we show you how to teach relativity in five-45 minute lectures, developing the intuitive concepts used throughout the course. We then discuss examples such as deriving the magnetic force law from Coulomb's law and the Lorentz contraction. We will then use the Fourier analysis capability of the MacScope II program to teach the time-energy form of the uncertainty principle and introduce Fourier Optics. MacScope II is a freely downloadable shareware audio oscilloscope that uses the computer's (Macintosh and Windows) audio input for acquiring data. Workshop attendees will receive a free copy of the Physics 2000 CD and printed texts.

CW10: Vernier – What's New in the World of Physics Data Collection?

Sponsor: Vernier Software & Technology
Date: Tues., July 31
Time: 1:30– 3:30 PM
Room: Augusta A

Leaders: David Vernier, John Gastineau

Attend this hands-on workshop to learn more about hardware and software developments at Vernier. Work with the new Vernier LabQuest, our color touch-screen handheld data collection and analysis device. Use LabQuest as a standalone device, or connect it to a computer and control it from Logger Pro software. Collect force, altitude and acceleration data with the Wireless Dynamics Sensor System (WDSS). Also, learn how to use the WDSS remotely, for example, on an amusement park ride. Use our spectrometers to collect emission spectra with Logger Pro software. You can now incorporate GPS data into Logger Pro files, and even export to a Google map. Finally, try out Logger Pro's improved support for video capture from digital video (DV) cameras.

CW11: Hands-on, Minds-on Interactive Physics

Sponsor: Design Simulation Technologies Inc.
Date: Mon., July 30
Time: 1:30–3:30 PM
Room: Meadowbrook

Leader: Kat Woodring

Interactive Physics is the world's leading software for demonstrating, teaching, and experiencing the concepts of Physics. It is in use by more than 13,000 schools worldwide. This workshop will provide you with an opportunity to see the software in action, obtain hands on experience, and learn how the world of physics can come to life for your students. Dr. Paul Mitiguy, a long time driving force behind the product, will conduct the workshop. In addition to discussing the software he will also review the over two hundred experiments that are part of the product and the innovative curriculum he developed to complement class room use.

CW12: And You Thought It Was About Homework

The way you imagined teaching could be™

Sponsor: WebAssign, Inc.
Date: Mon., July 30
Time: 1:30–3:30 PM
Room: Tidewater B

Leaders: John S. Risley, Peg Gjertsen

Help your students learn with WebAssign. Find out what's new. WebAssign, the premier online homework, quizzing, and testing system, continues to have all of the features you want and includes content from all major publishers. Access questions from all major physics and astronomy textbooks, or write your own. Check out our latest offerings with assignable simulations, assignable examples with content specific hints and feedback, more online components and tutorials—all specific to your textbook. Give partial credit with conditional weighting. Assign practice questions. Give group assignments. Select questions for your assignments knowing how difficult each question is and how many student have tried it before. Prepare your students for labs and collect their lab data, analysis, and reports—all using WebAssign. Streamline your work flow with WebAssign. It is easy to use, reliable, and helps you stay connected, your way. Quickly access student responses, view item analysis for each questions, communicate using class forums, Ask Your Teacher, and announcements, give students access to all of their course grades with complete class statistics, propagate common assignments to multiple sections, give secure quizzes and tests. Find out how to integrate WebAssign with Blackboard, Shibboleth, D2L, and other registration systems.
Over 190,000 students are using WebAssign. Find out why. Visit us at http://webassign.net.

Sunday, July 29

Registration: 7 AM–4:30 PM and 7–9 PM
Lobby

H.S. Share-a-thon: 4:30–6:30 PM
Imperial D

Welcome Reception: 8–10 PM
Imperial D

Session SUN: SPS/AAPT Poster Reception

Sponsor: Undergraduate Education
Location: Colony B-C
Date: Sunday, July 29
Time: 6:30–8 PM

SUN01: Determining Gluon Polarization in the Proton

Yevgeny Binder, Loyola Univ. Chicago, 847-791-7771; yev@freeshell.org*

Current research in high energy physics investigates the internal structure of hadronic particles. Composed of a submicroscopic sea of quarks and gluons, this dynamic system eludes direct observation and necessitates theoretical modeling. One topic that is still unresolved is the asymmetry between polarized and unpolarized gluons in the hadron. Several competing particle models depend on the value of this ratio. The results of this have a direct bearing on the internal motion of the hadron's components, so determining its value is important. We have written a computer program whose purpose is to calculate the asymmetry from theory and compare it to results determined by particle accelerator experiments. This is an undergraduate research project that can serve as a brief introduction to contemporary physics topics in the classroom.

* Sponsored by Gordon Ramsey, Loyola Univ. Chicago

SUN03: Measuring the Conceptual Diversity of Major Textbooks *

Jessica A. Clanton, Univ. of Arkansas, 479-575-4300, jaclant@uark.edu

John C. Stewart

Seven major textbooks at the different levels (conceptual, algebra-based, and calculus-based) were investigated and the conceptual problems of each cataloged. More than 900 unique conceptual problems were identified. The number of uses of each of the problems in each textbook is measured. Differences in the pattern of conceptual problem presentation of the textbooks at different levels are presented. The pattern of conceptual problem presentation is also compared with the pattern found in nationally published concept inventories.

* This work supported by NSF-CCLI 0535928.

SUN04: PongSats: Projects in a Near Space Environment

Martin S. Mason, Mt. San Antonio College, 909-594-5611, mmason@mtsac.edu

Co-authors: Ben Chu, Hilario Flores, Lawrence Wang

The Mt. San Antonio College Society of Physics Students designed and built a series of balloon experiments in collaboration with JP Aerospace. Details of the experiments and their results will be presented.

SUN05: Dynamics of a Viscoelastic Planar Arm Model in Microgravity

Jared L. Durden, Drury Univ., 417-838-1469, jdurden@drury.edu*

Adam Scott, Ben Taylor, Drew DeJarnette, Josh Pettit

We constructed a mechanical arm model consisting of a rigid upper arm and forearm which simulates vertical planar arm motion with two degrees of freedom: shoulder rotation and elbow rotation. Computer controlled servo-motors effect rotation of the elbow and shoulder joints through tensions incited in elastic materials which represent muscles. We predicted and then observed vertical planar arm motion in the laboratory under normal Earth gravity conditions, and on NASA's Weightless Wonder in near zero gravity conditions. Because the arm only has two degrees of freedom we were able to simulate near zero gravity in the laboratory and predict the subsequent motion by operating it in the horizontal plane. We will discuss results of the actual observed motion in these three environments, and compare them to the motion predicted based on the equations of motion. We will also discuss how the project was developed physically, mathematically, and electronically.

* Research advisor: Gregory Ojakangas; Talk Sponsor and SPS advisor: Brant Hinrichs

SUN06: Fabrication of Open Tubular Gas Chromatography Columns and MEMS-based Preconcentrators by the Layer-by-Layer Assembly Process

Reza Montazami, Virginia Tech, 540-557-7263, rezam@vt.edu

Vaibhav Jain

The layer-by-layer (LBL) assembly technique for adsorption of nanoscale layers of alternating electric charge has been used to form the stationary phase of open tube fused silica columns and coat embedded walls of MEMS-based preconcentrators for micro gas chromatography (GC). The thickness of the homogenous polymer and nanoparticle coatings ranges from 10-500 nm, and it can be easily controlled in the range of 0.3 to >10 nm per bilayer by varying the pH and salt concentration of polyelectrolyte solutions. The chemical properties of LBL films are tailored to enhance the separation resolution of complex gaseous mixtures. In addition, coating the embedded walls of a MEMS preconcentrator with layers of silica (45 nm) and gold (20 nm) nanoparticles provides a large surface area for interaction with and trapping of gas molecules. The overall mass reduction of the structure allows rapid thermal desorption to generate narrow bands for injection into GC columns. The preconc! entrator is fabricated using a silicon-on-glass process and has on-chip thermal control through integrated heaters and temperature sensors on the backside of the silicon wafer, which significantly reduces the dead volume of the system and band broadening of the injected plug in the transfer lines.

SUN07: Results From the FIU Undergraduate Learning Community*

Laird Kramer, Florida International Univ., 305 3486073, Laird.Kramer@fiu.edu

George O'Brien, Priscilla Pamela, Jeffrey Saul

We present results from Florida International Univ.'s (FIUs) undergraduate learning community where students serve as CHEPREO fellows, assisting in our inquiry-based classroom and performing high-energy physics research. FIU is a MSI research institution serving more than 38,000 students in Miami. CHEPREO, the Center for High-Energy Physics Research Education and Outreach, is an NSF-supported project that supports a rich learning, teaching, and research community of high school students and teachers, undergraduate and graduate students, as well as university faculty. CHEPREO's goal is to generate excitement about physics and science, support inquiry-based instructional methods in the classroom, and increase physics enrollment at both the high school and college level by using high energy physics as a foundation. Support of the fellows has spawned substantial change throughout the department.

* Work supported by NSF Award #0312038

Monday, July 30

Registration: 7:30 AM–5 PM
Sheraton-Greensboro, off lobby

Poster Session I 8–9 AM and 5–6 PM
Exhibit Hall–Koury Center

First Timers Gathering: 7–8 AM
Auditorium I

Photo Contest Viewing & Voting: 7:30 AM–10 PM
Exhibit Hall

Exhibit Show: 8 AM–2 PM and 4–6 PM
Exhibit Hall

Spouses Gathering: 9–9:30 AM
Edgewood

Session AA: Tutorial: Interactive LECTURE DEMONSTRATIONS—Physics Suite Materials that Enhance Learning

Co-Sponsors: Committee on Research in Physics Education
Committee on Educational Technologies
Location: Auditorium I
Date: Monday, July 30
Time: 9–10 AM

Presider: David Sokoloff, Univ. of Oregon, 541-346-4755, sokoloff@uoregon.edu

Co-Presider: Ronald Thornton

Session AB: Tutorial in Intermediate Mechanics

Sponsor: Research in Physics Education Committee
Location: Imperial A
Date: Monday, July 30
Time: 9–11 AM

__Invited__ – Bradley Ambrose, Grand Valley State Univ., 616-331-2524, ambroseb@gvsu.edu

Michale C. Wittman

Ongoing research in physics education has demonstrated that physics majors often do not develop a working knowledge of basic concepts in mechanics, even after standard instruction in upper-level mechanics courses. This two-hour invited session will actually serve as a "mini-workshop" focusing on Intermediate Mechanics Tutorials (IMT), a suite of research-based materials that provides an innovative instructional approach that supplements traditional lectures. These materials, modeled after Tutorials in Introductory Physics 2 and Activity-Based Tutorials, are designed to address persistent student difficulties and to guide students to make appropriate connections between the physics and mathematics. Participants will learn about recent results from the research and obtain firsthand experience with selected tutorials. Because intermediate mechanics courses vary in format and content from institution to institution, we will also discuss how IMT can be tailored appropriately. A copy of all IMT materials, which include conceptual, derivation, and computer-based tutorials, will be given to each participant.

Session AC: Contributions of Carolina Educators

Sponsor: Committee on Educational Technologies
Location: Imperial C
Date: Monday, July 30
Time: 9–11 AM

Presider: Anne Cox, Eckerd College, 727-864-8435, coxaj@eckerd.edu

AC01: 9 AM A Short History of the Foundation of the North Carolina Section

__Invited__ – John L. Hubisz, North Carolina State Univ., 919-362-5782, hubisz@unity.ncsu.edu

At first there were a few sparks. Then some matches were introduced. The fire started and a volunteer fire department was formed to control and manage the spread of the flames.

AC02: 9:30 AM Physics Education Research and Development at North Carolina State Univ.

__Invited__ – Shawn A. Weatherford, North Carolina State Univ., 336-266-4665, saweathe@ncsu.edu

Physics education research and development has been an experimental research group at NCSU since c. 1990. Thanks to the support of funding agencies over the past 17 years, the group has produced video based laboratories (VBL) and an assessment that measures student understanding of kinematics graphs. WebAssign, the web-based assessment tool emerged from research into assessment in different multimedia formats. The group is home of the Matter and Interactions curriculum and work on the VPython package of Python. SCALE-UP, a student-centered course has become a multidisciplinary reform of teaching and learning. We are also involved with building an academic PER community by fostering PER-CENTRAL, a digital warehouse of physical sciences education materials, and host the Phys. Rev. ST-PER journal. This poster reflects on these, and other NCSU PERD contributions to physics education worldwide. http://www.ncsu.edu/PER

AC03: 9:30–11 AM WebAssign and Physlets—Why are These Two NC-Born Technologies So Successful?

Poster – Aaron P. Titus, High Point Univ., 336-841-4668, atitus@highpoint.edu

As a graduate student at North Carolina State Univ. from 1993-1998, I had the opportunity to work with significant pioneers in the development and application of technology in physics education: Bob Beichner (NCSU), Wolfgang Christian (Davidson College), the late Larry Martin (North Park College), and John Risley (NCSU). During those booming years of the World Wide Web, two significant technologies developed by teachers and for teachers emerged in WebAssign and Physlets. This allowed us to create homework problems that were somewhat unique in that students had to make measurements in order to solve the problem. Today, WebAssign and Physlets are among the most recognized computer programs in physics education. In this poster, I'll elucidate the set of features that made WebAssign and Physlets so successful in the past yet sets them apart to this day.

AC04: 9:30–11 AM Modeling Physics in 2- and 3-D Virtual Learning Laboratories*

Poster – Gerald W. Meisner, UNC Greensboro, 336-334-4217, gerald.meisner@gmail.com

Harol Hoffman, Mike Turner

We have authored mechanics tutorials using Hestenes' Modeling pedagogy in highly interactive 2- and 3-D virtual laboratory environments. These online and on demand student learning tools can be used for problem-based learning, online tutorials or courses, remediation, anytime / anywhere lab investigations and are both learning- and cost-effective. Perform asynchronous 2-D experiments or collaborate synchronously with game technologies in 3-D winter worlds, Internet connections permitting.

*Supported by DEd Grant No. P339B990329 and NSF Grant No. 0325211

AC05: 9:30–11 AM A Distance Learning Course for In-Service High School Teachers

Poster – Bruce A. Sherwood, North Carolina State Univ., 919-513-4827, Bruce_Sherwood@ncsu.edu

The Matter & Interactions calculus-based introductory physics curriculum for engineering and science students in use at NCSU, Purdue, and Georgia Tech has students start analyses from fundamental principles, emphasizes throughout the course the atomic nature of matter and macro-micro connections, and incorporates serious computational physics through having students write programs using VPython (http://vpython.org). A distance learning version of this course is offered for graduate credit to in-service high school teachers. The intent is not to train teachers to teach this college-level course but to broaden and deepen their culture in physics. Teacher reaction has been extremely positive. An unusual pedagogical and technological innovation is the use of interactive video lectures, in which the distant learner responds to the same "clicker" questions as students did in the original lecture when it was filmed. More information: http://www4.ncsu.edu/~rwchabay/mi.

AC06: 9:30–11 AM What Do Robots, Toys and Food Have in Common? Come See What's Happening in NC!

Poster – Nina M. Daye, Orange High School, 919-732-6133 ex 20402, nina.daye@orange.k12.nc.us

What do robots, toys, and dinner meetings have in common? Come and learn about different programs that are being used to teach physics and physical science in NC. The programs described will include local, state and national programs. The information will focus mainly on programs for pre-high school and high school teachers. However, post high school people are invited to come and see how you can strengthen the physics background for your future students. Information about some of the extra-curricular programs that utilize physics will be included as well. Come and learn how you can get involved!

AC07: 9:30–11 AM Curriculum Development at Davidson College

Poster – Wolfgang Christian, Davidson College, 704-894-2322, wochristian@davidson.edu

Mario Belloni

Over the past dozen years Davidson College has produced some of the most widely used interactive curricular materials for the teaching of introductory and advanced physics courses. These materials are based on Java applets called Physlets and the new Open Source Physics programs and applications. While this work involves collaborators across the country and across the globe, the development originated in North Carolina. In this poster we will outline the pedagogical and technical features of Physlet and OSP programs and briefly describe our current efforts create and distribute material using the national digital libraries.

AC08: 9:30–11 AM "Fall Space Week" at Vance Elementary School — An Outreach Project

Poster – Judith A. Beck, Univ. of North Carolina–Asheville, 828-251-6049, jbeck@unca.edu

Jessica Varney

Educators from the Univ. of North Carolina–Asheville and from the Colburn Earth Science Museum collaborated in designing and implementing a week of programming for all students at Vance Elementary School, a designated "NASA Explorers School" in Asheville, NC. The programming consisted of inquiry-based activities surrounding space and space-related technology and design, as well as StarLab planetarium shows for each grade level. Following Space Week at the school, the students and their families were invited to attend a day of planetarium shows and family-oriented activities at the museum. Finally, we returned to the school for follow-up activities with all 4th and 5th graders. This poster will present the outreach project, including the activities provided for each grade level, and discuss its effectiveness in promoting student and public engagement in astronomy. This project was funded by the North Carolina Space Grant General Public Engagement Program.

Session AD: Innovations in TYC Curriculum

Sponsor: Committee on Physics in Two-Year Colleges
Location: Imperial G
Date: Monday, July 30
Time: 9–11 AM

Presider: Karim Diff, Santa Fe Community College, 352-395-5591, karim.diff@sfcc.edu

AD01: 9 AM Video Analysis in the Engineering Physics Laboratory

Martin S. Mason, Mt. San Antonio College, 909-594-5611, mmason@mtsac.edu

Video analysis allows everyday objects to become the subject of physics experiments. It helps to remove the separation students perceive of classroom reality vs. their own internal definitions. In the fall of 2006, Mt. San Antonio College moved into a new Science Laboratory building and at the same time had the opportunity to move all of the Engineering Physics courses into a Studio format. To address this new format a series of experiments were developed or adapted from the Univ. of Minnesota Problem Solving Laboratories. These experiments focus on students making and analyzing movies of everyday objects. A complete first semester curriculum involving over 20 different video analysis experiments has been implemented using inexpensive web cameras and the new video features of Logger Pro. In addition, video analysis tools are extremely valuable in project based learning.

AD02: 9:15 AM Creating a Climate of Success: Innovation in a Physics Classroom, an FDTC example

***Invited –** Joshua B. Phiri, Florence-Darlington Technical College, 843-661-8228, joshua.phiri@fdtc.edu*

The purpose of this session is to describe the creation of a climate of success in our physics classes at Florence-Darlington Technical College. We are the beneficiaries of exemplary Physics Education Research and have incorporated innovative products suggested by this research. We have adapted the ICP/21 modular approach, a student-centered curriculum organized into topic modules that encourages cooperative learning and keeps students actively engaged in the learning process. This is coupled with our version of project-based projects developed through funding from an NSF grant which utilizes industry based projects and course integration across disciplines. Having students take physics concurrently with math, communication and engineering technology and having physics projects as part of these courses creates a wonderful synergy between the courses. This approach has been used for several years and we will share examples of our successes and challenges. Information regarding our unique relationship with industry and its impact on our instruction will also be provided, and time will be allowed for Q & A.

AD03: 9:30 AM Modeling Discourse Management in the TYC Classroom

***Invited –** Dwain M. Desbien, Estrella Mountain CC, 623-935-8474, dwain.desbien@emcmail.maricopa.edu*

Modeling discourse management is a classroom management strategy aimed at getting the students involved in the classroom. Strategies include how to physically structure the classroom, what kind of activities to do, and how to get students prepared for such a course. This talk will focus on these three ideas and will share student responses to interviews, student work, and pictures highlighting this style of teaching. Examples of activities will also be shared.

AD04: 9:45 AM Conceptually Rich Uses of Clickers in the TYC Classroom

Invited – Paul Williams, Austin Community College, 512-223-4824, pwill@austincc.edu

Clickers provide an excellent tool for promoting active engagement in both large and small class settings. Generally clickers are used to implement Concept Tests which can be answered individually by students or can be incorporated into small group discussions. Clickers can also be used by students to make predictions prior to carrying out demonstrations.[1] This paper will describe how the author has incorporated clickers into the TYC classroom in conceptually rich ways. One use is to incorporate them into carefully sequenced Interactive Lecture Demonstrations (ILD) in the style of Sokoloff and Thornton.[2] A second use is to incorporate them into technology based Tasks Inspired by Physics education Research (Tipers). Simulations are shown to the students to pose a task such as a ranking task and then students use clickers to give their response to the Tiper. Results of some efficacy measures will be shown.

1. D. Duncan, *Clickers in the Classroom* (Addison-Wesley, 2005).
2. D. Sokoloff and R. Thornton, *Interactive Lecture Demonstrations* (Wiley, 2006).

AD05: 10 AM ATE Program for Physics Faculty Project *

Thomas L. O'Kuma, Lee College, 281-425-6522, tokuma@lee.edu

Dwain M. Desbien

This paper will report on this project for two-year college and high school physics teachers. It will include data from the recently held workshops that are part of this project, followup activities conducted by the participants of the project, and some surprising information from the project.

*Supported in part by NSF grant #ATE-0603272

AD06: 10:10 AM Studio Physics First – Conceptual Physics for the Next Generation

Anthony Genova, Windward School, 310-391-7127, agenova@windwardschool.org

*James Bologna, Thomas Haglund **

Windward School will discuss the pedagogical basis of using a studio model for the teaching of 9th grade conceptual physics. Additionally, we will discuss the content of an Electricity and Magnetism module for our freshman-level Conceptual Physics curriculum. The module uses simulations, demos, ranking tasks, TIPER (Tasks Inspired by Physics Educational Research) questions and assessments on a series of web designed resources for use in a technology-rich active learning environment.

*Both sponsored by Advanced Technological Education Program (ATE) of the National Science Foundation

AD07: 10:20 AM Engineering Physics 1 Student Success as a Function of Prerequisites

John P. Cise, Austin Community College, Rio Grande Campus, 512-751-4773, jpcise@austincc.edu

Students at Austin Community College enrolled in Engineering Physics 1 have a success rate (A,B,C grade) which is a function of: prerequisites completed, Grade Point Average at entry, course completion rate at entry (% of all courses completed without withdrawing), and other entry academic measures. Many years of data will be presented from a large sample of students from Austin Community College's 36,000 student body. Austin Community College has the largest Community College Physics Department in Texas with 40 sections/semester and 1000 students per semester.

Session AE: Problem Solving

Location: Colony B-C
Date: Monday, July 30
Time: 9–11

Presider: Charles Niederriter, Gustavus Adolphus College, 507-931-7315, chuck@gac.edu

AE01: 9 AM Discussion-Intensive and On-line Problem Solving: Effect on Understanding of Force

Sara J. Rose, Univ. of Illinois, Urbana-Champaign, 217-898-3696, sjwright@mail.physics.uiuc.edu

Fouad Abd-El-Khalick

This study aimed to assess the effect of augmenting web-interfaced homework with discussion-intensive recitation sessions on student understanding of forces in introductory college level physics courses, and to understand how discussion-intensive recitations impacted student cognitive processes during problem solving. Participants were 150 students enrolled in two calculus-based mechanics college level courses in two Midwestern universities. Instruction in the participant courses differed mainly in the inclusion of discussion-intensive recitation sessions centered on solving content-rich problems in small collaborative groups. Subsamples of students participated in think-aloud interviews over the course of the study, during which students solved physics problems involving forces. The discussion-intensive recitation sessions resulted in statistically significant improvements in students' conceptual understanding of forces, evident in differential improvements in FCI scores. Additionally, student problem-solving skills in the experimental group were substantially improved over the course of the study, evident by exhibiting more expert-like behaviors while solving problems.

AE02: 9:10 AM Stabilization: An Alternative Model of Problem Solving

Sherry L. Savrda, Seminole Community College, 407-328-2205, savrdas@scc-fl.edu

Think-aloud protocols of the problem-solving attempts of physics students were used to test the applicability of an alternative model of problem solving. The model suggests four primary factors governing the problem-solving process: categorization, goal interpretation, resource relevance, and complexity. Furthermore, it suggests a fifth superordinate factor called stabilization, which describes the shifting relationships between the primary factors over the problem-solving process. Stabilization is, in effect, a control factor which describes the problem solver's search for a stable understanding of the problem that will ultimately lead to a solution. Many of the observations from the study are consistent with the existing literature; however, the model provides an alternative framework with which to understand and synthesize those observations. Specific results and excerpts from the protocols will be provided to illustrate the model.

AE03: 9:20 AM Doing It Wrong So They Get It Right

John W. Zwart, Dordt College, 712-722-6288, zwart@dordt.edu

It can be a challenge to get students to carefully review worked example problems and to get them to carefully debug wrong solutions. Both of these important skills can be developed by providing wrongly solved problems to students, requiring them to find the errors, and to solve the problems correctly. Examples and benefits of this method will be discussed.

AE04: 9:30 AM Bait-and-Switch: Problem Solver Reaction to (Secretive) Problem Switch

Jose Mestre, Univ. of Illinois, Urbana-Champaign, 217-333-0098, mestre@uiuc.edu

Adam Feil

Expert-novice research has illuminated major differences in the way experts and novices encode, categorize, and solve physics problems. Experts' approach to problem solving can be characterized as much more top-down, principle-based compared to that of novices'. We report on a study that explores initial encoding of physics problems by experts and novices using a novel experimental technique. After reading a problem on a computer screen, experts and novices are asked to explain a procedure for finding a certain quantity. However, unbeknown to the participant, shortly after s/he encodes the problem and starts explaining it, the problem is switched to a slightly different problem. Based on the expert-novice literature we predict different reactions and behaviors to the switch from experts and novices. We discuss our findings in view of those predictions, and discuss pedagogical implications.

AE05: 9:40 AM Student Spatial Reasoning and Physics Problem Solving – A Preliminary Study

Charles J. De Leone, California State Univ. San Marcos, 760-750-8074, cdeleone@csusm.edu

Elizabeth Gire

Nonalgebraic representations, such as force diagram and graphs, are generally useful in solving physics problems. In a typical introductory physics course, a significant amount of instructional effort is focused on using these representations to improve problem solving, yet students have varied willingness and abilities to use these representations when solving physics problems. Psychometric tests show that people have varied spatial reasoning ability, a talent that may be useful in using nonalgebraic representations. In this talk we will report the results of a preliminary study about the relationship between students' spatial reasoning abilities and their use of nonalgebraic representations when solving physics problems.

AE06: 9:50 AM Problem Categorization in Teaching and Learning

Chandralekha Singh, Univ. of Pittsburgh, 412-624-9045, clsingh@pitt.edu

The ability to categorize problems is a measure of expertise in a particular domain. We discuss the response of graduate students enrolled in a TA training course to categorization tasks in which they were asked to group problems first from their own perspective, and later from the perspective of introductory physics students. A majority of the graduate students performed an expert-like categorization of physics problems. However, when asked to categorize from the perspective of introductory students', most students expressed dismay, claiming that either the task was either impossible or pointless. Most of the students who eventually attempted this second task did not believe that introductory students would respond any differently from TAs. Comparisons with introductory students show that indeed there are significant differences that instructors need to understand in order to bridge the gap between teaching and learning. We discuss the implication of this research for teaching at all levels.

AE07: 10 AM Patterns of Multiple Representation Use in Expert and Novice Physics Problem Solvers

Patrick B. Kohl, Univ. of Colorado at Boulder, 303-735-0627, kohlp@ucsu.colorado.edu

Noah D. Finkelstein

It is generally believed that using multiple representations in solving physics problems can be quite beneficial, and that novices should learn to use multiple representations in an expert-like way. In this study, we interview expert and novice physicists as they solve two kinds of multiple-representation problems: those in which multiple representations are provided, and those in which individuals must construct additional representations on their own. We analyze in detail the types of representations subjects use, and the order and manner in which they are used. From analysis of the commonalities and differences between expert and novice behaviors, we find (among other things) that experts use multiple representations more densely in time, and that novices tend to adhere to stricter patterns in their use of multiple representation. In addition, we find that an examination of the use of multiple representations alone is inadequate to fully characterize a problem-solving episode; one must also consider the purpose behind the use of a particular representation.

AE08: 10:10 AM Physics Majors' Modes of Thinking During Problem Solving

Elizabeth Gire, UC San Diego, 858-822-1370, egire@physics.ucsd.edu

Edward Price, Barbara Jones

Solving physics problems often involves multiple levels of analysis or ways of thinking, especially for difficult or complex problems. Studies involving expert/novice comparisons suggest differences in how these ways of thinking are coordinated. For example, physics faculty are more likely to qualitatively analyze a difficult problem than introductory physics students.[1] In this study, we conducted problem solving interviews with eight physics majors at various stages of degree progress. We identify three different ways of thinking (formal, conceptual, and reality-linked), and discuss how these students coordinate different ways of thinking when solving physics problems.

1. C. Singh, "When physical intuition fails," *Am. J. Phys.* **70**(11), 1103-1109 (2002).

AE09: 10:20 AM Epistemic Cognition in Physics Problem-Solving: Experts and Novices

Vazgen Shekoyan, Rutgers Univ., 732 266 2968, vazgen@physics.rutgers.edu

Eugenia Etkina

Epistemic cognition occurs when a person is solving a problem that does not have one right answer (an ill-structured problem) and thus she/he has to examine different possibilities, assumptions, and evaluate the outcomes. Epistemic cognition involves thinking about the limits of knowing, the criteria of knowing, identifying the assumptions made, looking at limiting cases, etc. and is used in ill-structured real-life and professional problems. How do we measure epistemic cognition? How does an expert's epistemic cognition differ from a novice's? To answer these questions we have conducted videotaped interviews with experts and novices (physics professors and students). During the interviews we asked the subjects to solve ill-structured physics problems. Using reflective questions, we encouraged them to review and possibly to refine their solution. They were prompted to search for criteria to validate different approaches. We present and discuss our analysis of the transcripts of the interviews.

AE10: 10:30 AM Problem Solving Skills Hold Across Discipline *

Wendy K. Adams, Univ. of Colorado, Boulder, 970-539-6154, wendy.adams@colorado.edu

Carl E. Wieman

Problem solving is a highly coveted skill in the physics classroom; however, we do not currently have an evaluation tool that can be used to measure student's problem solving skills. This missing tool is an indication of the complexity of the field. The most obvious and largest hurdle to evaluating physics problem solving skills is the physics content knowledge necessary to solve problems. Over the past several years we have been developing a problem solving evaluation instrument at Colorado. We will present results from our validation studies where we have seen that students' strengths and weaknesses in problem solving are consistent whether solving quantum mechanics problems or the complicated trip planning scenario contained within our Evaluation Tool.

*Supported in part by funding from National Science Foundation DTS.

AE11: 10:40 AM Do the Problems Assigned Cultivate Real-World Problem-solving Skills?*

Kathleen A. Harper, The Ohio State Univ., 614-292-1525, harper.217@osu.edu

Zachary D. Hite, Richard J. Freuler, John T. Demel, Thomas M. Foster

In previous work,[1] we hypothesized that students would be more likely to transfer problem-solving skills from one content area to another if they were taught to identify characteristics of problems that were associated with the application of particular skills. We have employed this categorization scheme to analyze the problems currently used in a physics sequence for first-year engineering honors students and to identify the problem-solving skills these students currently practice. We also have identified the skills that are not represented in the present problem selection and suggest alternative types of problems to make future problem-solving instruction more well-rounded.

1. Harper, Freuler, and Demel, "Cultivating Problem-Solving Skills via a New Problem Categorization Scheme," in *Proceedings of the 2006 Physics Education Research Conference*, McCullough, Hsu, and Heron, eds. (AIP, 2007).

* Sponsored by NSF grant DUE-0633677

AE12: 10:50 AM Robust Assessment Instrument for Student Problem Solving

Jennifer L. Docktor, Univ. of Minnesota, 612-625-9323, docktor@physics.umn.edu

Ken Heller, Pat Heller, Tom Thaden-Koch, Jun Li

Traditional physics grading systems that assess the correctness of solution steps give an incomplete description of a student's skill at solving problems. A more detailed and meaningful measure is desirable both for research in education and for use by physics instructors. A version of an assessment instrument has been developed at Minnesota in the form of a rubric, which evaluates student's written solutions to physics problems across multiple scales (Tom Foster, unpublished doctoral dissertation). Each category of the rubric is subdivided into levels designated by a numerical score and a description of the criteria met to attain that score. I will report on the scales and criteria levels of the rubric, as well as results for initial tests of validity and reliability.

Session AF: K-12 Teachers on Campus Supporting Teachers of Physics Across the Curriculum

Sponsor: Committee on Teacher Preparation
Location: Imperial B
Date: Monday, July 30
Time: 9–11 AM

Presider: Paul Hickman, 360 Huntington Ave, Boston, MA 978-470-1823, hickmanp@comcast.net

AF01: 9 AM A Quiet Revolution in Preparing Future Teachers of Physics*

***Invited** – Drew Isola, Western Michigan Univ., 269-599-8628, drew.isola@wmich.edu*

The use of exemplary K-12 teachers as agents of change has been stealthily making its way into teacher preparation programs around the country over the past decade. Many such programs have designated these individuals as Teachers-in-Residence (TIRs) or as Master Teachers (MTs). These individuals have been actively recruited and hired by teacher preparation programs and/or physics departments specifically for the purpose of providing a "reality check" and improving the preparation of future teachers of physics. Feedback from a number of institutions, who have utilized TIRs/MTs, seems to indicate that their unique combination of talents and experiences makes them particularly well suited to impact all aspects of the 'Learning to Teach Continuum' from the pre-service teacher to the novice teacher to the teacher leader. This talk will take a more in-depth look at this continuum and the impact that TIRs/MTs can have on teachers as they navigate their way through it.

*Supported in part by NSF (PHY-0108787)

AF02: 9:30 AM A Physics Department's Role in State-Mandated Mentoring

Michael D. Wolter, Muncie Central HS & Ball State Univ., 765-747-5609, mwolter@muncie.k12.in.us

Some states have already implemented mandatory mentoring programs for novice teachers. Because of the shortage of teachers in physics and other areas, mentoring is seen as an effective way to improve the retention of new teachers. The PhysTEC project at Ball State Univ. has been able to adopt strategies developed for the Indiana mentoring program as part of its TIR training and duties. As a result, recent physics teaching graduates of Ball State show a level of retention that significantly exceeds the national trends. This paper will provide a summary of the resources and strategies used to produce this success.

AF03: 9:40 AM Recruiting and Mentoring Pre-Service Teachers: Dual Roles of a TIR

Elaine Gwinn, Ball State Univ., 765-285-8902, jegwinn@bsu.edu

What does a Teacher In Residence do to support the preparation of teachers of physics? Shown to be a vital role in the PhysTEC project, a TIR's efforts are multi-faceted and depend on both the unique interests and skills of the individual TIR and the needs of the host institution. Ball State Univ. has chosen to focus on recruitment and mentoring as critical central duties of the TIR. This paper will follow the evolution of the TIR role at Ball State Univ. over the past five years and how the mentoring of pre-service and in-service teachers has been a central theme throughout the duration of the project. Data will be presented which shows the success of the program resulting in the recruiting of the largest group of highly qualified physics teachers historically being produced in the state of Indiana and in the very high retention rates of those teachers.

AF04: 9:50 AM TIR Support of Teaching Assistants and Future Teachers

Tracy Bond, Univ. of Arkansas, 479-361-9931, thebonds_1213@yahoo.com

Teaching assistants may enter the position without any teaching experience but may also want to become a teacher after graduation. The teaching assistant position is not one that mirrors many of the duties of a classroom teacher. A TIR is in a unique position to lend advice and assistance to these students; TIRs can point out pedagogical issues to the college students and guide their thinking about questions that may arise in the first few years of classroom teaching. This unique support benefits the universities by giving them better prepared teaching assistants, TAs by giving them a support system and mentor, and the TIR by giving them an outlet for knowledge gained in the classroom. This paper will deal with the experiences I have had this year in assisting the TAs, as well as plans for the future of the program.

AF05: 10 AM Implementation and Assessment of a Research Experience for Physics Teachers

Edward H. Conrad, Georgia Institute of Technology, 404 894-9086, edward.conrad@physics.gatech.edu

Leyla Conrad, Jill Auerbach

The Summer Teacher Experience in Packaging-Utilizing Physics (STEP-UP)* program at the Georgia Institute of Technology provides a comprehensive research experience for up to 10 high school physics teachers per summer. Its objective is to train metro Atlanta high school physics teachers in both modern physics concepts and their applications to engineering as well as their relevance to today's technology. The program runs successfully through collaboration with the School of Electrical and Computer Engineering, microelectronics Packaging Research Center (an NSF Engineering Research Center) and the School of Physics. Currently in its third year, the program has had 25 participants. Participating teachers have commented on how they have gained confidence in teaching physics and connecting physics to engineering applications and thus have been able to better instill an interest in engineering careers in their students. In order to assess the program's outcomes, a mixed method approach was used that involved both quantitative and qualitative evaluations.

* Supported by the NSF under award EEC-0401979

AF06: 10:10 AM The Multiple Roles of a Master Teacher in a Physics Department *

Lezlie S. DeWater, Seattle Pacific Univ., 206-286-7256, dewater@spu.edu

Lane Seeley, Eleanor W Close, Stamatis Vokos

The Seattle Pacific Univ. physics department is deeply committed to the providing of professional support and useful resources to pre-service and in-service classroom teachers. In order for a physics department to provide a substantive contribution to K-12 education it is necessary to build effective partnerships with in-service and pre-service science teachers, local school districts, the School of Education, and national efforts to improve teacher preparation. A resident master teacher who is grounded in an understanding of the challenges that teachers face and the culture in which they educate is ideally suited for this bridge building role. In this talk, we will describe the collaborative partnerships that are taking shape at SPU and the resident master teacher's role in building a community around the preparation and support of classroom teachers.

* Supported in part by NSF grant #ESI-0455796, The Boeing Corporation, PhysTEC, The Huston Foundation and the SPU Science Initiative

Session AG: PER: Instructional Reform

Location: Cedar
Date: Monday, July 30
Time: 9–11 AM

Presider: A. James Mallmann, Milwaukee School of Engineering, 414-277-7317, mallmann@msoe.edu

AG01: 9 AM Incorporating Philosophy of Science in Physics for Nonscience Majors

Todd K. Timberlake, Berry College, 706-368-5622, ttimberlake@berry.edu

I recently developed a series of 22 hands-on activities that I developed for use in a conceptual physics course for nonscience majors. [1] Although the activities did help students learn physics concepts they were ineffective in improving student understanding of the nature of science, as measured by pre- and post-instruction administration of the Epistemological Beliefs About Physical Science (EBAPS) survey. In spring 2007 I began supplementing these activities with explicit instruction in the Philosophy of Science. The class remains centered around the hands-on activities, but students are now frequently asked to analyze their findings from the perspective of the Philosophy of Science. In this talk I will provide a preliminary report on student reactions to this attempt to incorporate Philosophy of Science into this course, as well as updated EBAPS results.

1. The text for the course is Hobson's *Physics: Concepts and Connections*, 3rd ed. (Prentice Hall, Upper Saddle River, NJ, 2003).

AG02: 9:10 AM Assessing Adaptations of Physics by Inquiry: Student attitudes *

Leon Hsu, Univ. of Minnesota, 612-625-3472, lhsu@umn.edu

Karen Cummings, Jack W. Taylor

We report on one assessment of a collaborative effort to adapt the Physics by Inquiry (PbI) curriculum (McDermott) to a wide variety of environments by investigating how one can implement PbI without graduate student teaching assistants and with larger student: teacher ratios than in the environment in which PbI was originally designed. This talk focuses on an assessment of student attitudes toward physics and learning physics using the Colorado Learning Attitudes about Science Survey (CLASS). In virtually all standard introductory physics courses, students' responses to CLASS questions regress toward less expert-like attitudes or at best, remain largely stable over the time frame of the course. However, in our adapted PbI courses, we observe large significant shifts toward more expert-like attitudes in students' responses. We will discuss possible reasons for these positive shifts and correlations of the shifts with student performance, pre-test scores, etc.

*This work was supported by NSF DUE-0410804.

AG03: 9:20 AM Assessing Adaptations of Physics by Inquiry: Learning Outcomes *

Karen Cummings, Southern Connecticut State Univ., 203-392-7043, cummingsk2@southernct.edu

Leon Hsu, Jack Taylor

In this talk I will discuss conceptual learning outcomes in a modified Physics by Inquiry (PbI) course. This work is part of a larger project in which we study a variety of ways that one can implement PbI without graduate student teaching assistants and with larger student to teacher ratios than in the environment in which PbI was originally designed.

*This work was supported by NSF DUE-0410804.

AG04: 9:30 AM How to Teach with Analogy—A Research-based Approach

Noah S. Podolefsky, Univ. of Colorado at Boulder, 303-641-8217, noah.podolefsky@colorado.edu

Noah D. Finkelstein

We report on theoretical and empirical studies of students' use of analogy in learning physics. We briefly describe a model, analogical scaffolding, and then detail how it is applied to design curricular materials using multiple analogies. We successfully employ the model to predict the outcomes of student learning using both these materials and more traditional curricular approaches. Students presented with materials using blended representations (those consistent with the analogical scaffolding model) outperform students using the canonical (abstract) representations by a factor of three (73% vs. 24% correct, $p<0.002$). Data also confirm the utility of the model to explain when and why students succeed and fail to use analogies and interpret representations appropriately.

AG05: 9:40 AM Instructional Reform and the Importance of Promoting Coherence in Physics Knowledge

Mel S. Sabella, Chicago State Univ., 773-995-2172, msabella@csu.edu

*Stephanie A. Barr, Crystalann Jones**

The physics program at Chicago State Univ. (CSU) continues to make revisions in the instructional materials used in our algebra- and calculus-based introductory physics sequence. The evaluation of the effectiveness of these materials, in promoting student understanding, has become a central component of our program and has involved roughly half the faculty and a number of research students from physics, mathematics, and chemistry. In this talk we discuss how the physics program at CSU has adopted an instructional environment that embraces inquiry-based instruction, research on student learning, and instructional revision. A specific example that examines how students struggle to bridge between different representations will provide a context for our work in instructional reform. Supported in part by NSF grant #DUE-0410068

* Both sponsored by Mel Sabella

AG06: 9:50 AM Not All Interactive Engagement Is the Same: Variation in Faculty Use of Peer Instruction

Chandra A. Turpen, Univ. of Colorado, Boulder, 303-817-0250, Chandra.Turpen@colorado.edu

Noah Finkelstein

We investigate how the use of PER-based instructional tools is spreading throughout faculty practice and examine efforts to sustain the use of these innovations. We specifically focus on analyzing the local use of Peer Instruction[1] and variation of implementation among six different faculty members. By analyzing the classroom practices in six different large enrollment introductory physics courses, we identify a variety of themes that shape classroom interaction. These themes include but are not limited to: the role of student discussion, the value of correct and incorrect responses to ConcepTests, and faculty and student roles during Peer Instruction. We describe marked variations in faculty practices along these dimensions and speculate on potential effects concerning student engagement.

1. E. Mazur, *Peer Instruction* (Prentice Hall, Upper Saddle River, NJ, 1997).

AG07: 10 AM Towards a Set of Research-based Best Practices for Clicker Use

Christopher Keller, Univ. of Colorado at Boulder & i>clicker, 303-819-1102, christopher.keller@colorado.edu

Noah Finkelstein, Steven Pollock, Chandra Turpen

Adoption of clickers by faculty has spread campus-wide at the Univ. of Colorado at Boulder from one course in the fall of 2001 to currently 19 departments, 76 courses, and more than 10,000 students. Specifically, we study: how clickers have spread in various departments and fields, common practices among faculty, obstacles for adoption, and reasons for adoption. Additionally, we report on student attitudes and perceptions of clicker use along with how faculty use, practices, and experience correlates with student attitudes. We explore how these data may help us identify research-based best practices for clicker use to ultimately create a guide for faculty who integrate this educational tool into their courses.

AG08: 10:10 AM Transfer of Scientific Abilities: PER Research Design Project *

Eugenia Etkina, Rutgers Univ., 732-932-7496, etkina@rci.rutgers.edu

Alan Van Heuvelen, Anna Karelina, Maria Ruibal-Villasenor, David Rosengrant, Rebecca Jordan, Cindy Hmelo-Silver

What do we want our students to learn in introductory physics courses? For years the focus of PER has been to improve student conceptual understanding. We argue that in the 21st century, conceptual understanding is important but equally as important is helping students learn science process abilities such as solving open-ended problems, designing experimental investigations, evaluating assumptions, representing ideas in multiple ways, working collaboratively, and communicating. Our group has been developing formative assessment tasks and rubrics to help students develop these abilities. Today we report on a study that investigates whether laboratories in which students design their own experiments enhance certain scientific abilities and foster transfer. The project has an experimental research design and involves 180 students in an introductory physics course for science majors, which is taught via the Investigative Science Learning Environment (ISLE).

*Supported by NSF REC 0529065

AG09: 10:20 AM Design and Nondesign Labs: Does Transfer Occur? *

Anna Karelina, Rutgers Univ., 732-932-7496 ext 8339, anna.karelina@gmail.com

Eugenia Etkina, Alan Van Heuvelen, Maria Ruibal-Villasenor, David Rosengrant, Rebecca Jordan, Cindy Hmelo-Silver

Our group has been developing formative assessment tasks and rubrics to help students develop the abilities to solve open-ended problems, design experimental investigations, evaluate assumptions, represent ideas in multiple ways, work collaboratively, and communicate. In this talk we report on one aspect of a study that investigates whether students acquire these abilities during design laboratories and whether they can use them without instructor's scaffolding.
For a quantitative evaluation of students' abilities we used rubrics developed and described earlier. We studied the students' lab reports and answers on exam problems related to the labs. We evaluated their performance and compared it with the performance of a control group which had the same course but participated in non-design labs instead of design labs. The project involved 180 students in an introductory physics course for science majors, which was taught via

the Investigative Science Learning Environment approach (ISLE).

*Supported by NSF REC0529065

AG10: 10:30 AM From Physics to Biology: Helping Students Attain All-Terrain Knowledge *

Maria R. Ruibal-Villasenor, Rutgers Univ., 732 932 7496 ext 8339, mruibal@eden.rutgers.edu

Eugenia Etkina, Rebecca Jordan, Anna Karelina, Alan Van Heuvelen, Cindy Hmelo-Silver, David Rosengrant

Our educational system assumes that students carry with them what they learn in our classrooms, and that they will use school-learned lessons in many different contexts: other courses, home, or the workplace. However many of our tasks involve instructing students on how to complete specific procedures. Will this approach prepare them for our complex world? The Rutgers PER group has designed and it is testing a learning system (ISLE) and a set of ancillary tasks with the purpose of helping students transfer scientific abilities that they acquire in the laboratory. This study reports on part of a larger experiment that included 180 introductory physics students. After one semester in this learning environment, can students transfer the abilities they acquired in physics laboratories to solve a novel biology problem? Do students' habits acquired in the labs play any role in the occurrence of transfer?

*Supported by NSF REC0529065

AG11: 10:40 AM How Upper-Division Physics Students Respond to a Studio Laboratory Activity *

Fran Mateycik, Kansas State Univ., 785-532-7167, mateyf@phys.ksu.edu

Dyan McBride, N. Sanjay Rebello, Christopher M. Sorensen

Studio physics is most commonly associated with introductory courses and several variants of this format have been implemented at various institutions, including KSU.[1] In 2006 the KSU Physics Department extended the Studio format to its first upper-division Studio course –Optics I. Our goal in this study was to gain insights into how upper-division physics majors would respond to a laboratory activity in the Studio format. We conducted two sessions of teaching interviews with 12 physics majors. The first interview focused on single slit diffraction. The second interview focused on Poisson's Spot. Our analysis afforded us the opportunity to explore the mindset with which students approached the Studio laboratory activity. We also investigated students' difficulties with the Studio laboratory write-up as well as how their conceptual understanding of the topics prior to formal instruction affects the way in which they respond to the laboratory activity.

1. C.M. Sorensen, et al., "The New Studio format for instruction of introductory physics," *Am. J. Phys.* **74**(12), 1077-1082 (2006).

*Supported in part by the National Science Foundation under grant DUE-0511667

AG12: 10:50 AM Evaluation of the Physics and Astronomy New Faculty Workshop

Charles Henderson, Western Michigan Univ., 269-387-4951, Charles.Henderson@wmich.edu

Between 1996 and 2006, 759 new physics and astronomy faculty have participated in the New Faculty Workshop. This represents approximately 25% of all new physics and astronomy faculty in the US. The workshop is jointly administered by the American Association of Physics Teachers (AAPT), the American Astronomical Society (AAS) and the American Physical Society (APS) with funding from the National Science Foundation. The goal of the workshop is for participants to learn about new developments in physics and astronomy pedagogy and to integrate these ideas and materials into their instruction. During the spring of 2007 a web survey was administered to all former workshop participants as part of an evaluation of the impact of the New Faculty Workshop. This talk will present selected results from this survey.

Session AH: Advanced Placement (AP) Physics: Present and Future

Sponsor: Committee on Physics in High Schools
Location: Imperial F
Date: Monday, July 30
Time: 9–11 AM

Presider: Laurence S. Cain, Davidson College, 704-894-2347, lacain@davidson.edu

AH01: 9 AM The AP Physics Redesign: Process and Update

***Invited** – Laurence S. Cain, Davidson College, 704-894-2347, lacain@davidson.edu*

Deborah Roudebush, Gay Stewart

The College Board has undertaken a redesign of the Advance Placement (AP) science courses to improve the quality of teaching and learning in the nation's high schools. The Physics Redesign has focused on the AP Physics B course, the equivalent of the algebra-based introductory college physics course. This talk will focus on the background to this undertaking, the process that has been followed, and the current status of the redesign. Future steps in the process and the time frame for deployment of the redesigned course will be discussed.

AH02: 9:30 AM De-Mystifying the AP Physics Exam Process

***Invited** – William H. Ingham, James Madison Univ., 540-568-6676, inghamwh@jmu.edu*

Laurence S. Cain, Rick Morgan

Nearly a million high school students have taken AP Physics Examinations since the program's inception in 1956. We describe how the exams are created and graded, as well as how exam scores are translated to a recommendation on the AP Program's 5-point scale.

AH03: 10 AM The Importance of Laboratory Work in AP Physics Courses

***Invited** – Dolores Gende, Parish Episcopal School, 972-556-1851, mdgende@yahoo.com*

William H. Ingham

The importance of lab work in AP Physics courses will be discussed in terms of the goals and expectations of a college-level lab. This talk will cover different types of laboratory work, types of equipment, basic laboratory skills, assessment of labs, and resources to prepare students for the exam's Lab-Based Questions.

AH04: 10:30 AM An Open Forum for Discussion of Issues Raised

***Invited** – Gay Stewart, Univ. of Arkansas, 479-575-2408, gstewart@uark.edu*

This open forum will address questions from the audience about issues raised in the three previous talks as well as other AP issues, including the issue of college credit for AP courses and exams. All speakers from the previous three talks will be available for this forum.

Session AI: Physics Education at HBCUs and MSIs

Sponsor: Committee on Minorities in Physics
Location: Maple
Date: Monday, July 30
Time: 9–10:30 AM

Presider: Daniel Smith, South Carolina State Univ., 803-536-7162, dsmith@scsu.edu

AI01: 9 AM Medical Physics Option at South Carolina State Univ. *

***Invited** – Shadia S. El-Teleaty, South Carolina State Univ., 803-536-8510, sel-teleaty@scsu.edu*

A new medical physics option was instituted at South Carolina State Univ. in the fall of 2005 to respond to both the low enrollment in the physics major, and to the under-representation of African Americans in the medical physics profession. The regular physics curriculum is augmented by eighteen semester hours of medical physics courses, including two freshmen-year courses. Establishing financial and educational resources was necessary to offer the new courses. The NSF sponsored HBCU-UP program, the Medical Univ. of South Carolina, and Hampton Univ. have been the main supporters of training and conference attendance for students and for the program's coordinator. Visits to radiation diagnostic and treatment centers give students the opportunity to see state of the art equipment used by medical teams for diagnostic and treatment purposes. The growing student enrollment in the two freshmen year medical physics courses, along with student enthusiasm about the program are all very promising, preliminary signs of the success of the Medical Physics option.

*HBCU-UP Program at SCSU

AI02: 9:30 AM Physics Education and Research at North Carolina A&T State Univ.

Invited *– Abdellah Ahmidouch, North Carolina A&T State Univ., 336-285-2109, abdellah@ncat.edu*

The Department of Physics at North Carolina A&T State Univ. offers quality physics education both at the undergraduate and MS graduate level. Students have the option of specializing in one of six concentrations which include Professional Physics, Environmental Geophysics, Space Science, Interdisciplinary Physics, Engineering Physics and Physics Secondary Education. The Department believes strongly that a productive research program forms the foundation for a first-class educational experience. Physics faculty and students are engaged in cutting-edge physics research projects in the fields of experimental nuclear physics, chemical physics, geophysics, space science, material science and atmospheric science. This paper presents the Physics educational program at North Carolina A&T State Univ. and the ongoing research activities.

AI03: 10 AM Involving Spelman Students in Undergraduate Physics Research

Marta L. Dark, Spelman College, 404-270-5850, mldark@spelman.edu

Involving undergraduate students in research and serving as a mentor are important components of my efforts at Spelman College. I have worked with nine individual students on research projects. Currently, I am supervising a research team of four students, who have various majors. The research involves laser interactions with soft biological tissues of the knee joint. In addition to training upper-level students to work with lasers and optics, I have mentored first-year students on performing basic laboratory activities. I will address my experiences with helping students continue their forward progress. I will also discuss best practices on ways to help students with design experiments and prepare presentations. Mentoring undergraduate researchers is beneficial to both the student and the advisor. Student activities have resulted in both local and national presentations. One student's efforts helped obtain preliminary data, which was submitted in a proposal for NIH funding.

AI04: 10:10 AM Innovative Science and Mathematics Program for Tribal Colleges and Universities

Deva Sharma, Shaw Univ., 919-582-4979, dsharma@shawu.edu

Elvira S Williams

This is an Innovative Science Project to improve Physics, Chemistry and Mathematics teaching at 20 Tribal Colleges. The main objective of the project is to train Tribal College and Univ. (TCU) science and mathematics teachers in three innovations developed at other Minority Serving Institutions with Minority Science and Engineering Improvement Program (MSEIP) and National Science Foundation (NSF) support. A second objective of this project is to expand and strengthen the network among TCU science and mathematics faculty. The host institution and Project Director serve as facilitators of network activities. These objectives are being achieved by conducting summer workshops for faculty from 20 TCUs. During the two-week workshop in July 2006, the host institution's Science, Technology, Engineering, and Mathematics(STEM) faculty worked with seven TCU participants on innovative lab activities in Physics, Chemistry and Mathematics. Similar workshops will be conducted during July 2007, July 2008, and July 2009 for other TCU STEM faculty.

AI05: 10:20 AM 100% Retention Rate in Introductory College Physics

Daryao S. Khatri, Univ. of the District of Columbia, 703-274-5570, Dkhatri@udc.edu

Various research studies show that the single most important factor contributing to the general decrease in the number of students entering physics is the way we teach physics at both the high school and college levels. These studies also suggest that the current methods of teaching are having even a greater negative impact on minority and other diverse populations who might be interested in physics. A number of groups in the field of education research seem to put the blame on the lecture method used by most college faculty and high school teachers, but nothing in its place that is workable and has documented evidence of success has been offered. We at the Univ. of the District of Columbia have researched, documented, and tested various models in physics teaching with diverse student populations. We have discovered that lecture method after all is not as bad as many people might think. If the lecture method incorporates the practical and effective pedagogical techniques, it can have phenomenal success even with diverse student populations. We will share with conference participants the modified lecture method that has produced 100% retention rate in introductory college physics at the Univ. of the District of Columbia. This method has not only provided for enhanced learning, but has eliminated the seemingly endless need for extra time to cover the required course material.

Session AJ: Energy and the Environment

Sponsor: Committee on Science Education for the Public
Location: Oak B-C
Date: Monday, July 30
Time: 9–11 AM

Presider: Steve Shropshire, Idaho State Univ., 208-282-2212, shropshi@physics.isu.edu

AJ01: 9 AM Home Energy Savings After the Light Bulb

Invited *– Richard E. Flarend, Penn State Altoona, 814-949-5744, ref7@psu.edu*

The most commonly mentioned ways to conserve energy in the home are to use CFLs and to replace your 10+ year-old refrigerator. It is simple to change incandescent light bulbs to the appropriate CFLs and save about $150 per year. But although both of these will save energy, greenhouse gas emissions, and money, they are not the most important conservation measures available. Much more substantial savings can be realized from long-term improvements. Depending on the local climate, homeowners can save over $1000 per year using technologies that pay for themselves such as heat pump water heaters, front-loading washing machines, energy recovery drains, energy recovery ventilation, front-loading washing machines, geothermal heat pumps, and alternative construction techniques. These improvements can easily add $20,000 or more to the price of a new home or renovation, but can also result in a net savings of $75,000 over a 30-year period.

AJ02: 9:30–11 AM Global Warming 2007

Poster – Gordon J .Aubrecht, II, Ohio State Univ., 740-369-0992, aubrecht@mps.ohio-state.edu

What is the status of knowledge about human-caused warming? We summarize what is currently known, inferred, and guessed about global warming.

AJ03: 9:30–11 AM Electricity: From Table-Top to Power Plant

Poster – Timothy Moran, Schurz High School, 630-930-8606, t_j_moran@yahoo.com

Energy issues are reaching the top of education agendas, especially the generation of electricity. Hands-on activities can greatly enhance student understanding of how electricity is produced. Variable resistors help the analysis of small-scale electricity sources such as batteries, generators, and photovoltaic cells. After determining the maximum power available, comparisons can then be made to practical power sources and uses. Results from utilizing variable resistors are shown and discussed.

AJ04: 9:30–11 AM Energy Management Software Simulations

Poster – Richard W. Tarara, Saint Mary's College, 574-284-4664, rtarara@saintmarys.edu

The use of simulations of local, national, or international energy management systems can provide a central modeling exercise for energy related courses or course units. Computer simulations have been developed for student use spanning a number of levels of depth and complexity. All of these simulations deal primarily with the supply and demand for energy and the environmental effects. The software packages include: 1) Simplified U.S. model appropriate for High School and introductory College courses that can be completed within a single class period. This model deals with reducing the use of fossil fuels and the monetary and land costs to do so. 2) A U.S. and a World model that concentrates on managing both supply and demand. 3) A U.S. model that concentrates almost exclusively on the supply problem. 4) U.S. and international models that deal in more detail with choices of future resources and both monetary and land costs. 5) A more complex U.S. model that deals with all of the factors in one package. 6) A World model that incorporates the complexity of the above models but allows for fast execution of the model aimed at doing comparisons of various adjustable parameters such as population growth. The newest world model (6) will be demonstrated.

These software packages are available free for both Widows and Mac at: www.saintmarys.edu/~rtarara/software.html

AJ05: 9–11 AM An Intensive Course on "Energy for the 21st Century"

Poster – John L. Roeder, The Calhoun School, 212-497-6500, JLRoeder@aol.com

"Energy for the 21st Century" was a weeklong intensive course offered as part of The Calhoun School's "Winter Session," 12-16 February 2007. During this time students inventoried their use of energy, learned about future energy options, visited a rooftop photovoltaic array, and engaged in a cap-trading simulation, and completed Pat Keefe's spreadsheet to plan the U.S. energy future for the 21st century.

Session AK: Favorite Activities/Lessons in the TYC Physics Classroom

Sponsor: Committee on Physics in Two-Year Colleges
Location: Imperial H
Date: Monday, July 30
Time: 9–11 AM

Presider: Dwain Desbien, 3475 S. 256th Ave., Buckey, AZ, 623-935-8474, dwaindesbien@cox.net

AK01: 9–11 AM Hands-On Activities for Conceptual Physics Lecture Courses

Poster – Sherry L. Savrda, Seminole Community College, 407-328-2205, savrdas@scc-fl.edu

At many institutions, Conceptual Physics is taught as a lecture-only course, or may have only an optional lab associated with it. Students taking only a lecture course in physics miss out on valuable experiences, as well as the opportunity to see physics as a process of building models to help describe and explain observations. To address institutional and programmatic limitations that prevent all physical science students from taking a lab with their physical science course, a series of short hands-on activities were developed. The activities were designed to give students experience making observations and measurements, and to help them see the process of science in action. These activities can be easily carried out in a standard 50-minute

SOLAR VIEWING at the Summer Meeting

11 AM–9 PM
Koury Convention Center
Monday, July 30

Joe Heafner, Catawba Valley Comm College, heafnerj@sticksandshadows.com

The solar gaze will provide an opportunity for teachers at all levels, but especially high school teachers, to see how to view the Sun safely with various telescope and filter combinations. Too often, students are denied the chance to see the closest star from Earth out of fear of eye damage. Teachers are also usually afraid to attempt solar viewing because they have never been shown how to do it safely. Experienced amateur astronomers will be available with both simple and advanced equipment that anyone can learn to set up and use to watch solar goings on. While we cannot predict exactly what we will see on any given day, there will very likely be sunspots, prominences, surface granulation, and maybe even flare activity. If you do not know what these phenomena are, this is the perfect opportunity to see them and learn about them for the first time!

lecture period with time left to discuss the results. Several examples of the activities and student work will be provided.

AK02: 9–11 AM Using Pressure to Determine the Diameter of a Piston

Poster – Scott Schultz, Delta College, 989-686-9452, sfschult@delta.edu

Students place a five-kilogram mass on the plunger of a closed syringe. The mass causes the syringe to move, decreasing the volume. This crude experiment has the students work through pressure and end up calculating the diameter of the syringe with an error of about 1%. The poster will go over the process my students use to get their result.

AK03: 9–11 AM Calculation of Mercury's Perihelion Shift Using Calculus

Poster – Steven J. Siegel, San Diego Mesa College, 619-388-2629, ssiegel@sdccd.edu

This poster will examine a method for calculating the precession of Mercury's orbit using general calculus techniques. This lab was taken from Exploring Black Holes and General Relativity by Edwin Taylor and John Wheeler.

AK04: 9–11 AM Soak Da MovingTeach

Poster – David Weaver, Chandler-Gilbert Community College, 480-988-8997, david.weaver@cgcmail.maricopa.edu

I teach my courses in a project-based format where we spend ~five weeks on each of three projects. One of my (and my students') favorites has students designing, building, operating, and, most importantly, analyzing a water balloon launcher. I begin 15 m to the West and 15 m to the South of the students' launcher and I walk North at 1 m/s for 30 s. They are supposed to launch at least 3 balloons during my journey. They videotape the launch, the flight, and the landing and use LoggerPro to do the video analysis of each of the three phases. They also use Excel to develop a numerical model of the kinematics and of the energy/working for each phase. MathType/Equation Editor allows them to create readable equations and derivations. They pull all of their verbal, visual, symbolic, and numeric representations together in a Google Docs document.

AK05: 9–11 AM Incorporating Simulations into Technology-based Tipers*

Poster – Paul Williams, Austin Community College, 512-223-4824, pwill@austincc.edu

Tasks inspired by physics education research (Tipers) provide an excellent tool for probing and developing student conceptual understanding of physics. The author has incorporated technology into Tipers by posing a task such as a "ranking task" or a "what if anything is wrong task" based on a simulation. Students respond to the task with clickers either individually or after group discussion. Feedback on the task is provided by the simulation as well. Simulations have been drawn from the Physics Education Technology (PhET) website[1] as well as from Physlets. [2] Several of the author's favorite activities will be shown.

*This work was partially funded as a "Major Project Award" from the ATE Program for Physics Faculty

1. http://phet.colorado.edu
2. http://webphysics.davidson.edu/Applets/Applets.html

AK06: 9–11 AM Energy in the 21st Century

Panel – Pat Keefe, Clatsop Community College, 503-338-2434, pkeefe@clatsopcc.edu

Greg Mulder

We have found that engaging students in predictions of what form and how much energy will be used in the future is a very successful way to generate enthusiasm and further investigation of physics. We have developed two different group projects that involve designing energy systems. These modeling exercises look at past energy consumption patterns and develop a plan for energy usage in the 21st Century. Other considerations such as population, costs and efficiencies are also used to further expand the discussion and decision making that takes place.

AK07: 9–11 AM Making Your Own Lava Lamps in Introductory Physics Classes

Poster – Todd Leif, Cloud County Community College, 785-243-7301, tleif@cloud.edu

Turn Me On? Light Me Up? Watch Me Melt...Making Lava Lamps as a classroom activity. Historically this lab is a project similar to the types of projects described during a TYC Workshop Project Conference. The Large Contexts Teaching Process was described to me by a colleague who attended the conference. Students are asked to study an authentic 1960's lava lamp and then are required to create their own working model. This included a report on what they did, a demonstration of their working model and a defence of their final project. The poster will show results of this project and will discuss the students attitudes toward doing such a project.

AK08: 9–11 AM A Hands-On Version of a Classic Example Problem

Poster – William P. Hogan, Joliet Junior College, 815-280-2213, whogan@jjc.edu

My students do a quick MBL activity with a cart on an inclined track with friction instead of working the classic energy conservation example problem and get measured values that agree with calculated values to typically within 1%. Much of my time in lab is focused on building conceptual understanding instead of calculations and my students are thrilled to do something numerical that works as they expect. The activity also clarifies the difference between distance and height much like working the classic example.

AK09: 9–11 AM The Expansion of the Universe

Poster – Karie A. Meyers, 520-206-6695, karie.meyers@pima.edu

A demonstration using two overheads with the positions of galaxies plotted at two different times (now and 5 bya) shows that the universe has no center, and gives students a better idea of why the redshift of galaxies implies expansion of the universe.

AK10: 9–11 AM Goal-free Problems in Introductory Physics

Poster – Paul D'Alessandris, Monroe Community College, 585-292-2490, pdalessandris@monroecc.edu

Goal-free problems do not explicitly direct students to solve for a specific target variable. The goal of using goal-free problems is to diminish student reliance on means-ends analysis during problem solving. It has been suggested that problem solving using means-ends

analysis is counter-productive to the development of conceptual understanding. Examples of different types of goal-free problems, from different topical areas, will be provided. Anecdotal results from over 10 years of using goal-free problems will be reported. Goal-free problems are an integral component of Spiral Physics, an introductory physics curriculum in use at Monroe Community College since 1993.

AK11: 9–11 AM Using Camtasia and Powerpoint in an Online Astronomy Course

Poster – Alexander Dickison, Seminole Community College, 407-728-2202, dickisoa@scc-fl.edu

For the past three years I have been offering an Online Astronomy course. Students purchase access to an ebook along with a student companion workbook. Students are expected to complete an online quiz and a set of short essay questions each week on the assigned chapter. I found that many students had difficulty determining the important concepts and ideas from the ebook. This year I made available chapter outlines and video reviews for each chapter. The video reviews use Camtasia and Powerpoint to create "mini-lectures". Student reaction is included.

AK12: 9–11 AM Estimation: How Much Stuff Comes Out Your Car's Tailpipe

Poster – Dwain M. Desbien, Estrella Mountain CC, 623-935-8474, dwain.desbien@emcmail.maricopa.edu

This poster will show a fun little estimation problem I use to get students used to talking to each other. Students are asked to figure out many pounds of waste comes out the tailpipe of a typical car in a year. Results from students will be shown along with typical discussion items.

AK13: 9–11 AM Fun Stuff I Use in Class

Poster – Karim Diff, Santa Fe Community College, 352-395-5591, karim.diff@sfcc.edu

This poster describes samples from my favorite teaching activities: Classroom demonstrations, interactive simulations, conceptual quizzes emphasizing multiple representations, and applied mathematical

AM: Plenary I – Dresden Lecture

Location: Imperial D
Date: Monday, July 30
Time: 11 AM–Noon

Gerry Wheeler

Welcome Remarks: Patricia A. Sullivan, Chancellor, The University of North Carolina at Greensboro (UNCG)

The Many Ways of Doing Physics

Gerry Wheeler, National Science Teachers Association, 703-312-9255, gwheeler@nsta.org

Max Dresden was an outstanding physicist and an extraordinary teacher. He won a distinguished teaching award at Stony Brook not once but four times. This presentation will explore doing physics beyond traditional research, a thought Max once shared with me. The challenges are formidable mainly because most of the options are like a foreign land. I will deal with the successes and failures of scientists in the world of mass media and give some guiding principles for better communication in all aspects of doing science beyond "the bench."

techniques. The Van de Graaff generator is a great tool to stimulate discussions about various electrostatics and the dissectible Leyden jar is particularly useful in this context. Interactive simulations help me lead students into investigations that would be too cumbersome with equipment. With WebCT I have the possibility of quizzing students on a regular basis to assess their understanding of basic concepts. Multiple representations are heavily emphasized in these quizzes. One of the most challenging tasks for students in a physics course is to learn the art of making approximations to simplify problems that would be otherwise very difficult to solve. The binomial expansion is a recurring example I like to use in both first and second semester physics.

AK14: 9–11 AM Using Simulations in the Classroom

Poster – Thomas O'Kuma, Lee College, 281-425-6522, tokuma@lee.edu

There are a number of simulations available that make wonderful classroom tools to show and emphasize certain topical areas. This poster will present some examples of the use of simulations from Physlets to PhET that the author thinks make effective simulations.

AK15: 9–11 AM ATE Program for Physics Faculty Project: Update *

Poster – Thomas O'Kuma, Lee College, 281-425-6522, tokuma@lee.edu

Dwain M. Desbien

This poster will report on all the various activities of the Project. A section of the poster will discuss the workshops already conducted and future workshops offered in the near future. A special section will be devoted to the New Faculty Training for Two-Year College Physics Faculty Conference to be held March 6-8, 2008, at Delta College, Univ. Center, MI. Another section of the poster will be on the follow-up activities done by the participants as part of the Project. Initial results from the first year of this multi-year project will be exhibited.

*Supported in part by NSF grant #ATE-0603272

AK16: 9–11 AM Circuit Connections Through Construction, Calculation, and Composition

Poster – Michael C. Faleski, Delta College, 989 686-9495, michaelfaleski@delta.edu

Capacitors and resistors connected in series and parallel are encountered by students in all introductory physics classes. The activity described here uses the actual construction with circuit elements as a way for students to make series and parallel connections. Instead of presenting connected circuit elements and asking for equivalent values, students design their own connections in order to achieve a group of desired equivalent capacitances/resistances using identical elements. In addition, schematic diagrams of the connections are made. Symmetries play a large role in understanding the connections and this is seen through the use of sentences describing those connections.

AK17: 9–11 AM Teaching Work/Energy as Energy/Work

Poster – Michael C. Faleski, Delta College, 989-686-9495, michaelfaleski@delta.edu

In the past two years, I have reformed the teaching of work and energy in my introductory classes by reversing the order of presentation. Introduction of the First Law of Thermodynamics is done early in the presentation. In this way, the so-called work-energy theorem is not required to solve any of the standard problems and the subtleties of dealing with friction and work are avoided. In addition, rearranging the order of some of the standard topics in the course, such as momentum and rotation, aided this reform with energy and work. Further, not only was there no loss to the amount of content presented in the course, but there was an increase as more thermodynamics topics were discussed. The new logic of the courses, discussion of the changes to the energy/work curriculum, and preliminary results from this experiment will be presented as well as possible changes for the future.

AK18: 9–11 AM Physics Projects as a Central Theme in Engineering Physics

Poster – Martin S. Mason, Mt. San Antonio College, 909-594-5611, mmason@mtsac.edu

Student projects serve as a central theme in engineering physics courses at Mt. San Antonio College. Several student projects will be featured.

AK19: 9–11 AM My Favorite Peer Instruction Questions

Poster – Tom Carter, College of DuPage, 630-942-3346, carter@fnal.gov

Over the past five years, I have been using Peer Instruction in my introductory physics class and have accumulated a large set of "clicker" questions. I will display a dozen of my favorite questions and give a brief explanation of the key concept probed by each. Some of the questions were written by me and some were copied from other sources. I also would like this poster for form a central point for people to swap question sets, discuss what makes a good question and show off their own favorites. I will provide a thumb drive for use in up-loading and down-loading different sets. My own set will be available in MS Word format sorted by topic.

Session AL: The Physics Bazaar

Co-sponsors: Committee on Physics in High Schools, Committee on Apparatus
Location: Oak A
Date: Monday, July 30
Time: 9 AM–5 PM

Presider: Diane Riendeau, Deerfield HS, 224-632-3274, DRiendeau@dist113.org

Thomas Senior

AL01: 9 AM First Law Demonstration Apparatus, a Variation on the Hammer Head Demonstration

Thomas J. Senior, New Trier High School, 847-784-6739, thomasjsenior@yahoo.com

Although few of our students have direct experience with axes and hammers, this demonstration of Newton's first law (inertia) can be counter intuitive. To get the hammer head more firmly attached to the handle, hit the bottom of the handle on a tabletop. This device is a block of wood on a PVC tube that serves the same purpose, plus, if you hit the top of the tube with a mass, the block will seem to move upward. The friction between the block and tube is adjustable. Cost will be approximately $5.

AL02: 9 AM Thin Film Interference Regenerator Osmosis Straw

Gerald A. Zani, Brown Univ., 401-863-3964, gerald_zani@brown.edu

A simple device is offered that will end the problem of continually popping and restarting a thin film pattern. The easily produced device is constructed from a slit straw and a piece of magnet wire. It will sustain a permanent thin film interference pattern without repeated pops. This demonstrates interference colors, both transmitted colors and reflected colors. Show the osmosis process dramatically in class using nothing more than a short section of dialysis tubing and a straw. The osmosis straw is a very simple and effective way to demonstrate osmosis, osmotic pressure, semi permeable membrane, diffusion, membrane transport and equilibrium.

AL03: 9 AM Gee-Haw Whammey Diddle

Andrew C Morrison, Illinois Wesleyan Univ., 309-556-3888, amorriso@iwu.edu

The gee haw whammey diddle is a folk toy that is useful for demonstrating conversion of vibration energy to rotational energy.

AL04: 9 AM Priced to Sell, Liquid Level Accelerometers, Bumper Stickers, etc.

Jim Nelson, 352-395-6646, nelsonjh@ix.netcom.com

Jane Nelson

The Physics Bazaar is an AAPT/PTRA event that is being tried for the first time during an AAPT summer meeting. Inexpensive physics equipment (i.e., Liquid Level Accelerometers, Constant Speed Buggies, et cetera) will be sold at cut rate—first come, first serve.

Session AN: Mentoring Students in Undergraduate Research

Sponsor: Committee on Physics in Undergraduate Education
Location: Meadowbrook
Date: Monday, July 30
Time: 9–10:10 AM

Presider: Steve Turley, Brigham Young Univ., 801-377-5668, turley@byu.edu

AN01: 9 AM Taking Up the Challenge of Involving Undergraduates in Research

***Invited** – Eric G. Hintz, Brigham Young Univ., 801-422-4168, doctor@tardis.byu.edu*

Can undergraduates participate in meaningful research? Can you really require all undergraduate physics and astronomy majors to complete a research project? Those are two questions that the Department of Physics and Astronomy at Brigham Young Univ. has explored for approximately 10 years now. For many years a small percentage of our top students would seek out opportunities to be involved in research projects with the faculty. Then in the mid-1990' the faculty made the commitment to involve ALL majors in a research experience leading to a senior thesis or capstone project. Over the years we have developed a program that can make this requirement work and have learned just how large a time commitment it entails. A few of the highs and lows that come with requiring undergraduates to be involved in research will be explored.

AN02: 9:30 AM Research Experiences for Undergraduates: Mentoring Before, During, and After

***Invited** – Kathleen McCloud, National Science Foundation, 703-292-8236, kmccloud@nsf.gov*

The Research Experience for Undergraduates (REU) program has as its goal to provide meaningful research experiences to undergraduate students to attract them into, and retain them in, careers in science and engineering. These awards can either fund an REU site or fund a supplement to an existing research grant to involve one or more undergraduates. NSF strongly encourages involvement of under-represented minority students and students with limited research opportunities at their home institutions. Both formal and informal mentoring are crucial to the success of these programs and the subsequent success of the students involved. Ideally, mentoring takes place at both the home institution and the REU site, before, during, and after the research experience. Some findings on best practices including preparation, recruitment, the actual research experience, and follow-up will be discussed.

AN03: 10 AM Measurement of Earth's Local Magnetic Field Using Magnetic Torque Method

Misganaw Getaneh, Univ. of Tennessee at Martin, 731-881-7433, mgetaneh@utm.edu

Wallis A. Wimbish

A cylindrical neodymium magnet with axial magnetic dipole moment is suspended from a thin vertical string. In the absence of other magnetic fields it settles along the Earth's magnetic north-south line. A Helmholtz coil set was placed around the magnet, with the coil symmetry axis parallel to the Earth's field and with the magnet at its center. Rotating the magnet about an axis through the string results in a restoring torque, which when released, results in oscillations of the magnet with frequency that depends on current in the coil. The frequency was measured for several coil currents. The resulting frequency versus current data is used to determine the horizontal component of the Earth's magnetic field and the dipole moment of the magnet. The measurement for the Earth's field thus obtained is in very good agreement with measurement obtained using other methods.

Session BA: Klopsteg Award

Location: Imperial D
Date: Monday, July 30
Time: 2–3 PM

Neil deGrasse Tyson

Adventures in Science Illiteracy

Neil D. Tyson, American Museum of Natural History, 212-769-5912, tyson@amnh.org

Drawing on personal experiences from the world of politics, academia, print and broadcast media, and encounters with the general public, Tyson will highlight and comment upon some of the most egregious examples of science illiteracy that afflict America today.

Session BB: High School Physics: Laboratories, Curriculum, Concepts, and Competition

Sponsors: Committee on Laboratories, Committee on Physics in High Schools
Location: Imperial F
Date: Monday, July 30
Time: 3–5:20 PM

Presider: Carolyn Haas, Salem Comm. College, 856-351-2667, clhaas1808@aol.com

BB01: 3 PM Using Laboratory Activities in an APC Physics Course

Invited *– Joan E. Mackin, retired, 610-255-4034, rjemackin@aol.com*

Normally we think of AP Physics courses being taught using traditional strategies including lecture and modeling problem solving. Could an AP course be taught using laboratory activities dealing with real-world problems and application to engage students in inquiry type learning? Would the students be prepared for the AP exams and Univ. courses after completing this type of high school course that predominately used lab activities to teach physics concepts? A description of this standards-based APC Physics course including teaching strategies will be discussed in the presentation. Data taken for a three-year period from pre-tests and post-tests, APC tests results, surveys, and students' communications about their experiences in university courses will also be discussed.

BB02: 3:30 PM Effective Labs and the AP Environment

Invited *– Gregory Puskar, West Virginia Univ., 304-293-3422, gpuskar@mix.wvu.edu*

Laboratory experiences are a major component of the AP Program and are mandated by most state standards. However, pressures from various sources are exerted on teachers that tend to lessen or eliminate lab work. In the case of the AP Physics program, if lab activities are reduced or eliminated, a student conceivably may not have any lab experience until their upper level college courses, if at all. Activities will be described that serve to reduce these pressures while still providing a stimulating lab experience.

BB03: 4 PM Integrated Hands-On, Video, and Computational Labs for AP Physics C.

Jonathan Bennett, North Carolina School of Science and Mathematics, 919-416-2760, bennett@ncssm.edu

Jacqueline Bondell, Loren Winters

We have developed a set of lab activities for AP Physics C Mechanics and Electricity & Magnetism. The activities included hands-on labs, computational problems using spreadsheets, and video analysis labs. Many of these labs require students to develop their own techniques to examine the Physics of the problem, design the lab method, and analyze the data. Basic techniques of differential and integral calculus are introduced or otherwise implemented in preparing and carrying out the labs. We will describe a sequence of lab activities that integrate video, computational, and hands-on methods that address fluid drag in the turbulent and laminar regimes. We will also describe a sequence of computational and hands-on activities for calibrating a Hall Probe and then using it to measure magnetic fields of solenoids and Helmholtz coils. We have observed students to gain confidence in designing their own labs and in estimating uncertainties through the practice gained in carrying out these labs.

BB04: 4:10 PM Fine Fitting of Experimental Volt-ampere Characteristic of Light Bulb Using Simple Nodel

Seung man Kim, Seoul National Univ., 82-2-880-7755, hdoore@hanmail.net

Salavat Mansurovich Ishikaev, Junehee Yoo

The most usual and ordinary incandescent lamps demonstrate uncommon and unexpected volt-ampere characteristics at a certain range of applied voltages and frequencies. However, such complicated behavior can be described and numerically simulated on the basis of a simple model, in which only four most essential factors are considered. Electric power heats the tungsten filament of a light bulb, whose resistance linearly depends on temperature. The filament is cooling by thermal radiation (according to the Stephan's law) and heat losses (due to the thermal conductivity). And thermal inertia of filament (because of its heat capacity) is also taken into account. Using the proposed model one could easily simulate the volt-ampere characteristics on the computer. The numerical results could be successfully fitted to the experiment data in accessible frequency and voltage ranges. Thus, it is possible to define heat capacitance of the filament and thermal conductance between it and the environment, finding them as fit parameters in the computer simulation.

BB05: 4:20 PM Colorful Electron Configurations

Jennifer K. Gartner, Labette County High School, 620-784-5321, jegartner@usd5506.k12.ks.us

Knowing the number of electrons within an element is kind of like knowing the country in which someone lives. However, knowing the electron configuration of the electrons is similar to the street address of each the individual electrons. The electron configuration gives the energy level, shape of orbital and number of electrons present at each location. The large number is the energy level or principle quantum number. The letter s,p,d and f indicate the shape of the electron's orbital. The superscript is the number of electrons in each energy level and orbital. Using a colored periodic table to find the electron configuration of an elements is an easy method to teach and learn electron configuration. This tool can cut the time spent teaching electron configuration as well as relating it back to the periodic table.

BB06: 4:30 PM Inquiry-based Physics in the Freshman Physics Classroom

James C. Kernohan, Milton Academy, 617-898 2120, jim_kernohan@milton.edu

For the past three years, we at Milton Academy have taught an inquiry-based physics class to our 9th graders. I will present an overview of this class, outlining the topics we cover and those we omit, labs the student perform and the skills they learn. I will discuss the problems we have encountered and the steps we have taken to overcome them.

BB07: 4:40 PM Making Student Understanding of Introductory Circuits as Easy as Possible

Stephen P. Hogan, 1580 N Windsor Dr., Arlington Hts, IL, 773-407-9305, hogan@uwalumni.com

Damian C. Simmons

The authors believe that circuits, especially translating from circuit diagrams to building real-world circuits from loose parts, can be a daunting task for a typical introductory physics student. Creating a spaghetti-like circuit from a perfect-looking diagram often leads to confusion

Session BC: PIRA Crackerbarrel on Instructional Apparatus

Sponsors: Committee on Apparatus, Committee on Laboratories
Location: Imperial A
Date: Monday, July 30
Time: 3–4:30 PM

Presider: Dean Hudek, Brown Univ., 401295-7839, dean_hudek@brown.edu

Participants will interactively discuss design, construction, use, procurement, and maintenance of apparatus used in instructional laboratories and lecture demonstrations. Please come prepared to tell us about an apparatus, exchange ideas, ask questions, offer solutions, etc. Faculty and Dept. Chairs: Please bring this Crackerbarrel to the attention of your instructional support staff.

as to the path of current through a circuit, and also leads to problems for the teacher when it comes to troubleshooting malfunctioning or incorrectly built circuits. We'll discuss how the use of Snap Circuit Kits has helped to alleviate some of these problems at the introductory high school level, and how the kits can be used for other units in the classroom as well.

BB08: 4:50 PM The Meissner Effect: More Than Superconductivity

Brian McClain, Amos P. Godby High School, 850-514-2116, mcclainb@mail.leon.k12.fl.us

An expanded script for the Meissner Effect demonstration will be modeled. Too often, the Meissner Effect is used once in a physics course and only for a cursory demonstration related to superconductivity. This lesson expands the uses of the basic demonstration kit materials into other areas of physics through an inquiry-driven sequence of questioning. Topics include pre- and post demonstration topics, applications to kinetic and potential energy, and states and properties of matter. Teachers will leave with a copy of the script and links to supporting websites.

BB09: 5 PM Hands-on Electro-optics Activities Cause Students to Consider New Career Field

Christy Heid, Chatham College, 412-365-1194, cheid@chatham.edu

Feng Zhou

Due to the rapidly evolving career-field of photonics/electro-optics, Indiana Univ. of Pennsylvania (IUP) has developed an outreach program to local high schools. In addition to visiting their schools to share electro-optics (EO) techniques using theme packets for hands-on activities, we move one step further to invite interested students to IUP's EO labs to participate in hands-on activities such as measuring the thickness of a human hair using laser diffraction, splicing an optical fiber, open space communication, night vision, holography, and interferometry. Representatives from local electro-optic companies also take part in the activities, sharing information about career opportunities in photonics including examples of current projects at their companies. Many students, initially having no or very limited knowledge of this career field, have expressed an interest in a career in electro-optics through these visits.

BB10: 5:10 PM Been to a Good Physics Fight Lately?

Hugh B. Haskell, NC School of Science & Mathematics, 919-467-7610, haskell@ncssm.edu

The IYPT brings together physics students and their teachers who investigate interesting but broadly structured questions theoretically and experimentally. Each summer the IYPT selects questions which are distributed to teacher-student groups who spend a year working on solutions and come together the following July at the IYPT to present and defend their work. This learning model mimics the process of science; its instructional value to learning is clear. But one of its largest benefits is to those teachers who have not had the opportunity to participate in real research before and gain increased confidence in their understanding and ability to teach physics from it. Doing research makes better students and better teachers. The US Association for Young Physicists Tournaments this year instituted a National Young Physicists Tournament for high school teams, using questions from prior IYPTs. We have found that this concept works well with physics students of varying ability.

Session BD: Connecting Curriculum and Content Through Digital Libraries

Sponsor: Committee on Educational Technologies
Location: Auditorium I
Date: Monday, July 30
Time: 3–4:40 PM

Presider: Bruce Mason, Univ. of Oklahoma, 405-325-3961, bmason@u.edu

BD01: 3 PM A Digital Library of "Open" Simulations for Physics Teaching

***Invited** – Francisco Esquembre, Universidad de Murcia, +34619105779, fem@um.es*

We introduce a repository of free open simulations that in-service physics teachers can use to implement computer-based interactive engagement methods in their classrooms. The distinctive feature of these open simulations is that teachers can easily inspect, modify, and store them at a high, scientific-oriented level with no big programming requirements. This repository also allows for the interchange of opinions about the repository contents and of related pedagogic materials. We show in this talk how this process is achieved using the free Easy Java Simulations (Ejs) modeling and authoring tool. Different examples of complete Physics simulations will be presented.

BD02: 3:30 PM SERC Pedagogic Services: Teaching Examples, methods and materials for faculty

***Invited** – Cathryn A. Manduca, SERC, Carleton College, 507-646-7096, cmanduca@carleton.edu*

Sean Fox, Ellen R. Iverson, Bill Bruihler

The SERC pedagogic service uses teaching examples to inspire faculty to try new teaching methods. Each example is linked to the needed teaching materials as well as to a module on the methods that are used. Information in the teaching method module addresses what the method is, when and why it is valuable to use, and how it can be implemented. These modules are well referenced providing a bridge to the scholarly literature on the method. Digital libraries, centers for teaching and learning, or other groups can draw from a library of modules and activities to create their own customized websites supporting their particular community. They can also contribute modules and activities to the collection for use by others. ComPADRE has created an initial implementation of the service for the physics community.

BD03: 4 PM JiTTDL - Just-in-Time Teaching Digital Library *

***Invited** – Gregor M. Novak, United States Air Force Academy, 719-333-3028, gnovak@iupui.edu*

This year marks 10 years of the Just-in-Time Teaching initiative (www.jitt.org.) Starting in physics JiTT now includes all STEM disciplines and a few in the humanities Funded by NSF, JiTT will open a digital library of resources this summer (www.jittdl.org.) This presentation will describe the JiTT digital library and some additional JiTT initiatives.

* This work is supported substantially by NSF grant DUE-0333646

BD04: 4:30 PM Improved Web Support for Physics Teachers*

Brian W. Adrian, Kansas State Univ., 785-532-1824, badrian@phys.ksu.edu

Dean A. Zollman, Scott Stevens

Offering much-needed assistance to teachers of physics, the Physics Teaching Web Advisory (Pathway) is a dynamic digital library helping teachers of all levels prepare for their classes and easily obtain valuable assistance from peers and nationally known experts in physics pedagogy and high quality content. Combining Carnegie Mellon

Univ.'s digital video library and synthetic interview technologies with pedagogical advances developed at Kansas State Univ. and materials contributed by master teachers, Pathway provides continuously improving assistance and expertise. A major upgrade to the project has incorporated user suggestions, added many new features and significantly expanded the scope of the library. This talk will present some of these advances as well as some projected improvements.

*Supported by NSF grant numbers DUE-0226157, DUE-0226219, ESI-0455772 & ESI-0455813

Session BE: PER: Observing and Modeling Cognition

Location: Cedar
Date: Monday, July 30
Time: 3–5 PM

Presider: Jeffrey J. Williams, Bridgewater State Coll., 508-531-2081, j7williams@bridgew.edu

BE01: 3 PM Learning and Transfer of Learning Through Group Interaction *

Bijaya Aryal, Kansas State Univ., 785-532-7167, bijaya@phys.ksu.edu

Dean A. Zollman

We have investigated the effect of group interaction on activation of students' resources and facilitation of transfer of learning using physical models. We conducted teaching interviews using physics models with nine groups of students enrolled in an introductory level algebra-based physics course. The participating students worked in groups with minimal teacher intervention. After they reached consensus, they wrote their responses on worksheets. The study shows that the students' unstable reasoning was easily challenged when they worked with peers. The study also indicates that while working with their peers, the majority of the students brought in different ideas which they used to engage in qualitative reasoning before quantitative reasoning. We have found that most of the students who participated in this study built upon each other's ideas as they tried to understand complex phenomena and facilitate transfer of their learning from physical models.

*This work is supported in part by the National Science Foundation under grant DUE 04-2675

BE02: 3:10 PM Students' Patterns of Reasoning and Behavior During Physics Tutorials

Luke D. Conlin, Univ. of Maryland, 617-359-8036, luke.conlin@gmail.com

Ayush Gupta, Rachel E. Scherr, David Hammer

Analyzing student activity during an active learning exercise such as a physics tutorial is a complex task owing to the myriad interacting components including speech, gestures, and behaviors. Scherr[1] has observed stable group behavior modes separated by sharp transitions, and a preliminary study suggested a high correlation between particular behavior modes and mechanistic reasoning. This may have instructional implications; if some behavior modes more effectively promote scientific reasoning, then it may be a goal to precipitate transitions into those modes. We will present results for more episodes of student activity, using the previously developed coding schemes[1,2] to capture the dynamics of behavior and mechanistic reasoning in order to investigate the nature, scope and stability of the connections between them.

1. R. E. Scherr and D. Hammer, "Observing students' framing of tutorials," to be submitted to *Phys. Rev. Special Topics: Phys. Educ. Res.* (March 2007)
2. R. S. Russ, R. E. Scherr, D. Hammer, and J. Mikeska, "Recognizing mechanistic reasoning in scientific inquiry," *Sci. Educ.* (March 2007)

BE03: 3:20 PM Understanding Student Difficulties by Listening to What They Are Saying

David T. Brookes, Univ. of Illinois at Urbana-Champaign, 848-391-0527, dbrookes@uiuc.edu

Traditionally, information and knowledge are seen as objects that can be transmitted to a student by the instructor or the textbook. I will consider an alternative view of communication. In this view, information and knowledge are constructed as an act of negotiation of meaning between the instructor/researcher and learner. We all readily recognize that students may misunderstand what we tell them in a physics class. What about the other direction? How can we be certain that we correctly understand students' intended meaning when they talk to us? Traditionally researchers have argued that many students believe a constant force is needed to sustain a constant rate motion, or possess a reasoning primitive: "force as mover." Having examined examples from existing research on students' difficulties with force and motion, I will make the case that students' explanations do not support these interpretations.

BE04: 3:30 PM Beyond Confusion: Alternative Accounts of Students' Failure to Differentiate

Brian W. Frank, Univ. of Maryland, 301-405-6185, bwfrank@mail.umd.edu

Rachel E. Scherr, David Hammer

A variety of students' difficulties with introductory physics are attributed to failures to differentiate quantities. We describe an episode in which a student, Becky, uses the term surface area in a physics situation in which a standard correct answer would refer to mass. Classic failure-to-differentiate literature would likely identify Becky as confusing mass and volume. Only worse, since she would appear to be additionally confusing volume with surface area. Upon further investigation, it appears that some of Becky's ambiguity is facilitated by her thinking about matter in terms of molecules. In another situation, however, we observe Becky's tendency to think in terms of molecules as contributing to an understanding of density that helps her to cleanly differentiate mass and volume. We suggest that Becky is not simply "failing to differentiate" quantities, but instead sees fundamental relationships between them that guide her thinking in specific, context-dependent ways.

BE05: 3:40 PM Priming Epistemological Framing: "Answermaking" and "Sensemaking" in Introductory Physics Courses

Paul Hutchison, Univ. of Maryland, 301-405-5983, hooch@umd.edu

Renee Michelle Goertzen

Research on framing (ie. Tannen, 1993) shows that how individuals interpret the nature of activity influences how they understand meaning and how they participate. Hammer et al. (2005) argue this has important implications for thinking about student learning in introductory physics courses. We expect that particular framings of physics class activity are more or less desirable. In this talk we will report on our effort to utilize a quantitative survey to simply demonstrate that we are able to prime the activation of particular framings among college students in an introductory physics course, and that this has implications for student reasoning about physical phenomena. Our data shows interesting differences in response patterns across different large lecture sections. This result suggests that our success priming particular framings in students is influenced by the instruction they receive.

BE06: 3:50 PM Explicit Reflection in Introductory Physics

Michael L. Scott, Univ. of Illinois, Urbana-Champaign, 217-333-0272, mscott1@uiuc.edu

Tim Stelzer, Gary Gladding

The goal of instruction is to help shift a novice to a more expert-like state in matters of knowledge, understanding, and thinking. One important behavior of expert thinking is time spent reflecting upon the meaning and structure of things learned and of tasks worked. In this talk I will discuss a classroom implementation in which explicit reflective activities supplemented the problems students worked during class. This intervention spanned a 14 week period and was evaluated based on the relative performance between a control and treatment group. Instruments used in this study to assess performance included the Force Concept Inventory (FCI), a physics problem categorization test, and four class exams. I will discuss fully our implementation of the reflective exercises and the accompanying measures. I will also discuss possible limitations to this study and will give lines of future research.

BE07: 4 PM Effect of Viewing Order on Students' Judgments of Realistic Motion

Adam Feil, Univ. of Illinois at Urbana-Champaign, 217-333-0272, adamfeil@uiuc.edu

Jose Mestre

Previous studies [1] have found that physics students give different judgments of realism for animations of balls rolling on a pair of tracks depending on whether one or two balls are shown; however, education students gave similar judgments for both one and two ball conditions. In this recent study, additional factors that influence physics students' judgments have been identified. These new results will be presented, and implications regarding various views of student reasoning, such as coordination classes and naïve theories, will be discussed.

1. T.C. Thaden-Koch, R.J. Dufresne, R.J., and J.P. Mestre, "Coordination of knowledge in judging animated motion," *Phys. Rev. ST Phys. Educ. Res.* 2, 020207 (2006).

BE08: 4:10 PM Studying Fine Structures of Mixed Mental Model States

Stephen Stonebraker, Ohio State Univ., 614-688-3598, sstoneb@mps.ohio-state.edu

Lei Bao

Extending the current framework of Model Analysis, we are making a distinction between two subtypes of the "mixed" mental model state: an implicit mixed state, where a student is unaware of the mixing, and an explicit mixed state, where they are. We are developing a technique which may allow us to distinguish between these two states using traditional large-population multiple-choice instruments. Essentially, we have students rate their confidence and allow them to give more than one answer. Use of this technique and some early results will be discussed.

BE09: 4:20 PM Flipping the Mind: Switch Effect as a Tool for Measurement

Lei Bao, The Ohio State Univ., 614-292-2450, lbao@mps.ohio-state.edu

Jing Wang

From research, it is found that the features and orders of the questions on a test can have significant impact on student responses. To make use of this effect, we specifically design a pair of questions (switch pairs) testing identical physics content but with slightly different context features. By altering the order of these two questions, we get different response patterns from students, which we call switch effect. In a traditional concept test, questions triggering switch effect are things to be avoided. In our research, we use the switch effect as a tool to measure subtle and sometimes implicit cognitive processes such as conceptual priming and the transferability of student knowledge across contexts with varying similarity.

BE10: 4:30 PM How Prior Knowledge Affects Learning: Common Learning Theories Lead to Different Learning Models

David E. Pritchard, MIT, 617-253-6812, dpritch@mit.edu

Young-Jin Lee, Lei Bao

We present learning models based on assumptions motivated by various theories of learning: Tabula Rasa, Constructivist, and Socratic Tutoring. Constructivist models show a close connection with Item Response Theory. These models predict the improvement (on the post-test) as a function of the pretest score due to intervening instruction. Over a wide range of pretest scores on standard tests of introductory physics concepts, data from MIT fit the Tabula Rasa model (which embodies memorization); those from Univ. of Minnesota lie midway between Tabula Rasa and Constructivist models. The Constructivist model seems to support that "general" knowledge, such as verbal, logical and scientific thinking skills measured by the Lawson test, is associated with the domain knowledge that students are trying to understand.

BE11: 4:40 PM Revisiting the Ontological Characterization of Physics Concepts

Edward F. Redish, Univ. of Maryland–College Park, 240-731-3692, redish@umd.edu

Ayush Gupta, David Hammer

In a series of well-known papers, [1] Chi and Slotta have suggested that one reason for the well-known difficulties students encounter in learning physics is ontological: that students think about physics quantities as the wrong kind of objects matter-like instead of process-like. We suggest that the central idea of a barrier between different ontologies arises from a misunderstanding of expert knowledge in physics. Expert physicists regularly rely on ontological blending to make sense of physical quantities that do not match the simplistic ontologies of everyday speech. We cite examples including current flow and potential wells in quantum mechanics[2] to illustrate that an expert description of physical phenomenon itself is not tied to a correct ontological category. To promote one ontological description in physics instruction, as suggested by Slotta and Chi,[3] could suppress an essential skill for the development of expertise.

1. M. Chi, in R. Giere (Ed.), *Cognitive Models of Science: Minnesota Studies in the Philosophy of Science*, 129–160 (U. of Minn. Press, 1992); M. Chi, in W. Kintsch (Ed.), *Proc. of the 15th Annual Cog. Sci. Society Conf.*, 312–317 (Erlbaum, 1993).
2. D. Brookes, Ph.D. Thesis, Rutgers Univ. (2006).
3. J. Slotta & M. Chi, *Cog. & Instr.* **24**, 261-289 (2006).

BE12: 4:50 PM Student Models of Electric Current: An Ontological Analysis

Ayush Gupta, Univ. of Maryland-College Park, 301-405-6184, ayush_umd@yahoo.com

David Hammer, Edward F. Redish

We carry out an ontological analysis of models of electric current generated by students in an introductory inquiry based physics course at the Univ. of Maryland. It's suggested that certain topics in physics such as electric current are difficult for students to learn because they are inclined to think of them incorrectly as material substances rather than as emergent processes, which is their correct ontological category. [1] It has been proposed that instruction for these physics concepts should carefully avoid any analogy to substance-based concepts (such as blood flow to current).[2] In contrast, our data shows that students use models of blood flow and train on a track productively to understand their own observations of current in circuits and to make predictions. Preliminary analysis indicates that students can use these analogies to generate both matter and process like understanding of current.

1. M. Chi, *The Journal of the Learning Sciences*, **14**(2), 161-199 (2005).
2. J. Slotta & M. Chi, *Cog. & Instr.* **24**, 261-289 (2006).

Session BF: Computational Physics in the Two-Year College Curricula

Sponsor: Committee on Physics in Two-Year Colleges
Location: Imperial G
Date: Monday, July 30
Time: 3–4:10 PM

Presider: Steven Siegel, San Diego Mesa College, 619-388-2629, ssiegel@sdccd.edu

BF01: 3 PM Vpython Projects as a Central Theme in Engineering physics

Invited *– Martin S. Mason, Mt. San Antonio College, 909-594-5611, mmason@mtsac.edu*

Projects serve as an organizing principle for the first semester engineering physics course at Mt. San Antonio College. Students complete three major six week projects all of which require them to develop a computational model which will have predictive power. Vpython is used as the language of choice because of its visualization power and ease of use. The first project typically takes a topic from celestial mechanics. Past projects have included modeling orbital transfers, asteroid orbits and planetary landings. The second project has students make some measurements such as measuring the impulse curve for a solid rocket motor in a test stand and wind tunnel data for the rocket. From these measurements they develop a model that will allow them to predict the behavior of that object. For example, given that the previously measured rocket will be launched from a given angle with certain air conditions determine its trajectory. Student's models are then tested against the real performance of the model. In the final project students choose their own phenomena to measure and model.

BF02: 3:30 PM Study of Rockett-Wang Interatomic Potential for Growth Simulations

cancelled

BF03: 3:40 PM New Technologies for Teaching and Learning

Jeremy R. Wood, Hazard Community and Technical College, 6064873254, Jeremy.Wood@kctcs.edu

Participants will be shown how to use a new physics simulation and tutorial authoring software called Infinite Physics Simulator 2.0 for Windows and be shown the results of testing on the software at a 2 year college. The software focuses on four core areas: Optics, Vectors, DC Circuits and Electrostatics. Physics objects are inserted directly onto a page and behave like the real-world objects. Objects such as prisms, lenses, resistors, capacitors, batteries, point charges, and other objects are available from the objects toolbar. Ambient properties such as gravity and index of refraction can also be changed. Using the linear regression tool, entire labs can be performed on a variety of topics such as Coulomb's law, Ohm's law and more. The user can use physics objects along with their own text, graphics and animations to teach other areas of physics beyond the core. Students play tutorials using the free viewer version.

Session BG: Physics Research at HBCUs and MSIs

Sponsor: Committee on Minorities in Physics
Location: Maple
Date: Monday, July 30
Time: 3–5 PM

Presider: Daniel Smith, Jr., South Carolina State Univ., 803-536-7162, dsmith@scsu.edu

BG01: 3 PM Research Initiatives in the Physics Department at Howard Univ.

Invited *- Demetrius D. Venable, Howard Univ., 202-806-6245, dvenable@howard.edu*

The mission of the Department of Physics and Astronomy at Howard Univ. is to strive for a recognized level of national and international excellence in research and teaching in physics and to assure that students of African American descent and other underrepresented groups are given the opportunity to achieve their fullest potential in physics. The Department offers the PhD degree in Physics and is one of three departments that collaborate in the interdisciplinary program in Atmospheric Sciences. The approved major areas of research for the Department are: Atmospheric Physics, Condensed Matter Physics, Theoretical & High Energy Physics, and Spectroscopy & Optical Physics. In the past year the Department has been the lead, or a major participant, in a variety of national or international research initiatives including: WAVES_06; NASA-AMMA (Senegal); NOAA AEROSE (The Ronald H. Brown); NASA Satellite Measurements Validation activities; and the National Weather Service Consensus Reference Project.

BG02: 3:30 PM Plasma Physics Research at Florida A&M and Princeton

Invited – *Kyron M. Williams, Princeton Univ., 609-243-3623, kwilliams@pppl.gov*

Research in plasma physics has been ongoing at Florida A&M for more than 15 years. Through the Laboratory for Modern Fluid Physics (LMFP) and the Center for Nonlinear and Non-Equilibrium Aeroscience (CeNNAs) and now the Center for Plasma Science and Technology (CePaST) fundamental research on turbulence in plasma and hypersonic environments has evolved considerably from basic plasma physics research to include applications to fusion research and industry. Key findings such as a molecular dependence on transport parameters, evidence of turbulence universality, and evidence of characteristic frequencies of turbulence depending on molecular weight, have helped to motivate the need for a more microscopic description of turbulence. The applications of such an approach are useful in all environments where turbulence is known to exist. For this presentation, these key findings from work at FAMU as well as recent research at Princeton Univ. will be discussed.

BG03: 4 PM Analysis of Nitrogen Doped Diamond-like Carbon Thin Films Processed at Different Temperatures

Jason P. Gilchrist, North Carolina State Univ., 919-539-6325, jpgilchr@ncsu.edu

Elvira Williams

The current work was done on Nitrogen doped Diamonlike Carbon (DLC) thin films. These films were fabricated using a Plasma Enhanced Chemical Vapor Deposition (PECVD) Technique on Si [100] substrates that were heated to different temperatures as well as fabricated on unheated substrates.

Session BH: Educational Technology Demonstrations

Sponsor: Committee on Educational Technologies
Location: Oak B-C
Date: Monday, July 30
Time: 6–8 PM

Presider: Vern Lindberg, Rochester Inst. of Technology, 585-475-2546, vwlsps@rit.edu

BH01: 6 PM VPython Applications for Teaching Physics

Poster – Roberto B. Salgado, Syracuse Univ., 315-443-2061, salgado@physics.syr.edu

VPython, a real-time 3D graphics module for the Python programming language, provides a simple but powerful programming environment for physics educators and students. On the website listed below, we provide a small but growing collection of interactive visualizations and simulations along with their VPython source code that we have written for teaching physics. In the poster, we will demonstrate our examples in waves, kinematics, electromagnetism, relativity, tensor visualization, and nonlinear dynamics.*

*http://physics.syr.edu/~salgado/software/vpython/ also features a list of the growing community of VPython websites.

BH02: 6 PM Python Scripting Using the Open Source Physics Library

Poster – Craig C. Wiegert, Univ. of Georgia, 706-542-4023, wiegert@physast.uga.edu

The Open Source Physics project provides a full-featured Java class library for use in developing physics simulations and virtual demonstrations. Even with the many configurable Java program examples provided with the OSP library, the learning curve for Java development can be steep or time-consuming for curriculum developers or students. The Python language offers a alternative: a dynamically-typed interpreted language with a clear syntax. The Jython project allows Python programs to make full use of any Java libraries. I demonstrate examples of rapid prototyping of simulations using Python/Jython, which can then be compiled and distributed as Java applets.

BH03: 6 PM Creating Guided Inquiry Activities Using PhET Simulations

Poster – Trish J. Loeblein, Univ. of Boulder/ Evergreen High School, 303-982-5093, ploeblei@jeffco.k12.co.us

Kathy Perkins, Carl Wieman

Do you want to help your students make sense of Physics and Physical Science? The Physics Education Technology (PhET) Project has developed more than 60 simulations for teaching and learning introductory physics at the middle school, high school, and college levels. These research-based simulations create animated, interactive, game-like environments that are designed to engage students in active thinking, encourage experimentation, and help develop visual and conceptual models of physical phenomena, emphasizing their connections to everyday life. The simulations are free, and can be run from the PhET website (http://phet.colorado.edu) or downloaded to a local computer for off-line use. The PhET team has designed a set of guidelines that help teachers integrate the simulations into lessons using guided inquiry. This session will help you design effective, inquiry-based lessons using these guidelines to provide activities for students to construct their own understanding of physics and physical science ideas.

BH04: 6 PM Using Animated Textures to Visualize Electromagnetic Fields and Energy Flow

Poster – John W. Belcher, 617-253-4285, jbelcher@mit.edu

Carolann Koleci, Andreas Sundquist

The use of animated textures allows the visualization of the spatial structure and temporal evolution of vector fields at high spatial resolution. The "dynamic line integral convolution" method uses two time-dependent vector fields. The first of these vector fields determines the spatial structure to be displayed, and the second is a velocity field that determines the time evolution of the field lines of the first vector field. In electromagnetism, the velocity field is taken to be the ExB drift velocity of electric or magnetic monopoles, and the animation of the field structure shows the direction of the flow of electromagnetic energy. We discuss the utility of such animations when used in an educational setting. Supported under NSF CCLI # DUE-0618558.

Open source software available at http://web.mit.edu/viz/soft/

BH05: 6 PM Web Homework and Assessments with Physics Applets for Drawing (PADs) *

Poster – Scott W. Bonham, Western Kentucky Univ., 270-745-6196, scott.bonham@wku.edu

Web-based homework and assessments mainly utilize multiple choice and text inputs (including numbers). However, graphs and diagrams form an important component of may introductory physics curricula. The Physics Applets for Drawing (PADs) are a suite of Java Applets that allow graphical responses to questions, with automatic grading and optional feedback. They can be used to create line segment and polynomial graphs, free body diagrams and energy bar charts, ray diagrams, and graphical vector addition. PADs have been used as stand-alone applications and in WebAssign (http://webassign.net). This presentation will unveil new SCORM-compliant PADs packages, which will allow them to be used in almost all the major Learning Management Systems. More information can be found at http://www.wku.edu/pads.

* This work was supported by NSF CCLI grant DUE-0231353

BH06: 6 PM Math Animated, a Courseware of Calculus for Undergraduate Physics Students

Poster – Samuel Dagan, Tel-Aviv Univ., 972-3-6406117, dagan@post.tau.ac.il

A courseware, called "Math Animated," to be hosted at the web, based on a course called "Mathematical Introduction for Physicists," for undergraduate students at the Tel-Aviv Univ., has been developed. In addition to the text, examples, and exercises, the courseware takes advantage of the modern technology of interactive and animated graphics, which makes complicated concepts easy to understand. The graphics can be projected by the teacher in class, and accessed afterward at any time by the students. Interactivity and animation help the students to learn more effectively the material at their leisure. The courseware covers single and multi-variable calculus, containing over 110 interactive and animated graphics. Math Animated is technically based on non-proprietary open standards, developed at the Web Consortium (http://www.w3.org/), including the XML applications SVG (for graphics) and MathML (for mathematical expressions). This makes Math Animated accessible via the web without the need of any particular software.

BH07: 6 PM PSU/Schuylkill Physics and Astronomy Animations Project: What's New

Poster – Michael R. Gallis, Penn State/Schuylkill, 570-385-6053, mrg3@psu.edu

This poster provides an update on the Animations for Introductory Physics and Astronomy project at Penn State Schuylkill. This project was initiated to help students visualize aspects of 3-dimensional situations where traditional static drawings were seen as inadequate. The animations have been used to portray a wide variety of dynamical systems and processes for physics and astronomy topics typically presented in the advanced high school through introductory college level. This poster will present a selection of the more recent animations that have been created for this project. We will also discuss student response to the materials and a "virtual" Millikan Oil Drop experiment which uses artificial video and standard video analysis software. The animation collection can be found at http://phys23p.sl.psu.edu/phys_anim/Phys_anim.htm

BH08: 6 PM Non-Inertial Reference Frame Video Box

Poster – Thomas Dooling, UNCP, 910-521-6595, tom.dooling@uncp.edu

It is difficult for students to visualize the motion of objects in non-inertial reference frames, more specifically, a reference frame that is rotating. Objects appear to move under the action of the so-called "fictitious" forces such as the Centrifugal force or the Coriolis force. A very inexpensive (< $100) video camera (X10) is installed in an plastic box. The box is sealed with its own internal light source. The camera broadcasts via radio signals to a receiver attached to a television. As a result the box is free to move and rotate about the room. The student can see how the world looks from inside the reference frame of the box. If the box is rotated, the scene inside the box remains still. This box will be used to demonstrate the principle of a Foucault pendulum and the apparent centrifugal force on a mass connected to a spring.

BH09: 6–8 PM Using Simulations in College Physics II and Modern Physics

Poster – Karen A. Williams, East Central Univ., 580-310-5394, kwillims@mac.com

I will show how I use Franklin software (http://my.vbe.com/~ppeters/index.html) for electric field and potential plotting in General Physics II, an algebra based course. This software is free and is for Mac computers only. If time allows, I will also describe how I use ActivPhysics Online (http://wps.aw.com/) in Modern Physics. Students genuinely have a "light bulb" moment of understanding after using these gems.

BH10: 6 PM Open-Ended Questioning for Real-Time Formative Assessment in Advanced Physics Classes

Poster – Frank V. Kowalski, Colorado School of Mines, 303 273-3845, fkowalsk@mines.edu

Susan E. Kowalski

We demonstrate our use of open-ended questions for frequent in-class formative assessment to probe student understanding in advanced undergraduate physics courses. Previously, it has been difficult to incorporate into these classes many of the active learning and formative assessment techniques emerging as effective tools for increasing student learning. However, when each student (or group of students) is equipped with a tablet PC and uses Colorado School of Mines' free web-based tool (InkSurvey) to transmit his/her responses, one can pose open-ended questions during class. Student responses reveal understanding or misconceptions through words, sentences, paragraphs, sketches, equations, graphs, derivations, etc. The instructor receives an instantaneous compilation of web-based student responses. In addition to providing valuable data to the instructor, this real-time formative assessment also improves student metacognition and can be used for differentiated instruction. The courses utilizing this technique were: Intermediate Electromagnetism, and Electromagnetic Waves and Optical Physics.

*Sponsored by Michelle Strand

Session BI: Q&A with the AAPT Executive Officer

Location: Colony B-C
Date: Monday, July 30
Time: 6–8 PM

Presider: Toufic Hakim, AAPT

The AAPT Executive Officer answers participants' questions about AAPT future strategy and planning, organization, and visibility.

Session BJ: Crackerbarrel on Physics and Society Education

Sponsor: Committee on Science Education for the Public
Location: Imperial A
Date: Monday, July 30
Time: 6–7:30 PM

Presider: Jane Flood, Muhlenberg College, 484-664-3411, flood@muhlenberg.edu

Are you looking for ways to incorporate societal issues into a physics course? Join your colleagues to share questions and ideas in an informal discussion about how to accomplish this. A small number of people will make brief presentations on their successful activities, then the session will open for all to share and discuss. Information about presenters will be posted through the PHYSOC listserv prior to the meeting.

Session BK: Professional Concerns of Two-Year College Physics Faculty

Co-Sponsors: Committee on Professional Concerns
Committee on Physics in Two-Year Colleges
Location: Imperial G
Date: Monday, July 30
Time: 6–8 PM

Presider: Steven Siegel, San Diego Mesa College, 619-388-2629, ssiegel@sdccd.edu

Co-Presiders: Dean Hudek

Participants will interactively discuss matters of professional concern to Two-Year College Physics Faculty. Please come prepared to tell us your situation, exchange ideas, ask questions, offer solutions, etc.

Session BL: New Technologies for Teaching and Learning

Sponsor: Committee on Educational Technologies
Location: Imperial C
Date: Monday, July 30
Time: 6–8 PM

Presider: Michelle Strand, Southeast Comm College, 402-761-8288, mstrand@southeast.edu

BL01: 6 PM Bringing the Excitement of the Large Hadron Collider into Your Classroom: How QuarkNet is Helping

Kris Whelan, Lawrence Berkeley National Laboratory, 510-486-6610, kkwhelan@lbl.gov

With the approaching start-up of the Large Hadron Collider this year at CERN, it is critical to disseminate information to high school students and teachers. In support of that, QuarkNet held a week long workshop at Fermilab in July of 2007. Nineteen LHC Teacher Fellows were identified from existing QuarkNet centers across the United States and were trained during this program. Teachers developed curriculum and strategies that will be shared with physics teachers at local, state, regional and national meetings. The nineteen Fellows may be called upon as resources for the LHC project. I will give a summary of the workshop and will share general information about the LHC.

BL02: 6:10 PM International Research Opportunities (M-12) Through Web Browsers: The e-Lab Suite

Thomas J. Loughran, Univ. of Notre Dame, 574-631-3362, loughran.8@nd.edu

The already wide gulf between the science that pre-college students see and science as actually practiced threatens to widen further, even as U.S. workforce concerns and the need for a scientifically informed humanity make it clear that this gap needs to narrow. But the same Grid computing technology which accelerates advances in science may be harnessed to enable student participation in advanced science. e-Labs are grid-enabled online research environments putting access to the data and analysis tools from large international scientific collaborations in the hands of any student with browser access. Students are doing research with data from cosmic ray detectors, the CMS test beam, environmental sensing monitors from the LIGO-Hanford experiment, and soon from the ATLAS detector at the LHC and from RHIC's STAR detector. This e-Lab suite will continue to grow, and with it opportunities for students to experience research in a variety of cutting-edge scientific research contexts.

BL03: 6:20 PM Wii've Got Your Physics Right Here!

Laura M. Nickerson, Beaver Country Day School, 617-733-0227, physnicks@gmail.com

Did you know that you can buy a 3-axis accelerometer for about $40? Did you know that an increasing number of your students have such devices in their own homes or dorm rooms? The Nintendo Wii® video game is designed to make players more active participants. The Wii remote serves as a bowling arm, a golf club, a weapon, a steering wheel, or just about anything else that game developers can come up with. In WiiTennis, for instance, the player holds the Wii-mote as a tennis racket. When the ball comes at the player, the player hits the ball by swinging the Wii-mote. A hard swing will land the ball at the back of the court or possibly out-of-bounds, and a tap will drop the ball in the near court or possibly not clear the net. Positioning of the device happens through the use of infrared LEDs located above the television screen, while the strength of the shot is detected through data read out from the MEMS accelerometer through Bluetooth technology. These accelerometers are the same as are located in your laptop and that protect your hard drive from harm when dropped, but with the Wii's use of Bluetooth, we can access the readout and actually see the impulse from a tennis swing.

BL04: 6:30 PM The Transfer of Learning from Physics to Technology and Engineering Applications *

Roman Ya. Kezerashvili, New York City College of Technology, CUNY, 718-260-5277, rkezerashvili@citytech.cuny.edu

Our goal is to develop an innovative approach to enable students' studying technology and engineering to apply the concepts learned in physics to engineering problem-solving challenges and to facilitate students' transfer of knowledge from theory to engineering applications, thereby increasing student academic performance, retention, persistence, and graduation in fields of technology and engineering which continues to be a critical national, regional, and local problem. The approach has two primary and complementary foci that will facilitate students ability to transfer knowledge of physics to engineering applications: 1) To establish the laboratory as a primary learning tool in physics at an early point in students' academic careers so that students have a taste of the excitement of science and engineering research; 2) to demonstrate the efficacy of using e-learning and e-teaching through Blackboard system. To achieve the goals we are creating a virtual community of students and faculty as a vehicle for promoting the transfer of learning using e-learning and e-teaching mechanisms.

*Supported by U.S. Department of Education grant P120A060052

BL05: 6:40 PM Physics Bytes: Podcasting in the Physics Classroom

Russell Herman, UNC-Wilmington, 910-962-3722, hermanr@uncw.edu

As audio podcasting has grown and video podcasting is capturing the attention of more students, can physicists find uses for this new technology in the classroom? We describe some initial efforts at using studio and video bytes to enhance teaching of physics and mathematics.

BL06: 6:50 PM Video iPod Use in the Introductory Physics Classroom

William McNairy, Duke Univ., 919-660-2689, mcnairy@phy.duke.edu

For the past semester I have used the Video iPod technology in my introductory Physics course for Life Sciences Majors. The goal of this project has been to enrich the experiences of students in the course, not by replacing interactions, but by presenting them for review at a later time. Screen captures from a tablet PC have been linked to the audio from the classroom to create videos of course lectures. These have been posted to a course website under iTunes U from Apple. In addition, some demonstration videos and lab introduction videos have been posted to the site. I will share comments from the end-of-semester course survey and discuss possible future uses of this emerging technology.

BL07: 7 PM Using Contemporary Vision Diagnosis for Teaching Physics*

Dyan McBride, Kansas State Univ., 785-532-7167, dyanm@ksu.edu

Dean A. Zollman, Giuseppe Colicchia, Hartmut Wiesner

Wavefront abberometry [1] is a relatively new method for diagnosing defects related to vision. This application of basic physics can remove much of the subjective nature of an eye examination. As part of larger projects to prepare teaching materials on the application of physics to contemporary medicine, we are developing a series of lessons which help students learn about optics of the eye and wavefront techniques. The research-based instruction involves both hands-on and computer models in an interactive learning environment. The instructional materials are being developed in both English and German. Pilot test versions can be found at http://web.phys.ksu.edu/mmmm/eye and http://www.physik.uni-muenchen.de/didaktik/.

1. Giuseppe Colicchia and Hartmut Wiesner, "Measuring aberration of the eye with wavefront technology" *Physics Education* **41** 307-310 (2006).

*The U.S. development is supported in part by the National Science Foundation under grant DUE 04-27645

BL08: 7:10 PM An Item Response Analysis of Existing Concept Surveys

Jing Wang, Ohio State Univ., 614-247-4587, wang.870@osu.edu

Lei Bao

Understanding what physics concept tests measure is one of the important topics in physics education research. Issues such as the reliability, validity, and comparative scaling are widely researched. Most of the previous studies used classical test theory to analyze the physics tests. In our research, we use item response theory (IRT) to analyze the existing physics concept surveys. This can give us a different view of these frequently used assessment tools. We will report the detailed analysis results and discuss the methodology, the applicability, and implications of the method.

BL09: 7:20 PM Gender Differences in Using Voting Machine in Introductory Physics Courses

Albert H. Lee, Ohio State Univ., 614-247-4587, alee@mps.ohio-state.edu

Lei Bao, Pengfei Li, Neville W. Reay, Jing Wang

The Physics Education Research Group at The Ohio State Univ. has developed and tested a new methodology for using voting machines (VM) to enhance active learning in introductory physics lectures. In our experiment to test the effectiveness of the VM methodology, we observed interesting changes in gender differences between classes using and not using VM. This difference also changes with respect to the content topics and student population. We will discuss the results and possible implications.

BL10: 7:30 PM Using BlackBoard in an Introductory Algebra-based Physics Course

Sharon L. Rosell, Central Washington Univ., 509-963-2757, rosells@cwu.edu

This talk will outline a first attempt at introducing the use of BlackBoard in an algebra-based physics sequence. A commercial PowerPoint package and course cartridge were used in conjunction with the use of BlackBoard.

BL11: 7:40 PM Math Animated, a Courseware of Calculus for Undergraduate Physics Students

Samuel Dagan, Tel-Aviv Univ., 972-3-6406117, dagan@post.tau.ac.il

A courseware, called "Math Animated," to be hosted at the web, based on a course called "Mathematical Introduction for Physicists," for undergraduate students at the Tel-Aviv Univ., has been developed. In addition to the text, examples and exercises, the courseware takes advantage of the modern technology of interactive and animated graphics, which makes complicated concepts easy to understand. The graphics can be projected by the teacher in class, and accessed afterwards at any time by the students. Interactivity and animation help the students to learn more effectively the material at their leisure. The courseware covers single and multi-variable calculus, containing over 110 interactive and animated graphics. Math Animated is technically based on non-proprietary open standards, developed at the Web Consortium (http://www.w3.org/), including the XML applications SVG (for graphics) and MathML (for mathematical expressions). This makes Math Animated accessible via the web without the need of any particular software.

BL12: 7:50 PM Using Individual Response Cards in an Introductory Physics Course

Jeffrey S. Spear, United States Military Academy, 845-938-4545, hj1125@usma.edu

David J. Palazzo

We report significant conceptual learning gains subsequent to the implementation of a personal response system (PRS) in a calculus-based introductory physics course composed of nearly 900 non-physics majors. Normalized learning gains by concept on the Force Concept Inventory are measured both before and after the implementation of the personal response system. We observe statistically significant increases in conceptual gains on the FCI subsequent to the implementation of the PRS, and as compared to instructors who chose not to implement the PRS. We observe a linear correlation ($r = .67$, $p < .006$, $N = 15$) between the amount of peer instruction used and the average increase in normalized gain, g, before and after the use of peer instruction. However, we observe no relationship between an instructor's use of the PRS and their student's performance on quantitative problems measured using the course final examination.

* Sponsored by Bryndol Sones

BL13: 8 PM Undergraduates' Roles in Improving Education

Shannon A. Schunicht, Texas A&M Univ., 979-218-5764, mnemonicmind@alpha1.net

While in the Army, Mr. Schunicht was involved in a mid-air collision rendering him unconscious for three weeks. Everything had to be re-learned, as nursing actions were reported as having been displayed upon awakening from the extended unconsciousness (19 days). Studies in recovery brought about some pragmatic discoveries to compensate for the residual memory deficits. The most valuable discovery was having each vowel represent a mathematical sign, i.e. "a" for multiplication implying "@", "o" for division implying "over", "i" for subtraction implying "minus", "u" for addition implying "plus," and "e" implying equals". Most constants and variables are indeed consonants, e.g. "c" = "speed of light" and "R" = "Rate/time variable". **Note how addition letters may be added for intelligibility, but must be consonants- NO VOWELS! Examples will be shown of this techniques applicability to formula mnemonics by formulas presented by attendees.

Session BM: Introductory Undergraduate Physics Textbooks

Location: Imperial E
Date: Monday, July 30
Time: 6–6:40 PM

Presider: TBD

BM01: 6 PM Human Food Consumption: Non-equilibrium Thermodynamics for College Physics

Ulrich Zurcher, Cleveland State Univ., 216-687-2429, u.zurcher@csuohio.edu

Introductory physics texts focus mostly on closed systems, and illustrate the notion of equilibrium and non-equilibrium is illustrated by a mass moving in the gravitational potential energy. In contrast, biological systems [cells and organism] are open and thus exchange mass and energy with the environments. Biological systems are not in thermal equilibrium: they are in stationary non-equilibrium state. This requires that energy flows through the system, and entropy is produced in accordance with the second law of thermodynamics. This has profound consequences for the discussion of food consumption: one cannot treat the human body as a thermal engine as is frequently done in College Physics texts. We show that an object in free fall and subject to a velocity-dependent air resistance has many of the characteristics of an open system; the case when the particle falls at the terminal speed corresponds to the steady state of the system.

BM02: 6:10 PM More Physics that Textbook Writers Usually Get Wrong

Robert P. Bauman, UAB, 205-951-0479, robertbauman@bellsouth.net

Earlier articles, appearing in *TPT* in 1992, pointed out that work is defined, by the needs of thermodynamics, as a mode of energy transfer between a system and its surroundings; "heat" has too many "technical" meanings to be useful except as a rough association; tension must not be confused with a force; and the factitious forces (defined for a specific purpose) are important but must not be confused with central forces. Problems continue. The familiar tablecloth pull, Bernoulli's equation, and the conservation laws are typically analyzed at the grade-school non-physics level, and we analyze gyroscopes with a method for which we laugh at students.

BM03: 6:20 PM Teaching Without a Text

Beth Thacker, Texas Tech Univ., 806-742-2996, beth.thacker@ttu.edu

A talk about how textbooks are a version of telling, just like lectures, and how they minimize critical thinking, instead of helping develop it. An argument that the use of hand's-on, laboratory-based curricula and materials that do not use (or can be used without) a text are more effective at promoting critical thinking than the use of a text.

BM04: 6:30 PM Learning Critical Thinking Through Astronomy

Joe Heafner, Catawba Valley Community College, 828-464-1055, heafnerj@sticksandshadows.com

An introductory astronomy textbook and course are presented that hopefully correct the primary deficiency in existing textbooks and courses, namely that reasoning and critical thinking are not present. Built around critical thinking, inquiry activities, and integrated assessments, this approach allows topics that are traditionally omitted to be included. The textbook should be ready by 2012.

Session BN: PER: Surveys and Other Assessments

Location: Cedar
Date: Monday, July 30
Time: 6–8 PM

Presider: Harold T. Stokes, Brigham Young Univ., 801-422-2215, stokesh@byu.edu

BN01: 6 PM Does Feedback Improve Scientific Writing Quality Independent of Grade Motivation?

Dedra Demaree, College of the Holy Cross, 614-668-3321, demaree.2@osu.edu

Gordon Aubrecht, Lei Bao

In an ongoing project to study writing to learn in a quantitative fashion, we investigated the effect of feedback on writing during winter quarter, 2006. Claims in the literature state that when writing is used as formative assessment, students learn how well they understand the content, and thus, writing can help learning. However, no qualitative studies support this claim. In physics 104 ("The World of Energy") at The Ohio State Univ., students watch weekly videos then turn in full-page summaries as part of their homework grade. These are given points if completed, but are not graded for quality. In this study, we gave feedback to some students on the quality of their writing and the coherence of their summaries. We were then able to do a quantitative test of whether the feedback impacted the witting in the absence of the grade as an external motivator.

BN02: 6:10 PM Scientific Reasoning and Metacognition: Results of an Exam Reflection Survey

Craig C. Wiegert, Univ. of Georgia, 706-542-4023, wiegert@physast.uga.edu

Many students in introductory physics lack effective learning strategies for such a course. This is true even of students who have taken many previous math and science courses. Encouraging and modeling effective strategies is often not enough to convince students who have succeeded in the past with other study methods requiring less effort. For these students, evidence of their peers' "secrets of success" may be more convincing. To that end, I surveyed an introductory mechanics class after their first exam, on the topic of their exam study strategies. I then presented the survey data in class, organized by exam letter grade, and asked the students to interpret the results. This simple and practical example provided an opportunity to discuss several aspects of scientific reasoning, including the distinction between induction and deduction, correlation versus causation, and binning bias.

BN03: 6:20 PM Using Clickers in Upper-division Physics Courses: What Do Students Think?

Katherine Perkins, Univ. of Colorado, 303-492-6714, Katherine.Perkins@colorado.edu

Chandra Turpen, Noah Finkelstein, Christopher Keller

The use of clickers and concept tests in introductory courses in physics is becoming more and more popular among faculty at institutions across the United States; however, the use of these tools in upper-division physics courses is more limited. At the Univ. of Colorado at Boulder, a handful of faculty have started incorporating these teaching approaches and tools into upper-division courses. In this talk, we report on students' response to the use of clickers in these upper-division courses. We examine how useful and enjoyable students find the clickers/concept tests for their learning compared to other aspects of the course. Preliminary results show that students in an upper-division course taught by a non-PER faculty member are overwhelmingly supportive of the use of clickers, with 85% recommending or strongly recommending their use. We report on how this response varies with the course-level (sophomore through senior) and how the clickers were implemented in the classroom. Finally, we report on students' perception of the characteristics of clicker use they find most valuable for their learning.

BN04: 6:30 PM Peer Instruction: Clickers vs. Flashcards, Is There a Difference? *

Nathaniel Lasry, John Abbott College, 514-865-5820, lasry@johnabbott.qc.ca

Peer Instruction is a frequently cited Interactive Engagement approach which engages students through the use of in-class ConcepTests. Although well documented at Harvard, data concerning its effectiveness in other populations—such as 2-year college students—is scarce. A study of Peer Instruction conducted in a 2-year college classroom is presented. In this study, two main empirical questions are addressed. 1) Is it fair to assume that what works at Harvard can work in a college classroom? In measurable terms, does the effectiveness of Peer Instruction depend on the student's before instruction proficiency level? 2) Peer Instruction can be carried out with clickers or flashcards. Is there a measurable difference in learning between students using clickers and flashcards? Results and instructional implications will be discussed.

*This study was made possible through the support of the Programme d'Aide a la Recherche en Enseignement et en Apprentissage (PAREA)

BN05: 6:40 PM A New Clicker Methodology for Introductory Physics Lectures *

Poster – Neville W. Reay, The Ohio State Univ., 614-292-6956, reay@mps.ohio-state.edu

Lei Bao, Albert H. Lee, Pengfei Li

It is well received in the research community that learning is context dependent. Based on existing work, the Physics Education Research Group at The Ohio State Univ. has developed and tested a new methodology for using clickers to enhance active learning in introductory physics lectures. Every concept is presented in a series of questions, each with different surface features. Two types of question sequences were tested in four electricity and magnetism quarters of calculus-based introductory physics. Students in lecture sections using clickers consistently exhibited higher scores on concept inventories and common examination questions than students in non-clicker lecture sections. Clickers also were of particular benefit for female students. Surveys indicated that students enjoyed using VM, believed that VM helped them learn, and preferred question sequences over single questions on each topic. Detailed results, examples, and snapshots of ready-to-use curriculum materials will be presented.

We wish to thank the National Science Foundation under grant DUE 0618128 and The Ohio State Univ. for jointly funding this research.

BN06: 6:50 PM Designs and Evaluations of Two Types of Clicker Question Sequences

Pengfei Li, The Ohio State Univ., 614-312-5769, li.427@osu.edu

Neville Reay, Albert Lee, Lei Bao

At The Ohio State Univ., clicker, an in-class polling system, was assessed in three electromagnetism quarters of a year-long introductory class. Two different types of question sequences: "easy-hard-hard" sequences and "rapid-fire" sequences were used during this test. In this presentation, methods for designing these two types of question sequences will be discussed. Results on the effectiveness of these two types of question sequences on students at different academic performance levels will also be presented.

BN07: 7 PM Using Cluster Analysis to Group Written 2-D Kinematics Responses

R. Padraic Springuel, Univ. of Maine, 207-581-1038, r.springuel@umit.maine.edu

Michael C. Wittmann, John R. Thompson

We use clustering, an analysis method not presently common to the physics education research community, to group and characterize student responses to written questions about two-dimensional kinematics. Typically, clustering is used to analyze multiple-choice data; we analyze free response data that includes both sketches of vectors and written elements. Our primary goal is to describe the methodology itself; we include a brief overview of relevant results. We find that cluster analysis leads to identifiable groups of responses that make sense to us as physics education researchers and also provide additional information about unexpected differences between groups of student responses. Sponsored in part by NSF REC-0633951.

BN08: 7:10 PM Revised Methods for Analyzing the Force and Motion Conceptual Evaluation

Trevor I. Smith, Univ. of Maine, 207-581-1010, Trevor.I.Smith@umit.maine.edu

Michael C. Wittmann, Tom Carter

The Force and Motion Conceptual Evaluation is a well-known assessment tool for evaluating learning in introductory mechanics.[1] Many researchers and educators have used the template developed by Wittmann[2] to analyze the results of pre- and post-instruction assessment. We have found several shortcomings with this template. We propose three modifications: 1) redefined clusters of questions that group by question content and presentation; 2) consideration of students' mental resources activated for incorrect responses; and 3) correlation of responses to various questions to determine students' modes of thinking. We present our new methodology and give examples of information it uncovers. (Supported in part by NSF DUE-0510614.)

1. R. K. Thornton & D. R. Sokoloff, *Am. J. Phys.* **66**, (1998).
2. available at: http://perlnet.umaine.edu/materials/

BN09: 7:20 PM Critical Thinking and the Learning of Force and Motion Concepts

Susan E. Ramlo, The Univ. of Akron, 330-972-7057, sramlo@uakron.edu

Giancarlo and Facione (2001) describe critical thinking as a self-regulatory, recursive process that allows a person to form judgments about what to believe. This description is similar to processes described in the development of conceptual understanding by Posner, et al, (1982) and Staver (1998). Previous studies, such as Ramlo (2004), indicate that linear regression models that include covariates of age, prior physics course-work, and Force and Motion Conceptual Evaluation (FMCE) pretest score accounted for no more than 30% of the variance (R2) in the dependent variable of post-test FMCE score. By including critical thinking skill levels, determined by the SOLO Taxonomy (Chan, Chan & Hong, 2002) or Holistic Critical Thinking Scoring Rubric (Facione & Facione, 1996), similar linear regression models accounted for up to 52% of the variance in the FMCE post-test score. Implications of these results are discussed.

BN10: 7:30 PM Constructivism and Science Anxiety I: Questionnaires and Interviews

Jeffry V. Mallow, Loyola Univ. Chicago, 773-508-3546, jmallow@luc.edu

Helge Kastrup

We have embarked on a project to delineate the components of successful constructivist science pedagogy, and to distinguish it from constructivist assumptions regarding the nature of science. We are especially concerned about what role some of these assumptions might play in undercutting the pedagogy itself: driving students, especially females, away from science. As a first step, we are testing whether some constructivist beliefs are correlated with science anxiety and avoidance, especially among females. Our binational research group[1,2] has developed a new Science Attitudes Questionnaire, for use in tandem with the well-known Science Anxiety Questionnaire. We have also developed an interview protocol for use with subsets of our American and Danish cohorts.

1. Loyola Univ. Chicago: Fred Bryant, Psychology; Nelda Hislop, Education; Jeffry Mallow, Physics; Rachel Shefner, Center For Science and Mathematics Education; Maria Udo, Physics
2. Copenhagen Day and Evening Seminary: Helge Kastrup, Mathematics and Science; Jan Roennow, Pedagogy and Psychology

BN11: 7:40 PM Constructivism and Science Anxiety II: Study Results

Helge Kastrup, Copenhagen Day and Evening College of Education, 011 45 45 82 28 06, Helge.Kastrup@skolekom.dk

Jeffry V. Mallow

Our binational research group (see previous paper) administered the new Science Attitudes Questionnaire together with the Science Anxiety Questionnaire to Loyola Univ. Chicago science and non-sience majors, education majors, Chicago public school teachers, and foreign students studying science (in English) at a Danish university. The questionnaires were translated and administered to first- and second-year Danish gymnasium science and nonscience students, teacher training students, and university students studying introductory and advanced science. We also conducted structured group interviews with a subset of our cohort. We have analyzed preliminary data for correlations between constructivist views of science as measured by the Science Attitudes Questionnaire, and anxiety as measured by the Science Anxiety Questionnaire. We have also investigated correlations with gender and course of study.

BN12: 7:50 PM Influencing Student's Attitudes and Expectations in Introductory Physics

Jeff Marx, McDaniel College, 410-386-4619, jmarx@mcdaniel.edu

Karen Cummings

To gauge the impact of instruction on students' general expectations about physics and their attitudes about problem-solving, we administered two different, but related, survey instruments to students in a two semester sequence of introductory, calculus-based physics at McDaniel College. The surveys we used were the Maryland Physics Expectation Survey (MPEX) and the Attitudes about Problem-Solving Survey (APSS). With both survey instruments we found that McDaniel College students' overall matched responses were more "expert-like" after the first and second semesters. All of the students to whom we administered the MPEX and a significant sub-group to whom we administered the APSS realized these improvements without experiencing any explicit instructional intervention aimed at improving attitudes or expectations. These results contrast with much of the previously reported findings in this area.

Session BO: Crackerbarrel on Retention of Minority Students

Sponsor: Committee on Minorities in Physics
Location: Maple
Date: Monday, July 30
Time: 8–9 PM

Presider: Daryao Khatri, Univ. of the District of Columbia, 202-274-5570, dkhatri@udc.edu

Session BP: Professional Concerns of High School Physics Faculty

Co-Sponsors: Committee on Professional Concerns
Committee on Physics in High Schools
Location: Imperial F
Date: Monday, July 30
Time: 8–9:30 PM

Presider: Wayne Fisher, Myers Park H.S., Charlotte, NC, 704-343-5800 ext. 541, w.fisher@cms.k12.nc.us

Co-Presider: Dean Hudek

Participants will interactively discuss matters of professional concern to High School Physics Faculty. Please come prepared to tell us your situation, exchange ideas, ask questions, offer solutions, etc.

Session BQ: What Are the Criteria for Textual Material Suitable for a First Course in Physics?

Sponsor: Committee on Physics in High Schools
Location: Imperial G
Date: Monday, July 30
Time: 8–9:30 PM

Presider: John Hubisz, North Carolina State Univ., 919-362-5782, hubisz@unity.ncsu.edu

This will be an open discussion on how the currently available texts stack up.

Session BR: Crackerbarrel on Physics on the Road Handbook

Sponsor: Committee on Science Education for the Public
Location: Imperial A
Date: Monday, July 30
Time: 8–9 PM

Presider: Patricia Sievert, Northern Illinois Univ., 815-234-8355, sievert@physics.niu.edu

Come help the members of the Committee on Science Education for the Public establish an online handbook to encourage and support those who wish to begin or expand their outreach efforts by taking physics on the road. Your input is needed and welcomed whether you are an experienced outreach professional or just curious about the project!

Session BS: Professional Concerns of Instructional Resource Specialists

Co-Sponsors: Committee on Professional Concerns
Committee on Apparatus
Location: Imperial B
Date: Monday, July 30
Time: 8–10 PM

Presider: Dean Hudek, Brown Univ., 401-863-2062, Dean_Hudek@Brown.edu

Co-Presiders: Dale Stille

Participants will interactively discuss matters of professional concern to people who work in demonstration areas, instructional laboratories, resource centers, etc. Please come prepared to tell us your situation, exchange ideas, ask questions, offer solutions, etc.

Session BT: Outline Courseware: Learning Outcomes, Marginal Costs and New Directions

Sponsor: Committee on Educational Technologies
Location: Imperial C
Date: Monday, July 30
Time: 8–8:40 PM

Presider: Gerald W. Meisner, UNC Greensboro, 336-334-4217, gerald.meisner@gmail.com

BT01: 8 PM Modeling in a Virtual Laboratory: Cognitive and Affective Learning Outcomes

Gerald W. Meisner, UNC Greensboro, 336-334-4217, gerald.meisner@gmail.com

Harol Hoffman

A cohort of 22 students carried out "classwork" of an introductory mechanics course in a highly interactive virtual lab environment. We find a sizeable increase in the modified Hake for these students when compared to traditional learners. Results of student responses to questions dealing with transferability of equipment familiarity and lab skills from virtual to physical lab as well as questions dealing with other aspects of online learning will be presented.

BT02: 8:10 PM Post-processing in WebAssign for the Automated Grading of Lab Assignments

Peter A. Knipp, Christopher Newport Univ., 757-594-7827, pknipp@pcs.cnu.edu

Online homework systems are popular because they provide instant feedback, eliminate manual grading, and reduce "bad" collaboration. For most of these systems the grading algorithm involves the straightforward comparison of the student's answer with a value specified by an answer key. However in lab settings this paradigm is less appropriate for manifold reasons, such as the presence of experimental uncertainty and the nonuniqueness of "good" data. Here I discuss an alternate method for automated lab grading, which involves the use of "postprocessing", a capability of WebAssign that enables, for instance, the calculation of chi-squared, the standard quantitative measure of the agreement between a theoretical model and a set of experimental data. These calculations facilitate an awarding of grades based on the "quality" of students' data, and it is even possible to process large datasets that are collected by systems such as PASCO's DataStudio and Vernier's Logger Pro.

BT03: 8:20 PM Using Online Forum to Foster Interaction Outside Classroom

Lili Cui, Univ. of Maryland–Baltimore County, 410-455-2535, lili@umbc.edu

Eric C. Anderson, Lei Bao

Blackboard is the course management system used at Univ. of Maryland–Baltimore County. The discussion board in Blackboard allows students and teachers to openly communicate with each other outside of the classroom. This function was implemented in large enrollment algebra-based and calculus-based introductory physics courses. Students' participation and activities are logged in the database. Statistical analysis shows a strong correlation between students' forum participation and their course performance. Quantitative and qualitative feedback from students about using the forum was also collected and will be discussed.

BT04: 8:30 PM LHC Online and Masterclasses

Kenneth Cecire, Hampton Univ., 757-728-6533, ken.cecire@hamptonu.edu

In November 2007, the Large Hadron Collider (LHC) at CERN is scheduled to see first beam. Are we ready? LHC Online is a developing virtual center where students and teachers can find data-based activities related to the LHC; premier among these are Masterclasses in particle physics.

Session BU: AAPT Planning

Sponsor: Committee on Programs
Location: Colony B-C
Date: Monday, July 30
Time: 8–10 PM

Presider: Toufic Hakim, AAPT

EO and members of the Planning Group discuss AAPT's future proposed goals and objectives and engage attendees in conversations regarding related issues and implementation.

Session BV: Integrating Computation into the Curriculum

Sponsor: Committee on Physics in Undergraduate Education
Location: Oak B-C
Date: Monday, July 30
Time: 8–10 PM

Presider: Wolfgang Christian, Davidson College, 704-894-2322, wochristian@davidson.edu

BV01: 8 PM Computation in the Paradigms Curriculum at Oregon State Univ.

Invited *– David H. McIntyre, Oregon State Univ., 541-737-1696, mcintyre@ucs.orst.edu*

Paradigms in Physics is a novel upper-division physics curriculum developed at Oregon State Univ. The junior year comprises 10 modular courses, each focused on a specific paradigm or class of physics problems that serves as the centerpiece of the course and on which different tools and skills are built. A variety of computational examples and exercises are used throughout the courses. Our students are comfortable with computational techniques and tools since they take a required introductory computational physics course that also acts as a gateway for our Computational Physics degree program. We use Maple, Mathematica, Java, and other software packages to help students do calculations, visualize graphics, and perform simulations. In particular, we have developed a Java version of a program to simulate Stern-Gerlach spin 1/2 experiments that forms an integral part of our first quantum mechanics Paradigm course. This and other examples from our curriculum will be presented.

BV02: 8:30 PM Fun and Learning with Physics Simulations

Invited – *Fu-Kwun Hwang, Taipei, Taiwan, hwang@phy.ntnu.edu.tw*

Students learn physics and become excited about physics by constructing models of the real world. This modeling involves making assumptions and approximations about important physical processes, estimating numerical values, and testing models to see how well the model predicts the observed behavior of real systems. We have developed hundreds of physics simulations to help students gain a deeper understanding of physics concepts. In addition to running these simulations, users can view the physics model behind the simulation, modify the model, and generate new simulations to test their own model. We find that students who user our simulations to visualize the complex systems enhancing their comprehension of the underlying physics concepts. NTNU simulations are freely available on NTNU JAVA website (http://www.phy.ntnu.edu.tw/ntnujava/).

BV03: 9 PM Developing a Mobile Environment for Teaching High Performance Computational Physics

Invited – *David Joiner, Kean Univ., 908-737-3427, djoiner@kean.edu*

Robert Panoff

Problems in computational physics are becoming increasingly complex, as it becomes more common for applications to include multi-physics, asymmetric conditions, and problems that change over a wide range of scales. The resources required to tackle these problems tend to be made up of large parallel machines, either through dedicated parallel machines, clusters of workstations, or distributed processes. Teaching students about the architectural and algorithmic issues in high performance computing (HPC) requires that students and faculty have access to three things: the hardware, the software, and curriculum. We have developed a platform for teaching HPC that addresses these issues by combining a portable low-cost cluster (LittleFe) with an operating system designed for easy creation of parallel clusters (the Bootable Cluster CD) and a library of computational science education resources (the Computational Science Education Reference Desk). Applications to teaching Physics will be presented.

BV04: 9:30 Modeling with Easy Java Simulations

Poster – Wolfgang Christian, Davidson College, 704-894-2322, wochristian@davidson.edu

Mario Belloni, Francisco Esquembre

The premise of Easy Java Simulations (Ejs) modeling is that when students are not actively involved in modeling they lose out on much of what can be learned from computer simulations. Although the modeling method can be used without computers, the use of computers allows students to study problems that are difficult and time consuming, to visualize their results, and to communicate their results with others. Ejs is a free open-source Java application that simplifies the modeling process by breaking it into activities: (1) documentation, (2) modeling, and (3) interface design. The Ejs program and examples of models will be available on CD. Ejs models, documentation, and sample curricular material can also be downloaded from Open Source Physics and Easy Java Simulations websites: http://www.opensourcephysics.org http://www.um.es/fem/Ejs Partial funding for this work was obtained through NSF grant DUE-0442581.

BV05: 9:30 PM Computational Exercises for Intermediate Physics Courses

Poster – David M. Cook, Lawrence Univ., 920-832-6721, david.m.cook@lawrence.edu

During the past two decades, numerous computational exercises have been added to assignments in intermediate-level courses in mechanics, electromagnetic theory, and quantum mechanics at Lawrence Univ. Favorite exercises focus on the large-amplitude pendulum (numerical solution of ODEs), normal modes of coupled systems (eigenvalues and eigenvectors), on- and off-axis electrostatic potentials (symbolic and numerical integration), Legendre polynomials (symbolic differentiation), quantum energy levels (numerical solution of ODEs), and quantum matrix elements (symbolic integration). We aim as much to develop an appreciation for and some skill in the use of symbolic, numerical, and graphical computational tools as to use those tools to address difficult problems that can be solved only by computational means. Thus, the exercises often address problems that can be solved—though perhaps tediously—by hand.

Curricular development at Lawrence has been supported by the W. M. Keck Foundation, the National Science Foundation, and Lawrence Univ..

BV06: 9:30 PM Introducing Wavelet Analysis to Physics Students using Atmospheric Data

Poster – Joseph J. Trout, Drexel Univ. / Sun Microsystems, 610-348-6495, joetrout@comcast.net

Fourier Analysis is an important and interesting topic to use for analyzing data and understanding oscillating systems. It is not the only tool available and does extract all the information available about the oscillating systems from data streams of observations. Wavelet transforms contains spectral information at different scales and locations of observed data. Wavelet transforms can provide information about the intensity of the frequencies at specific locations or time. This provides information about frequency changes and transition regions in data streams. This paper introduces wavelet analysis and Fourier analysis to physics students, using atmospheric data.

BV07: 9:30 PM Integrating Computation into the Curriculum

Poster – Douglas Allen, Dordt College, 712-722-6306, dallen@dordt.edu

In September 2006, a meter-sized object was temporarily captured by the Earth's gravity. Designated 6R10DB9, the object will make three orbits around the Earth before leaving geocentric orbit, according to the Jet Propulsion Laboratory's HORIZONS solar system data and ephemeris computation service (http://ssd.jpl.nasa.gov/horizons). This event provided an excellent case-study for an upper-level undergraduate classical mechanics course. The students used a Mathcad four-body (Sun, Earth, Moon, and 6R10DB9) simulation to reproduce the object's path and examine its dynamics. Initial positions and velocities were downloaded from the HORIZONS service and integration was performed using a fourth-order Runge-Kutta scheme. The sensitivity to initial conditions was examined along with a determination of the lunar gravitational influence. It was found that the Moon's presence causes 6R10DB9 to orbit the Earth three times rather than once. Coupling the Mathcad program with HORIZONS data allows numerous other potential applications for physics and astronomy classes.

BV08: 9:30 PM Scientific Reasoning

Poster – Brian K. Clark, Illinois State Univ., 309-438-5502, bkc@phy.ilstu.edu

Most students at Illinois State Univ. must take three science courses to complete their general education requirements. One of the many courses that students can choose to meet the requirement is Chaos and Complexity. The content of the course can be instructor specific, but generally includes topics from non-linear dynamics, chaos, fractals, cellular automata, control, and synchronization. My section is designed to place a heavy emphasis on students learning from and producing graphs instead of reliance on equations. We want students to leave the course with a positive impression of physics and show a significant increase in their science literacy. Students generally express positive impressions about physics after taking this course, but has there been a significant increase in their science literacy? In this presentation, I compare student test performance on graph related questions to more traditional equation related questions in an attempt to determine the change in science literacy.

BV09: 9:30 PM Integrating Computation into the Curriculum

Poster – Javier E. Hasbun, Univ. of West Georgia, 678-839-4092, jhasbun@westga.edu

At the Univ. of West Georgia physics department students have the option of enrolling in a computational physics course that makes use of Fortran, Matlab, Maple, and Latex.[1] Offerings of similar courses at various institutions appears to be a national trend. Next, we need to practice and employ learned computational concepts in upper level physics courses. I will present the approach I have taken in incorporating Matlab into a classical mechanics textbook.[2] While the analytic approach is retained, the computational environment is blended with Matlab scripts. For students who have previously enrolled in a computational physics course, this enhances the course's key concepts. For students without a computational background, exposure to the use of computational physics in classical mechanics is essential without the need to become experts in programming.

1. D. M. Cook, *Computation and Problem Solving in Undergraduate Physics* by David M Cook.
2 . To be published, Jones and Bartlett Publishers.

Session BW: PER: Student Understanding of Topics in Physics & Tas

Location: Cedar
Date: Monday, July 30
Time: 8–10:10 PM

Presider: Randolph Peterson, Univ. of the South, 931-598-1550, rpeterso@sewanee.edu

BW01: 8 PM "The Concept of Color" of Middle School Science Teachers

Seongeun Lee, Seoul National Univ., 82-17-311-2830, aqua0202@snu.ac.kr

SeongEun Lee, Sungmuk Lee

The purpose of this study is to find out the concept of color of middle school science teachers. We developed the questionnaire which composed of objective and subjective details for searching their different thoughts fully. The questionnaire is composed of 'color name, structure of eyes, the theory of color, color of objects, the change of color (dispersion, composition of light, composition of pigment)'. we could get an effective test about color since the teachers solve multifarious problems consists of photos and pictures. Therefore, we could get the meaningful results through the various analyses of the answers. Through this study, we could find out the concept of color of science teachers and it can lead the science teachers to the professional. We also suggest that results of this study be used to the teacher training to teach the color scientifically.

BW02: 8:10 PM Student Understanding of Kinematics Graphs in Algebra- and Calculus-based Mechanics Courses

Michael E. Loverude, California State Univ. Fullerton, 714-278-2270, mloverude@fullerton.edu

Steve Kanim, Luanna G Ortiz

As part of an NSF-funded curriculum development project, we have developed and tested a series of laboratory exercises for the introductory mechanics course. Our aim has been to adapt instructional strategies developed in the context of the calculus-based course to algebra-based courses. In the context of this work, we have examined student understanding of kinematics graphs in these two courses at CSUF. We will describe student responses and provide comparisons. Supported in part by NSF grant DUE 0341350.

BW03: 8:20 PM Will Students Construct a Free-Body Diagram for this Problem?

David R. Rosengrant, Rutgers, The State Univ. of New Jersey, 301-523-562, rosengra@eden.rutgers.edu

Eugenia Etkina, Alan Van Heuvelen

Our previous work has shown that students will construct free-body diagrams (FBDs) to help solve exam problems when they are in a representation rich course. This means that the instructor emphasizes multiple representations in all aspects of the course; large room meetings, problem solving sessions, and laboratory sections. However, do certain features of a problem further affect whether or not students may construct FBDs to solve problems? We found a pattern in one of our previous studies that showed a relationship between features of a problem and the number of students who constructed an FBD for that problem. For example, if the question asked students to solve for a magnitude of force as opposed to acceleration, time, etc., then more students constructed an FBD and conversely if there was a picture associated with a problem then fewer students constructed an FBD. In this follow-up study, we further investigate these two relationships.

BW04: 8:30 PM An Investigation Into Student Understanding of Longitudinal Standing Waves

Jack Dostal, Montana State Univ., 406-994-3382, dostal@physics.montana.edu

Students often have difficulty understanding the nature of longitudinal standing waves, especially in air columns where the medium is not visible. Instructors rely on analogies to transverse standing waves, but students often misinterpret those analogies. After instruction, students can usually pattern-match the right resonances to the right tube, but commonly have difficulty describing the longitudinal standing waves present. To get a sense of the difficulties students have with standing waves in air columns, we have developed the Standing Wave Diagnostic Test (SWDT), a 22-question multiple-choice instrument. Using information from the SWDT and student interviews, we have also developed a research-based tutorial designed to teach the basics of longitudinal standing waves in the context of sound. The SWDT has been used with several hundred introductory college physics students, both with and without the tutorial intervention. Results from that investigation will be presented in this talk.

BW05: 8:40 PM Facilitating Student Understanding of Motors in an Everyday Context *

Jacquelyn J. Haynicz, Kansas State Univ., 785-532-7167, haynicz@phys.ksu.edu

Research has shown that students can be motivated to learn science by demonstrating its connection to everyday life.[1] Here, we investigate students' understanding of some everyday electrical devices. In Phase I of the research, reported previously,[2] we found that students are interested in learning about a wide range of electrical devices, but they tend to focus on usability rather than function. Therefore, we chose to investigate students' understanding of the motor in a simple blender. We first probed their initial understanding of how a blender worked and then introduced a series of hands-on demonstrations to scaffold their understanding. Teaching/learning interviews with students from different levels of introductory physics were conducted in the summer of 2005 and the spring of 2007. We describe students' progression through the teaching/learning interview and the impact of the demonstrations on student understanding of the blender.

1. P.R. Pintrich, Schunk, D., *Motivation in Education: Theory, Research and Application* (Merrill Prentice-Hall, Columbus, OH, 1996).
2. J. J. Haynicz, P.R. Fletcher, and N. S Rebello, *College students' ideas about some everyday electrical devices*. Paper presented at the National Association for Research in Science Teaching Annual Meeting, San Francisco, CA, 2006.

*This work is supported in part by National Science Foundation Grant REC-0133621

BW06: 8:50 PM Studying Student Reasoning About Energy Diagrams

Jeffrey T. Morgan, Univ. of Northern Iowa, 319-273-2290, jeff.morgan@uni.edu

Energy diagrams are used throughout many advanced undergraduate physics courses. Previous research on quantum tunneling [1] revealed that students had difficulty interpreting the standard square-barrier energy diagram often used to describe quantum tunneling. To further probe these challenges, we have begun a series of interviews with sophomore-level physics students in a modern physics course, asking them for their interpretations of the various energy diagrams they encounter during their class. We discuss preliminary results from these interviews, and what they suggest are common representational challenges encountered by physics students in a modern physics course.

1. J. T. Morgan, "Investigating How Students Think About and Learn Quantum Physics: An Example From Tunneling," Ph.D. dissertation, Univ. of Maine (2006).

BW07: 9 PM Interpretations of Entropy Among Advanced Undergraduates Across Disciplines *

Brandon R. Bucy, The Univ. of Maine, 207-944-1481, brandon.bucy@umit.maine.edu

We have developed diagnostic questions to assess student understanding of entropy and the Second Law of Thermodynamics in the context of ideal gas processes. We have administered these questions to upper-level undergraduates in classical thermodynamics, statistical mechanics, thermal physics, physical chemistry, and chemical engineering thermodynamics. Our investigation has illuminated discipline-specific reasoning patterns. Different student populations tend to emphasize either the thermodynamic or the statistical interpretation of entropy. Both approaches present students with advantages as well as hurdles to a complete understanding of the concept. The statistical interpretation appears to be preferred by students, but is often employed in an incomplete manner. Similarly, reliance on a simplified thermodynamic interpretation is also associated with specific student difficulties. Populations that have a strong grasp of both interpretations perform better and are able to use the approach that provides the most effective solution to any given problem.

*Supported in part by NSF Grant #PHY-0406764

BW08: 9:10 PM Should We Teach the Bohr Model?

S.B. McKagan, Univ. of Colo., 303-492-7815, mckagan@colorado.edu

K. K. Perkins, C.E. Wieman

Some education researchers have claimed that we should not teach the Bohr model of the atom because it inhibits students' ability to learn the true wave nature of electrons. Although the evidence for this claim is weak, many in the physics education research community have accepted it. We present results from a study designed to test this claim by developing curriculum on models of the atom, including the Bohr and Schrödinger models. We examine student descriptions of atoms on final exams in reformed modern physics classes using various versions of this curriculum. We find that if the curriculum does not include sufficient connections between different models, many students still have a Bohr-like view of atoms, but using an improved curriculum with better integration between different models and designed to develop model-building skills, nearly all students describe atoms using the Schrödinger model.

BW09: 9:20 PM Transfer of Learning in Medical Imaging: Analogies and Computer Simulations *

Spartak Kalita, Kansas State Univ., 785-532-7167, spartak@phys.ksu.edu

Dean A. Zollman

Based on our previous research on pre-med students' models of X-rays we designed a hands-on lab using semi-transparent Lego bricks to model computer assisted tomography. Without "surgery" (i.e. without breaking the Lego "body") students determined the shape of an object, which was built out of opaque and translucent Lego bricks and hidden from view. A source of light and a detector were provided upon request. Using a learning cycle format, we introduced CT scans after students successfully completed this task. Then the students interacted with a computer simulation, [1] which illustrates CT scans. By comparing students' ideas before and after the teaching interview we investigated transfer of learning from basic physics to a complex medical technology, which involves contemporary physics.

1. Monica Ring Muthsam, CTSim: Ludwig Maximilian Univ., Munich, 1999. English translation available at http://web.phys.ksu.edu/mmmm/CTSim/

*Supported by the National Science Foundation under grant DUE 04-27645.

BW10: 9:30 PM Learning about Physics Graduate Student TAs Using Case Studies

Renee Michelle Goertzen, Univ. of Maryland, 301-405-6185, goertzen@physics.umd.edu

Rachel E. Scherr, Andrew Elby

A new research project at the Univ. of Maryland is investigating the specific nature of TAs' experience with reform instruction. The study combines data from many sources to create detailed case studies of individual TAs as they develop into experienced tutorial instructors. For example, we may observe an individual TA as he works through a specific tutorial in preparation for his teaching that week; serves as a tutorial instructor; reflects on his teaching experience in a weekly teaching seminar; and responds to a course evaluator who inquires about his impressions of the course's success and his own plans for future teaching. We will discuss some of our preliminary findings about how the TAs that we observe view the nature of physics, their interpretations of instructional advice, and the utility of case studies to better understand how tutorial TAs.

BW11: 9:40 PM Graduate Students' Motivation to Teach

Yuhfen Lin, The Ohio State Univ. 732-763-9929, lin.490@osu.edu

Teaching is a complex cognitive process. It requires coordination of several different skills: the ability to make judgments, the ability to evaluate the effectiveness of instruction and modify strategies to help students learn. Similar to the learning strategies of a learner, the types of strategies an instructor chooses to accomplish his/her task are highly dependent on her/his motivation. From interviews with graduate students on how they teach and learn, I will show that the way they approach teaching is dependent on whether they are motivated intrinsically or extrinsically. An unmotivated instructor might choose work avoidance and ways to minimize his/her effort. On the other hand a highly motivated instructor may choose more learner-centered approaches to teaching, disregarding the extra effort required. Case studies show that both intrinsic and extrinsic motivation can coexist in the same person. The type of motivation is strongly context dependent.

BW12: 9:50 PM Project Crossover: Studying the Transition from Student to Scientist

Geoff Potvin, Univ. of Virginia, 434-227-7060, geoffpotvin@gmail.com

Robert H. Tai, Scott S. Lloyd

This study investigates the transition from graduate student to independent researcher in physics and chemistry utilizing a mixed methodology that includes a large qualitative interview component as well as nationally-representative survey data from chemists and physicists at all levels. The factors and experiences in doctoral programs that are important for facilitating a graduate student to become a scientist with an independent research agenda are explored. The advisor/advisee relationship is a central feature of graduate school in the sciences and has a significant, long-term impact on the research career of graduate students. Also important to this discussion are individuals' conceptions of success and productivity (both intrinsic and extrinsic), broader career goals, the correspondence between advisor and advisee attitudes, and the intersection of these factors with doctoral completion.

BW13: 10 PM Impact of Undergraduate Teaching Assistants in SCALE-UP physics

Jonathan C. Hall, Penn State Erie, The Behrend College, 814-898-6307, jch12@psu.edu

Meredith G. Hyldahl, Charles A. Barr, Arthur G. Russakoff

In an active learning environment such a SCALE-UP, undergraduate teaching assistants are an integral and vital part of the teaching and learning that goes on both in and outside of the classroom. After a semester as teaching assistants in a SCALE-UP physics course at Penn State Erie, physics majors will report on the variety of ways that they became involved in the learning process, and their observations of the process and the learning outcomes.

Session BX: More Exciting High School Physics

Location: Imperial E
Date: Monday, July 30
Time: 8–10 PM

Presider: TBD

Attention:
First Time Meeting Attendees!

Join us for our

First-Timers Gathering

and meet new friends,

learn about AAPT meetings

See you Monday
7–8 AM
Auditorium I

BX01: 8 PM Reasons for Decline in Popularity of the Most Widely Used High School Physics Text

Stewart E. Brekke, Northeastern Illinois Univ. (fmr grad student), 630-963-1755, stewabruk@aol.com

What used to be a user friendly most popular high school text, *Physics: Principles and Problems*, has declined in use from about 50% of all high school teachers to 40%. The original format of a single concept lesson with examples on how to do every problem type with drills and practices of about 6-10 problems of the same type has been abandoned in the latest edition for a much more difficult format of three or four different problems based on a formula. This latest format is much more difficult not only for the average student, who could easily master the problem types in earlier editions, but also for the teacher who will have to make his own drills and practices usually taking hours of preparation not needed in earlier editions of this text.

BX02: 8:15 PM Best Practices in Teaching with Technology

Kendra Rand, American Physical Society, 301-209-3206, rand@aps.org

Jessica Clark

Many high school students do not know the range of opportunities open to physics graduates. In order to expose high school students to the variety of careers available to people that study physics and to combat misconceptions about what physicists "look like," the American Physical Society created the Adopt-a-Physicist program. Through this program, high school physics students find out first-hand about the careers, educational backgrounds, and lives of physics graduates (defined as people with bachelor's degrees or higher in physics). Classes "adopt" physicists by registering for their online discussion forums hosted on compadre.org. Students and physicists then interact regularly during the three-week session when the discussion forums are active. Results from the preliminary session and upgrades for the coming session will be discussed. More details are available at http://www.adoptaphysicist.org.

BX03: 8:30 PM PIRA Session: NASCAR and the Physics of Automobile Racing

Jim M. Vetrone, Hinsdale Central High School, 630-570-8521, jimandlaurav@yahoo.com

Joe Liaw

Upper-class high school physics students were taken to Chicago Indoor Racing where each student drove race karts at speeds up to 35 mph, calculated their performance from track data, and re-evaluated the safety of their driving behaviors. This unique field trip was part of a unit focusing on teenager driving, Newton's laws of motion, and methods of video analysis. Since the only tools needed are a stopwatch, meter stick, and a digital camera, our experiences could be applied to any go-karting type facility. Students quickly connected their appreciation of the safety and physics of high speed race karts to their own personal vehicles. The authors will discuss the types of possible measurements that the students themselves can do, how the video data can be analyzed using free software, and the logistics of the field trip.

Tuesday, July 31

Registration *Sheraton-Greensboro, off lobby*	7:30 AM–5 PM
Poster Session II *Exhibit Hall*	8–9 AM and 5–5:30 PM
Summer Picnic *UNCG Campus, The Quad*	5:30–7:15 PM
Photo Contest Viewing & Voting *Exhibit Hall*	7:30 AM–6 PM
Exhibit Show *Exhibit Hall*	8 AM–2 PM and 4–6 PM
Evening Demo Show *UNCG Campus–Taylor Theater*	7:15–8:30 PM

Session CA: Blogs, Wikis and Forums

Sponsor: Committee on Educational Technologies
Location: Imperial C
Date: Tuesday, July 31
Time: 9–10 AM

Presider: Michelle Strand, Southeast Comm. Coll., Milford, NE, 402-761-8228, mstrand@southeast.edu

CA01: 9 AM Using Technology to Keep Your Students "Talking" (Electronically) About Physics

Invited *– Frank V. Kowalski,* Colorado School of Mines, 303 273-3845, fkowalsk@mines.edu*

Susan E. Kowalski

Through technology, you can encourage your students to "talk" (electronically) about concepts in physics, both within and beyond the classroom. We discuss the effective use of wikis and electronic forums to actively engage students with the subject matter by communicating (with their peers and with you) between class meetings. Additionally, we briefly discuss using tablet PC computers for real-time formative assessment in class through the use of open-ended questioning strategies. Although our explorations have involved students in upper-level undergraduate physics courses, these tools are appropriate for helping students at all levels to correct misconceptions and refine their understanding of physics.

*Sponsored by Michelle Strand

CA02: 9:30 AM Blogging in the Physics Classroom

Invited *– Gintaras K. Duda, Creighton Univ., 402-280-5730, gkduda@creighton.edu*

Even though there's been a tremendous amount of research done in how to help students learn physics, students are still coming away missing a crucial piece of the puzzle: why bother with physics? Students learn fundamental laws and how to calculate, but come out of a general physics course without a deep understanding of how physics has transformed the world around them. In other words, they get the "how" but not the "why". Studies have shown that students leave intro physics courses almost universally less excited about the topic than when they came in. This talk will detail an experiment to address this problem: a course "blog" which addresses real-world applications of physics. Statistical data on student attitudes and responses will be presented, which have been generally quite positive. Students claim that the "blog" makes the things we study in the classroom come alive for them and much more relevant.

Session CB: Conceptual Understanding: Models & Measurement I

Sponsor: Committee on Research in Physics Education
Location: Cedar
Date: Tuesday, July 31
Time: 9–11 AM

Presider: Lei Bao, Ohio State Univ., 614-292-2450, lbao@mps.ohio-state.edu

CB01: 9 AM The Dynamics of Coherence in Conceptual Understanding *

Invited – *David Hammer, Univ. of Maryland, College Park, 301-405-8188, davidham@umd.edu*

Research on conceptual understanding has been moving toward complex systems accounts of knowledge and learning. I will review this shift in perspective, using examples of student reasoning from our group's work at the Univ. of Maryland, and discuss its implications for how educators might conceptualize what constitutes progress in learning physics, from elementary through graduate school.

*This material is based upon work supported by the National Science Foundation under Grant No. REC 0440113. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

CB02: 9:30 AM Measuring Understanding: Dependence of Student Answering on the Question Task

Invited *– Andrew F. Heckler, Ohio State Univ., 614-688-3048, heckler@mps.ohio-state.edu*

A considerable number of studies demonstrates that students answer questions differently when the content surface features of a question is changed. Some researchers have used these differences in student answering to measure the extent and nature of student understanding of a concept. In this study, we document that students also tend to answer questions differently when the question task is changed. For example, student responses to a dynamics question can depend on whether they are asked to draw a force diagram or write out a list of forces. It is argued that, similar to the dependence of student answering on content surface features, this dependence on the question task calls for a careful examination of the definition and nature of student conceptual understanding and provides another dimension in the measure of their understanding. Finally, it is shown that this behavior may be predicted by some cognitive models of reasoning.

CB03: 10 AM Conceptual Change and Transfer: Consolidating Varying Viewpoints*

Invited *– N. Sanjay Rebello, Kansas State Univ., 785-532-1539, srebello@phys.ksu.edu*

Transfer of learning is often considered to be the ultimate goal of education. Significant effort in physics education research has focused on conceptual understanding and change. Can efforts in these seemingly different areas complement and support each other? We argue, as others have, that transfer in its most general sense is indistinguishable from conceptual change or learning. Therefore, the diverse perspectives of transfer can inform research in conceptual development and change. Based on our own qualitative research on student understanding in various contexts, we have developed a theoretical framework that allows us to explore the issue of transfer and its connections to conceptual change. We will describe our theoretical framework and will present its implications for curriculum development and instruction.

*Work supported in part by the National Science Foundation under grants REC-0133621 and DUE-0206943

Session CC: Physics and Art

Sponsor: Committee on Research in Physics Education
Location: Meadowbrook
Date: Tuesday, July 31
Time: 9–11 AM

Presider: Larry Badar, Case Western Reserve Univ., 440-331-2586, larrybadar@aol.com

CC01: 9 AM Pollock's Paintings: Are They Really Fractal

***Invited** – Katherine A. Jones-Smith,* Case Western Reserve Univ., 415-373 8963, kas59@case.edu*

Fractal analysis has recently been used in a debate over the authenticity of newly discovered paintings that may be the work of Jackson Pollock. Thus it is of interest to re-examine the basic ideas that underlie the fractal analysis. These ideas are: first, that the "defining visual character" of Pollock's drip-paintings is their fractal nature; second, that the process by which he created fractals is chaotic motion over the canvas; and third, that Pollock's paintings have quantitative features so distinctive and well-defined that they can be used to aid in the authentication of newly discovered works of uncertain provenance. Originally published in 1999, the fractal analysis of Pollock's paintings was subject to startlingly little critical examination despite receiving a great deal of media attention. A rigorous treatment of the fractal analysis is presented, and the shortcomings of the method as an aid in authentication attempts are discussed.

*Sponsor: Larry Badar

CC02: 9:30 AM Drip Paintings and Fractal Analysis

***Invited** – Harsh A. Mathur,* Case Western Reserve Univ., 216-386 4009, hxm7@case.edu*

The study of Jackson Pollock's drip paintings has motivated us to investigate some new problems in fractal and image analysis. In this talk I will give a pedagogical introduction to the fractal analysis of drip paintings and describe some new results regarding the non-fractal geometry of objects obtained by superimposing fractals, the statistics of noise in box-counting curves and the geometry of short random walks. I will also discuss the problem of separating a multicoloured image into single color components.

* Sponsor: Larry Badar

Session CD: Need for Speed

Sponsor: Programs Committee
Location: Colony B-C
Date: Tuesday, July 31
Time: 9–11 AM

Presider: Mario Belloni, Davidson College, 704-894-2320, mabelloni@davidson.edu

CD01: Catching Up with Superluminal Sound and Light

***Invited** – Joel Mobley,* Univ. of Mississippi, 662-915-6937, jmobley@olemiss.edu*

Of the all the parameters for describing wave propagation, the group velocity is perhaps the most enigmatic. From quantum wavepackets to classical microwave bursts, the group velocity is said to represent speeds of particles and energy, and yet it is also known to exhibit arbitrarily large and negative values. For electromagnetic waves, the reality of superluminal (i.e., > c, or < 0) group velocities is well-established with observations dating back several decades. More recently, measurements of acoustic group velocities exceeding the speed of light have been reported, bridging a gap five orders of magnitude wide between c and ordinary acoustic speeds. To illustrate the physical manifestation of "fast sound" and "fast light," we show how superluminal wavepackets are constructed and detected in the laboratory. Through simulations, several aspects of superluminal propagation are addressed, including backward waves, signal velocities, and causal compatibility.

*Sponsored by Mario Belloni

CD02: 9:30 AM Video Analysis Of High-Speed Motion *

***Invited** – Robert B. Teese, Rochester Institute of Technology, 585 475-6578, rbtsps@rit.edu*

Video-based motion analysis has become a popular tool in physics education. However, some interesting motions occur too quickly to be captured with consumer-grade equipment that has a maximum speed of 60 frames per second. I will describe the equipment and methods that are needed to make educationally useful as well as surprising or stunning videos of fast phenomena. As examples I will show videos made for the LivePhoto Physics project using high-speed techniques, including soap bubbles in a wind tunnel and schlieren videos of shock waves from an explosion.

*Supported in part by National Science Foundation grant DUE-0424063

CD03: 10 AM High-Speed Flash Photography

***Invited** – Loren M. Winters, North Carolina School of Science and Mathematics, 9194162775, winters@ncssm.edu*

I'll describe methods that can be used to "stop" high-speed motion and to observe the temporal progression of high-speed events. My emphasis will be on the use of short-duration light sources rather than cameras to stop the action. The 30-microsecond burst of light from an electronic flash unit works well for studies of subsonic motion. For supersonic motion, the sub-microsecond spark across an air gap is needed. I'll show examples from student projects using the two kinds of lighting. In addition, I'll describe how to obtain quantitative information through the rapid sequencing of flash bursts and how to spatially separate the multiple images so obtained on a single frame of a still camera. Throughout the presentation, I'll show how I use images of high-speed events in physics classes. I'll also provide a brief historical perspective on the development of high-speed photography from Wheatstone to Edgerton.

Session CE: Historical Apparatus

Sponsor: Committee on History and Philosophy of Physics
Location: Auditorium I
Date: Tuesday, July 31
Time: 9–11 AM

Presider: James Hicks, Barrington High School, UJHicks@Juno.com

CE01: 9 AM Mechanical Analysis of Musical Sounds – Circa 1900

***Invited** - William Fickinger, Case Western Reserve Univ., 216-368 -4100, wjf@cwru.edu*

Four mechanical devices, used a hundred years ago for the analysis of sound waves, will be described. Dayton Miller's phonodeik was used to make high resolution photographic traces of sounds from a variety of sources. Olaus Henrici's harmonic analyzer was used to determine the amplitudes of the partial waves making up the sounds. Lord Kelvin's harmonic synthesizer was used to create drawings corresponding to specified frequencies and amplitudes. Hermann von Helmholtz's synthesizer was an attempt to recreate the corresponding sounds. Altogether, these "pre-electronics" instruments represent early efforts to understand the production and perception of musical and vocal sounds. The talk will be illustrated by old lantern slides and new videos.

CE02: 9:30 AM Acoustical Apparatus of Rudolph Koenig

Invited – Thomas B. Greenslade, Jr., Kenyon College, 740-427-2989, Greenslade@Kenyon.edu

When he died in 1901, Rudolph Koenig was the premier maker of acoustic apparatus in the world. In that pre-electronic era, his apparatus was to be found in many physics departments in North America. The collection of apparatus that he brought to the Centennial Exhibit in Philadelphia in 1876 was sold, with part going to the United States Military Academy at West Point, and the remainder to the physics department at the Univ. of Toronto. I have visited both collections and have photographed many examples of the apparatus that he used to generate and analyze acoustic signals.

CE03: 10 AM History of the Heisenberg Uncertainty Relation

Dan Maronde, Univ. of Central Florida, 407-658-0255, maronde@physics.ucf.edu

The Heisenberg uncertainty relation is probably the most widely recognized expression used in Quantum Mechanics. The concept it represents captures the essence of the break modern physics made with classical Newtonian physics early in the 20th century. Here we give a brief history of the motivation for, inspiration leading to, and development of this famous inequality.

CE04: 10:10 AM The Harmonograph: A Reconstruction of a Historical Apparatus

Cheryl P. Schaefer, Missouri State Univ., 417-836-6852, CherylSchaefer@MissouriState.edu

Robert J. Whitaker

This session will feature a demonstration of a harmonograph copied after the design of Newton, whose harmonograph is in the Smithsonian Institution. The harmongraph features two physical pendulums swinging at right angles to each other. One pendulum has a pen attached, the other has a platform and paper. When activated the tracings of the pen form Lissajous Curves, similar to the tracing of a spirograph. The relation of the period of each pendulum to the other determines the type of curve produced.

CE05: 10:20 AM Early Physics Laboratory Equipment at St. Albans School

Robert A. Morse, St. Albans School, Washington, DC, 202-537-6452, robert_morse@cathedral.org

Curiosity about old physics equipment and the approaching centennial of St. Albans School led me to look more deeply into the history of the physics curriculum at the school. Archival research in school publications and old ledgers reveals an ambitious laboratory program in place by the 1915 school year. In this talk I will share show examples of equipment, and what I have discovered about the laboratory portion of the curriculum of that time.

Session CF: PIRA Session: Data Acquisition and Analysis Software used in Demonstrations and Labs

Sponsor: Committee on Apparatus
Location: Imperial B
Date: Tuesday, July 31
Time: 9–10 AM

Presider: Brian Andersson, Univ. of Minnesota, 621-624-6584, banders@physics.umn.edu

CF01: 9 AM Writing Graphical User Interfaces for Data Acquisition with Matlab

Invited – Thomas J. Bauer, Wellesley College, 781-283-3017, tbauer@wellesley.edu

When supplied software doesn't do what you want, it becomes necessary to write your own. An example of this is a digital multimeter that came with data logging software that could not send data to Excel or any format other than itself. It was desired to write software to collect the data and save it to a compatible format. Matlab provides a programming environment that simplifies this job by supplying a wealth of ready made tools useful for creating graphical user interfaces. The talk will demonstrate these tools by examining a program which records voltage as a function of time from the above meter and saves the data to an Excel compatible file.

CF02: 9:30 AM How to LabVIEW in Physics Education

Invited – Urs Lauterburg, Physikalisches Institut, Univ. of Bern, **41 31 631 44 88, urs.lauterburg@space.unibe.ch*

A presentation about merging LabVIEW, the industry standard programming environment for measurement and automation, with a playful and fun way of teaching university-level physics to students of natural sciences and medicine. After a short introduction of the LabVIEW graphical programming concepts, a small number of selected characteristic application examples in the domains of demonstration experiments, student labs and interactive simulation tools for teaching physics will be shown and discussed.

*Brian Andersson Tate Laboratory of Physics Assistant Education Specialist President-Elect, PIRA School of Physics and Astronomy Minneapolis, MN 55455 Univ. of Minnesota

CF03: 10 AM Flexible Software for Computer-Based Problem Solving Labs

Invited – Brita Nellermoe, Univ. of Minnesota, 612-625-9323, nell0021@umn.edu

Jennifer Docktor

Engaging Introductory Physics students in a laboratory environment is challenging. Laboratories are also constantly changing to accommodate new technology, new pedagogy, or new laboratory ideas. It is important to have a laboratory structure flexible enough to suit both students and faculty. The Univ. of Minnesota uses computer-based laboratory problems to help engage students and encourage them to think critically in a laboratory setting. To provide flexibility, the software is based on a commercial product available in most physics departments, LabVIEW. Here we will discuss the problem structure and software behind the computer-based laboratory pedagogy, its use in teaching laboratories, and its flexibility to adapt instructor preferences.

Session CG: Institutional Family Friendly Policies

Sponsor: Committee on Women in Physics
Location: Maple
Date: Tuesday, July 31
Time: 9–11 AM

Presider: Barbara Whitten, Colorado College, 719-389-6579, bwhitten@coloradocollege.edu

CG01: 9 AM Family Friendly Policies at Southern Illinois Univ. Edwardsville

Panel – Kimberly A. Shaw, Southern Illinois Univ. Edwardsville, 618-650-2472, kshaw@siue.edu

Southern Illinois Univ. Edwardsville is a regional university with a total enrollment of over 13000 students. This institution, founded in the 1950s, has seen a large wave of retirement in recent years. As the older faculty have left, an opportunity to hire significant numbers of new faculty has arrived. With the new hires, SIUE has seen an increase in the percentage of women faculty, and an increased interest among all faculty for family friendly policies In late 2005, some faculty came together to form a task force to bring the needs of the faculty to the attention of the administration. In this talk, I will discuss SIUE's family leave and other relevant policies as they currently stand, the goals of the task force, and what we have accomplished to date.

CG02: 9:30 AM The Bryn Mawr Work And Family Project

Panel – Elizabeth McCormack, Bryn Mawr College, 610-526-5356, emccorma@brynmawr.edu

Bryn Mawr College's Center for Science in Society as part of its Women in Culture project has begun an inquiry into aspects of its STEM programs that contribute to enhancing the engagement of women with science, both professionally and generally. The project involves faculty from both science and nonscience departments and includes workshops and on-campus conversations on the interaction of career choice and notions of life balance. The Bryn Mawr Work And Family Project in particular is collecting and analyzing information from a discrete group of alumnae in coordination with a study of the relationship between family and work obligations. The goal is to learn about and bring to light the daily challenges faced by parents who are balancing simultaneously work and family role responsibilities. For background see http://serendip.brynmawr.edu/local/scisoc/workfamily/ and Balancing Children and Work, Bryn Mawr College Alumnae Bulletin, Winter 1999. http://www.brynmawr.edu/Alumnae/bulletin/wi99.htm

CG03: 10 AM What Makes an Institution Family-Friendly; Why Does it Matter?

***Invited** – Laurie E. McNeil, Univ. of North Carolina at Chapel Hill, 919-962-2079, mcneil@physics.unc.edu*

Making an institution "friendly" to women and families (and men) requires both putting in place good policies and making them effective. Policies that minimize discrimination in hiring and promotion, actively promote the recruitment and success of dual-career couples, provide generous family/medical leave when it is needed, make affordable child care available, and allow extensions of the pre-tenure probationary period when children are added to the family all make an institution a better place for women, men and their families. However, unless administrators are aware of the policies and actively promote their use when appropriate and guard against any adverse consequences for those who take advantage of them, having good policies does not help. I will discuss examples of policies that work (and why some don't), and their impact on women, men, and families.

CG04: 10:30 AM Family Friendly Policies at Jamestown Community College

Panel – Marie Plumb, Jamestown Community College, 716-665-5220, MariePlumb@mail.sunyjcc.edu

Jamestown Community College (JCC), a regional two-year college with a total enrollment of about 4000 students, is tucked away in the southwest corner of New York State. Founded in 1950, it was the first community college in the State Univ. of New York system. The college encompasses two campuses (50 miles apart) and two extension sites (one in Pennsylvania). Over that past several years the college has made an effort to attract highly qualified female scientists. The trend in hiring has reversed the ratio of female to male the full time science faculty at JCC. The ratio was 1:2 and is now 2:1, female to male. This talk will discuss JCC's family leave and other relevant policies.

Session CH: Early Field Experiences: The Impact on Potential Teachers of Physics

Sponsor: Committee on Teacher Preparation
Location: Imperial F
Date: Tuesday, July 31
Time: 9–10 AM

Presider: Ingrid Novodvorsky, Univ. of Arizona, 520-626-4187, novod@email.arizona.edu

CH01: "I Can't Believe How Much Has Changed Since High School!"

***Invited** – Marcia K. Fetters, Western Michigan Univ., 269-387-3538, marcia.fetters@wmich.edu*

Ingrid Novodvorsky

Early field experiences provide pre-service teachers with the opportunity to work with local physics teachers and physics students to discover the full complexity of the classroom. As high school students, they formed images of teaching and learning through the lens of student. They bring those same images to the classroom as future teachers and never realized all the hidden aspects of a class discussion, and how a teacher makes decisions to facilitate learning. If we do not help pre-service teachers learn how to examine a classroom through the lens of a teacher they get overwhelmed during their internships or first years of teaching. Structured activities for early field experiences can help pre-service teachers start the process of exploring and shifting their identity from student to teacher. This paper describes some of the interviews, surveys, classroom and community based activities that can support pre-service teachers move from student to teacher.

CH02: 9:30 AM The Impact of Certification Requirements on Physics Teacher Preparation: A National Discussion

***Invited** – Carl J Wenning, Illinois State Univ., 309-438-2957, wenning@phy.ilstu.edu*

The number of criteria that teacher candidates must meet in order to become certified to teach in public schools has increased dramatically during recent years. Has this made a difference in the quality of practice among the teachers that we prepare? While some accrediting agencies claim that program accreditation makes a difference, does it really? Following a brief introduction, the presenter will lead a discussion to determine if differences have been observed after more stringent certification criteria have been put in place.

CI: Successful Implementation of PER-based Strategies Around the World

Co-Sponsors: Committee on International Physics, Committee on Research in Physics Education
Location: Oak B-C
Date: Tuesday, July 31
Time: 9–11 AM

Presider: Genaro Zavala, Tecnologico de Monterrey, 52-818-358-2000, genaro.zavala@itesm.mx

CI01: 9 AM Tutorials in Introductory Physics in Secondary and Post-secondary Education in Germany

***Invited** – Christian H. Kautz, Hamburg Univ. of Technology (TUHH), +49 40 42878 4259, kautz@tu-harburg.de*

Oliver Liebenberg

For several years, the Tutorials in Introductory Physics[1] have been used at Hamburg Univ. of Technology (TUHH), both in the original and in a German translation. In order to implement the materials within the context of engineering education at the undergraduate level in Germany, some modifications in content and format have been made. Various instruments are currently being used to assess the effectiveness of the materials in this context. While preliminary results clearly indicate that overall student conceptual understanding has been enhanced by the Tutorials, some student groups seem to benefit from the materials to a greater extent than others. Following their adoption at the university level, there is some interest in using the Tutorials for advanced physics courses at local high schools. There is evidence that the materials are particularly appropriate for this context and may be used in place of (rather than as a complement to) traditional instructional formats.

1. L.C. McDermott, P.S. Shaffer, and the Physics Education Group at the Univ. of Washington, *Tutorials in Introductory Physics* (Prentice Hall, 2002).

CI02: 9:30 AM Experientially Based Physics Instruction: A Symbiosis between American and European Thinking

Invited *– Jonte Bernhard, Engineering Education Research Group, ITN, Linköping Univ., +46 11 363318, jonbe@itn.liu.se*

A common objective in physics education should be "to learn relationships." In 1995 I started at a smaller university in Sweden a project to develop "conceptual labs" in physics, primarily in introductory and advanced mechanics courses. The project was implemented as "design-based research." The instructions were written in Swedish and the design was inspired by "Tools for Scientific Thinking," "Real-Time Physics" and "Workshop Physics." Theoretically Dewey, Lewin and Vygotsky inspired the design. The first project was named "Experientially based physics instruction" to acknowledge that we see conceptions as reflecting person–world relationships and to acknowledge the projects philosophical connections. Later on the project has been implemented at Linköping Univ. and the designs have been improved using the theory of variation developed by Ference Marton and co-workers. We have achieved a g(FMCE)=61%. We will present an analysis of our results in light of post-cognitivist theories for learning.

CI03: 9 AM Investigation of Student Understanding of the Uncertainty of Measurement

Poster – Hugo Alarcon, Tecnologico de Monterrey, (52) 81 83582000, halarcon@itesm.mx

Teresita Marin-Suarez, Genaro Zavala

Although the use of uncertainty and significant figures are included in most of the college physics textbooks, it is well known that students cannot understand the concepts involved in the process of measuring physical quantities. The PER Group of Tecnologico de Monterrey has begun a study of students' difficulties to understand the process of measuring, such as to perform a measurement, to estimate the uncertainty, to identify the sources of errors, and to manipulate a measurement result in calculations. The technique of performing individual demonstration interviews [1] has been proven to be a good method to get a taxonomy of students' difficulties and misconceptions and has been widely used by several PER groups.[1,2] An interview has been designed for this study, and 20 in-depth interviews with undergraduate and graduate students have been carried out in the first part of this investigation that will be presented in this work.

1. D. E. Trowbridge and L. C. McDermott, "Investigation of student understanding of the concept of velocity in one dimension," *Am. J. Phys*. **48**, 1020–1028 (1981).

2. M. C. Whittmann, R. N. Steinberg and E. F. Redish, "Investigating student understanding of quantum physics: Spontaneous models of conductivity," *Am. J. Phys*. **70**, 218-226 (2002).

CI04: 9 AM Using Tutorials in an Intermediate Course of Statistical Physics

Poster – Hugo Alarcon, Tecnologico de Monterrey, (52) 81 83582000, halarcon@itesm.mx

Alejandro Mijangos, Juan J. Velarde-Magaña, Genaro Zavala

Statistical Physics is an intermediate course [1] for engineering physics students at Tecnologico de Monterrey. Previous to this course the students have taken a traditional lecture-based introductory course of thermal physics, with no tutorials, and a thermodynamics course focused on engineering processes and not necessarily in physics concepts. In order to review at the beginning of the course some important required concepts, such as the behavior of an ideal gas and the First Law of Thermodynamics, we have applied two tutorials designed by the PER Group of Univ. of Washington.[2] In this practice, the students have taken the pre and post tests recommended by the authors, have worked in the tutorial assisted by prepared instructors and in problem solving sessions in cooperative groups. In this work we will present the analysis of the results of this implementation, as well as the comparison with previous results reported by the authors of these particular tutorials.[3,4]

1. F. Mandl, *Statistical Physics*, Wiley (1988)

2. McDermott, L. C., Shaffer, P. S., & PER, *Tutorials in Introductory Physics,* Prentice Hall, 2001.

3. C. H. Kautz, P. R. L. Heron, M. E. Loverude and L. C. McDermott, "Student understanding of the ideal gas law, Part I: A macroscopic perspective," *Am. J. Phys.* **73**, 1005 (2005).

4. M. E. Loverude, C. H. Kautz and P. R. L. Heron, "Student understanding of the first law of thermodynamics: Relating work to the adiabatic compression of an ideal gas," *Am. J. Phys*. **70**, 137 (2002).

CI05: 9 AM Implementation of PER Activities in Tecnologico de Monterrey

Poster – Hugo Alarcon, Tecnologico de Monterrey, (52) 81 83582000, halarcon@itesm.mx

Tecnologico de Monterrey is a private Mexican Univ. that has initiated a change in the definition of its educational model in the last decade. In this model, the student is in the center of the teaching-learning process, which is constructivist and experiential [1], while the professor acts as a facilitator of learning. The Physics Department carried out an exercise of redesigning the introductory physics courses in order to include the new elements of the model in them, where the educational intentions, the conceptual, practical, and attitudinal contents of the courses have been identified. Also, it has been agreed that cooperative learning [2] should be as the global strategy for physics learning. The PER-based activities Tutorials in Introductory Physics[3] as a central part of the curriculum has been implemented. In this presentation, details of this implementation will be shown.

1. M. Martin, *El modelo educativo del Tecnologico de Monterrey*, Tecnologico de Monterrey, 2002.

2. D. W. Johnson and R. T Johnson, L*earning Together and Alone: Cooperative, Competitive, and Individualistic Learning.* Allyn & Bacon; 5 edition, (1998).

3. McDermott, L. C., Shaffer, P. S., & PER. T*utorials in Introductory Physics,* Prentice Hall (2001).

CI06: 9 AM Assessing Student Understanding of Graphs in Kinematics: Improving the Tool

Poster – Genaro Zavala, Tecnologico de Monterrey, +52 81 83582000, genaro.zavala@itesm.mx

Santa E. Tejeda, Juan J. Velarde, Hugo Alarcon

It has been some years since the Test of Understanding Graphs in Kinematics, TUG-K, one of the few scientifically developed multiple choice tests available, was published. [1] The test has been successfully used to assess whether a student or a group of students have acquired the competency defined by seven objectives in which the test is divided. Recently, our group has been involved in modifying the test with the intention to obtain more accurate results in its assessment of student understanding, i.e. a complete taxonomy of the student state in kinematics. In this work we are going to report the modifications that have been made and the results of the administration of the test as pre- and post-test in an introductory physics course where kinematics is a great part of the curriculum.

1. R.J. Beichner, "Testing student interpretation of kinematics graphs," *Am. J. Phys*. **62**, 750-762 (1992).

CI07: 9 AM Developing Feedback Materials about Curl for Undergraduate Students in Upper-level Mechanics Course

Poster – Kyesam Jung, Seoul National Univ., 82-11-365-6902, kye3@snu.ac.kr

Gyoungho Lee

During an upper-level mechanics course, we observed that many students' concepts about curl were unstable and incorrect. Since mathematical understanding is important for physical understanding, we should help students correct their mathematical knowledge that relates to physics. For this purpose, we need to understand the sources of students' difficulties. To understand the sources of students' difficulties, we used results of previous study and Ambrose's test to investigate students' difficulties about curl. Throughout this way, we found the major sources of students' difficulties. Based on these, we developed feedback materials and applied it to students who had difficulties in understanding curl.

CI08: 9 AM Utilizing Popular Scientific Lectures for Teaching Contemporary Physics

Poster –S hulamit Kapon, Weizmann Institute of Science, Israel, 972-8-9342298, shulamit.kapon@weizmann.ac.il

Uri Ganiel, Bat Sheva Eylon

Have you ever heard a popular scientific lecture, enjoyed it, and yet could later recall only the title, and perhaps a few jokes? Have you ever wondered how to incorporate contemporary physics into high school physics? The National Center of Physics Teachers in Israel conducted a distance learning in-service course for 22 teachers on early 20th century physics, which recently has become obligatory in the high school physics syllabus. Three excellent popular physics lectures were integrated into this course as enrichment in contemporary issues: high energy particle physics, quantum mechanics, and contemporary astrophysics. Each lecture was accompanied by activities supporting the teachers in the learning process (using analogies, knowledge integration etc). The activities were based upon an analysis of explanations in popular physics lectures. We shall present the intervention, some of the activities and preliminary results of its impact on the teachers.

CI09: 9 AM PER-based Active Learning Experiences in San Luis, Argentina

Poster – Julio Benegas, Universidad Nacional de San Luis, +54-2652-422803, jbenegas@unsl.edu.ar

Myriam Villegas, Julio Sirur Flores, Silvina Guidugli, Cecilia Fernandez Gauna

Different implementations of PER-based teaching strategies that foster active learning at the high school and introductory physics level will be reported. The high school experiences have been carefully documented and compared with the results of traditional instruction. The Univ. level applications includes the use of Peer´s Instruction and Interactive Lecture Demonstrations in relatively large university courses, which are complemented with the use of Tutorials in Introductory Physics and Cooperative Problem Solving of Context Rich Problems in small, tutorial-type groups. This experimental implementation served as the base for the translation of Tutorials in Introductory Physics to Spanish.[1] High school experiences have been based largely on the use of Tutorials in different subjects of mechanics, electricity and fluids.

1. Mc Dermott L., Shaffer P. and the PEG, *Tutoriales para Física Introductoria (*Prentice Hall, Buenos Aires, 2001).

CI10: 9 AM Implementing Physics Education Research to Inform and Enhance Pedagogical Approaches

*Poster – Brian Bowe, * PERG, School of Physics, Dublin Institute of Technology, +35314027884, brian.bowe@dit.ie*

Paul Irving, Robert G Howard, Laura Walsh

Since 1999 the School of Physics in the Dublin Institute of Technology has been critically analyzing its pedagogical strategies, leading to a reconsideration of teaching, learning and assessment practices. In 2001, the Physics Education Research Group (PERG) was established to develop, implement and evaluate pedagogical initiatives in physics education and to undertake rigorous education research to inform and evaluate these developments. Since then, various innovative pedagogical approaches including problem-based learning, project-based learning, peer instruction and eLearning have been implemented. These pedagogical developments were informed by education research studies which examined students' conceptual understanding and problem-solving skills, lecturers' conceptions of learning and teaching and group interactions and dynamics. Further education research studies are continually carried out to evaluate all pedagogical approaches in order to enhance and improve the students' learning experience. These studies, which are both qualitative and quantitative, are conducted primarily using phenomenography, phenomenology, action research or evaluative research approaches.

* Sponsor: Genaro Zavala

CI11: 9 AM Cross Culture Comparison of Results from Physics Concept Tests

Poster – Kai Fang, TongJi Univ., 86-21-65983381, fangkaitj@mail.tongji.edu.cn

Tianfang Cai, Jing Wang, Lili Cui, Lei Bao

The physics education community has been using standardized concept tests for decades with great success. It is also well known that students from different culture and education systems will produce different results. This study is an effort to systematically collect carefully documented data of the popular concept test from entry level college students in China. The results will provide a baseline for further analysis of student characteristics across different countries. In this presentation, we will provide detail comparison of college students in the United States and China on three tests: FCI, BEMA, and Lawson Test.

CI12: 9 AM FCI-based Multiple Choice Test for Investigation of Students' Representational Coherence

Poster – Antti Savinainen, Kuopio Lyseo High School, +358-50-4949597, antti.savinainen@kuopio.fi

Pasi Nieminen, Jouni Viiri, Jukka Korkea-aho, Aku Talikka

It has been suggested that the ability to use multiple representations is a key factor in understanding physics concepts. [1] However, existing tests provide only limited possibilities to evaluate students' skills in using multiple representations. This is why we have developed a multiple choice test — the Representation Test — which evaluates students' representational coherence on some aspects of gravitation and Newton's third law. Representational coherence means that a student can use consistently multiple representations and is able to move between different representations.[2] The Representation Test addresses verbal, graphical, bar chart, and vectorial representations. It was developed on the basis of five questions taken from the Force Concept Inventory (FCI) [3] : original verbal alternatives of the FCI questions were redesigned using multiple representations but changing the physical content and contexts of the questions as little as possible. Student data (n = 54) from Kuopio Lyseo High school, Finland are presented.

1. D.E. Meltzer, "Relation between students' problem-solving performance and representational format," *Am. J. Phys.* **73** (5), 46-478 (2005).
2. A. Savinainen, "High school students' conceptual coherence of qualitative knowledge in the case of the force concept," *Dissertations* **41,** Department of Physics, Univ. of Joensuu.
3. I. Halloun, R. Hake, R., E. Mosca, and D. Hestenes, *Force Concept Inventory* (Revised 1995).

Session DA: Space Science and Astronomy Missions: Their Science and e/PO Programs

Location: Oak B-C
Date: Tuesday, July 31
Time: 12–1 PM

Presider: Jordan Raddick, 410-516-8889, raddick@pha.jhu.edu

DA01: 12 PM Exploding Stars and Blazing Galaxies: From NASA into the Classroom

***Invited** - Lynn R. Cominsky, Sonoma State Univ., 707-664-2655, lynnc@universe.sonoma.edu*

Exotic objects such as monstrous black holes, gamma-ray bursts and highly magnetized neutron stars and white dwarfs can provide excitement and engage students from middle school through high school. The Sonoma State Univ. Education and Public Outreach group supports NASA's Gamma-ray Large Area Space Telescope (GLAST) and Swift missions, as well as the joint ESA/NASA XMM-Newton

Session CJ: Robert A. Millikan Award

Location: Imperial D
Date: Tuesday, July 31
Time: 11 AM–12 Noon

David R. Sokoloff

Building a New, More Exciting Mousetrap is Not Enough!

David R. Sokoloff, University of Minnesota, Department of Physics, sokoloff@uoregon.edu

Two exciting, parallel streams of advancement in the last 2-3 decades have so changed the introductory physics course at many universities, colleges and high schools that Robert Millikan, a true educational innovator of his time, would hardly recognize it! These were (1) expanding interest in Physics Education Research, initially driven by the work of Arons and McDermott and popularized by Halloun and Hestenes, FCI, and (2) development of computer-supported pedagogical tools, MBL, digital video analysis, WWW, clickers, etc. Interest in applying the results of PER and the availability of robust tools have resulted in a proliferation of new approaches. Yet true reform of physics teaching requires a five-step approach including (1) research, (2) development, (3) evaluation, (4) refinement and (5) dissemination. This lecture will detail the importance of these steps in the reforms made possible by curricula like RealTime Physics and Interactive Lecture Demonstrations, that were developed by the author and his colleagues, Ronald Thornton and Priscilla Laws.

mission. In this talk, I will provide an overview of high-energy astrophysics mission science and showcase some of our curricular materials. I will also demonstrate how we use real data to encourage students to think scientifically, provide hands-on activities to explain abstract concepts, and connect familiar and nearby astronomical objects such as the Earth to explain distant and exotic objects such as pulsars. The resources available through our Global Telescope Network will be described, including classroom activities and instructional materials for a range of levels and interests, and mentoring in research practices, telescope use, and data analysis.

DA02: 12:30 PM Incorporating Space Missions into a Fundamental Astronomy Course

Andrew C. Morrison, Illinois Wesleyan Univ., 309-556-3888, amorriso@iwu.edu

One of the major reasons for the dramatic increase in our understanding of planetary systems in the past 35 years has been the ability to send probes out to the planets and their moons. In my Fundamental Astronomy class, students are assigned space missions that they must read about and discuss in class. We also use data from recent space missions in the laboratory component of the course. In this presentation, I will discuss the benefits and challenges of incorporating space missions as a major theme of a traditional fundamental astronomy course.

Session DB: PER: Topical Group Town Hall

Sponsor: Committee on Research in Physics Education
Location: Cedar
Date: Tuesday, July 31
Time: 12–1 PM

Presider: Michael Wittmann, Univ. of Maine, 207-581-1237, wittmann@umit.maine.edu

Session DC: Professional Concerns in the Teaching of Astronomy

Co-Sponsors: Committee on Space Science and Astronomy, Committee on Professional Concerns
Location: Oak B-C
Date: Tuesday, July 31
Time: 1–2 PM

Presider: Rebecca Lindell, Southern Illinois Univ., 618-650-2934, rlindel@siue.edu

In this crackerbarrel, we will discuss professional concerns of astronomy instructors. Concerns raised at the 2006 Summer AAPT meeting included: Being the only astronomy instructor in high schools, starting your own observatory and how to use computerized instruction. These concerns as well as others raised by participants will be discussed.

Session DD: Professional Concerns of Minorities in Physics

Co-Sponsors: Committee on Professional Concerns, Committee on Minorities in Physics
Location: Maple
Date: Tuesday, July 31
Time: 1–2 PM

Presider: Dean Hudek, Brown Univ., 401-863-2062, Dean_Hudek@Brown.edu

Co-Presider: Floyd J. James

Participants will interactively discuss matters of professional concern to Minorities in Physics. Please come prepared to tell us your situation, exchange ideas, ask questions, offer solutions, etc.

Session DF: Conceptual Understanding: Models and Measurement II

Sponsor: Committee on Research in Physics Education
Location: Cedar
Date: Tuesday, July 31
Time: 3–5 PM

Presider: Andrew Heckler, Ohio State Univ., 614-688-3048, heckler@mps.ohio-state.edu

DF01: 3 PM Facets and Facet Clusters as a Framework for Organizing, Interpreting, and Analyzing Student Responses *

***Invited** – Jim Minstrell, FACET Innovations LLC, 206-634-9225, jimminstrell@facetinnovations.com*

Pamela Kraus, Jim Minstrell, Jim Minstrell, Jim Minstrell

Learners appear to construct their explanations and their problem solutions based on past experiences and ideas and based on the salience of features in a context for the task. We call these constructions of one or more pieces of knowledge and reasoning "facets of thinking." While we do not believe the facets exist in the heads of learners, we use the clusters of facets as a way to organize and interpret student responses when asked to explain a common situation or to solve a problem. We will discuss issues of conceptual understanding and coherence of student thinking from our facet-based framework. Our results and conclusions will be informed by early data from over twenty years ago and from the past three years of responses on our online assessment site, Diagnoser.com.

*Supported in part by NSF grants #ESI-0455796 and #ESI-0435727

DF02: 3:30 PM Comparing the Probabilistic Frameworks of Popular Quantitative Education Measurement Methods

***Invited** – Lei Bao, The Ohio State Univ., 614-292-2450, lbao@mps.ohio-state.edu*

DE: Plenary II: Racing as Metaphor

Location: Imperial D
Date: Tuesday, July 31
Time: 2–3 PM


Janet Guthrie

Racing as Metaphor

Janet Guthrie, GRLLCwebsite@cs.com

Motivational speakers at business meetings often use sport, whether football or auto racing, as a metaphor for business activities. Can the many elements of physics that enter into motorsports, from compression ratios to centrifugal force, be useful in adding excitement to the subject?

A given quantitative data analysis tool is always developed based on certain basic assumptions, which are usually expressed in terms of a constrained probability framework describing the relations and uncertainties among different measures and variables of the system. This talk will provide a comparison among the probabilistic frameworks of three commonly used quantitative analysis methods: the item response theory, the normalized gains, and model analysis. The comparison will be made with both the theoretical analysis of the methods and empirical evidence from experiments. The goal of this study is to gain insights into the relations among models, data, and results.

DF03: 4 PM Defining "Conceptual Understanding" Through Appropriate Constraints on a Knowledge Domain

***Invited** – David E. Meltzer, Univ. of Washington, 515-451-3618, dmeltzer@u.washington.edu*

For an expert, "understanding" of a particular concept refers merely to an arbitrarily circumscribed portion of a broad array of tightly interconnected knowledge elements. In the expert's mind, the domain of all knowledge elements is hierarchically organized and densely interlinked, with multiple access paths to any particular subdomain. When assessing student understanding one must select a subdomain of both elements and links, chosen as appropriate for a given level of student preparation. The extent to which the student demonstrates facility with ideas in this selected subdomain can serve as a definition of "conceptual understanding" in a particular context. Understanding so defined is always implicitly constrained by the boundary selected to define the subdomain. I will give concrete illustrations of these ideas with student response data related to concepts in electromagnetism and thermal physics, as well as other topics.

Supported in part by grants from NSF DUE, REC, and PHY

Session DG: Women on the Biophysics Frontier

Sponsor: Committee on Women in Physics
Location: Maple
Date: Tuesday, July 31
Time: 3–5 PM

Presider: Peggy Hill, Southeast Missouri Sate Univ., 573-651-2394, phill@semo.edu

DG01: 3 PM Two Applications of Quantitative Fluorescence Microscopy in Cell Membrane Biophysics

***Invited** – Nancy L. Thompson, Univ. of North Carolina at Chapel Hill, 919-962-0328, nlt@unc.edu*

The combination of total internal reflection illumination with fluorescence correlation spectroscopy (TIR-FCS) allows one to examine in quantitative detail a variety of biophysical properties related to the motions and interactions of fluorescent molecules near the interface of a transparent planar surface and an adjacent solution. Several experimental and theoretical aspects of this combination will be described. TIR-FCS has allowed characterization of local diffusion coefficients and concentrations of fluorescently labeled antibodies in solution but very close to substrate-supported phospholipid bilayers. TIR-FCS has also been used to examine the interaction kinetics of fluorescently labeled mouse IgG specifically and reversibly associating with the mouse receptor FcGammaRII, which was purified and reconstituted into substrate-supported planar membranes. The use of quantum dot blinking for measuring submicroscopic distances will also be described.

DG02: 3:30 PM Accurate and Efficient Electrostatics for Large Scale Biomolecular Simulations

***Invited** – Celeste Sagui, Department of Physics NCSU, 919-515-3111, sagui@ncsu.edu*

Thomas A. Darden, Lee G. Pedersen, Christopher M. Roland

An accurate and numerically efficient treatment of electrostatics is essential for biomolecular simulations, in particular, when a smooth interface to quantum chemical descriptions is needed. Force field used in classical biomolecular simulation codes such as AMBER and CHARMM assign "partial charges" to every atom in a simulation in order to model the interatomic electrostatic forces. The respective charge values are obtained via least-squares fitting to the Coulombic potential produced by quantum chemical procedures Unfortunately, the fitting procedure for large, conformationally flexible molecules is under-determined, which is a major source of errors. There are two main problems associated with the treatment of classical electrostatics: (i) how does one eliminate artifacts associated with the point charges as used in force fields, and thereby improve the electrostatic potentials in a physically meaningful way?; (ii) how does one efficiently simulate the very costly long-range electrostatic interactions? Here, we present results on a recently developed distributed multipole method and discuss the importance of this method for large scale biomolecular simulations.

Invited by Margaret P. Hill

DG03: 4 PM Exploring the Role of Calcium in Cardiac Cell Dynamics

***Invited** – Carolyn M. Berger, Duke Univ., 919-660-2512, cberger@phy.duke.edu*

Salim F. Idriss, Ned Rouze, David K. Hall, Daniel J. Gauthier

Bifurcations in the electrical response of cardiac tissue can destabilize spatio-temporal waves of electrochemical activity in the heart, leading to tachycardia or even fibrillation. Therefore, it is important to understand the mechanisms that cause instabilities in cardiac tissue. Traditionally, researchers have focused on understanding how the transmembrane voltage is altered in response to an increase in pacing rate, i.e. a shorter time interval between propagating electrochemical waves. However, the dynamics of the transmembrane voltage are coupled to the activity of several ions that traverse the membrane. Therefore, to fully understand the mechanisms that drive these bifurcations, we must include an investigation of the ionic behavior. We will present our recent investigation of the role of intracellular calcium in an experimental testbed of frog ventricle. Calcium and voltage are measured simultaneously, allowing for the previous research regarding voltage to guide our understanding of the calcium dynamics.

Session DH: The Art and Science of Teaching

Co-Sponsors: Committee on Physics in Undergraduate Education, Committee on Research in Physics Education
Location: Colony B-C
Date: Tuesday, July 31
Time: 3–5 PM

Presider: Ray Burnstein, Illinois Institute of Technology, 312-567-3379, burnsteinr@iit.edu

DH01: 3PM "There Is No 'Art,' There Are Only Artists" [1]

Invited *– Dwight E. Neuenschwander, Southern Nazarene Univ., 405-491-6361, dneuensc@snu.edu*

With respect to the art of teaching I am no authority, but am merely a fellow searcher. I have no finger-wagging maxims for telling other teachers what to do. But perhaps I can share the sources of my own inspiration. Their lessons suggest a recurring theme: The central importance of the personal creative spirit. I would encourage us to remove the detached objectivity that puts distance between teacher and students, and be WHO WE ARE as individuals. Only when I am authentic can I communicate with my students on a meaningful level. I would say to my fellow teachers: You bring to physics teaching a combination of skills, passions, perspectives, experiences, and attitudes that are unique. Each of us therefore has something unique to offer. I will try to describe how this principle can be applied to physics teaching.

1. E.H. Gombrich, *The Story of Art* (Phaidon, 2004).

DH02: 3:30 PM Can Scientific Research Enhance the Art of Teaching?

Invited *– Richard R. Hake, Indiana Univ. Emeritus, 818-992-0632, rrhake@earthlink.net*

Good teaching is properly regarded as an art. Nevertheless scientific research in the form of formative pre/post testing is being successfully employed to improve the effectiveness of teaching in undergraduate astronomy, economics, biology, chemistry, economics, geoscience, engineering, math, and physics. But such research is still anathema to many members of the psychology-education-psychometric community. I argue that this irrational bias impedes a much needed enhancement of student learning in higher education. I then review the development of diagnostic multiple-choice tests of higher-level learning; normalized gain and ceiling effects; the documented two-sigma superiority of interactive engagement to traditional passive-student pedagogy in the conceptually difficult subject of Newtonian mechanics; the probable neuronal basis for such superiority; education's lack of a community map; higher education's resistance to change and its related failure to improve the public schools; and, finally, why we should be concerned with student learning. This talk is based on reference #1.

1. R.R. Hake, "Should We Measure Change? Yes!" online as ref. 43 at http://www.physics.indiana.edu/~hake. To appear as a chapter in "Evaluation of Teaching and Student Learning in Higher Education," 2007, a monograph of the "American Evaluation Association."

DH03: 4 PM The Case of the Conservation of Energy and Momentum

Invited *– Patricia M. Heller, Univ. of Minnesota, 612-750-2031, helle002@umn.edu*

Good teaching can be described as an art. But like any creative, complex skill, some good teaching practices can also be learned through mentoring and guided practice. We can also use research to inform and improve our teaching. In the past 25 years, significant research has been conducted about students' naïve or alternative conceptions in physics, and why some students' alternative ideas are very resistant to change. Teachers also have alternative conceptions about learning and teaching physics that are resistant to change. This talk will explore this resistance to change through the examination of the teaching of the conservation of energy and momentum.

Session DI: Demonstration of Mastery: The Future of the Exams

Sponsor: Committee on Graduate Education in Physics
Location: Imperial G
Date: Tuesday, July 31
Time: 3–5 PM

Presider: Michael Thoennessen, Michigan State Univ., 517-333-6323, thoennessen@nscl.msu.edu

DI01: 3 PM Panel Discussion "Demonstration of Mastery: The Future of the Exams"

Panel – Michael Thoennessen, Michigan State Univ., 517-333 6323, thoennessen@nscl.msu.edu

The 2006 Joint AAPT/APS Task Force on Graduate Education in Physics Report (www.aapt.org/Resources/GradEdReport.dfm) studied the current status of the graduate education in physics PhD programs and made recommendations on several issues. The report made "no recommendation concerning the use of comprehensive exams except to note that there needs to be some method of evaluating students' knowledge of the core subjects." The report then recommends "that the physics department chairs engage in discussions of comprehensive examinations and their alternatives." Many departments have recently changed or are considering modifications to their exam structure. Representatives from several universities have agreed to discuss their experiences and future plans, including Marianne Breinig (Tennessee), Terry Oswalt (Florida Tech), Prof. Andrew Zangwill (Georgia Tech) Joe Perez (Auburn), Tim Newman (Arizona State) David Tedeschi (South Carolina). In addition Eric Adles from North Carolina State will represent the graduate students.

Session DJ: Teacher Preparation and Professional Development

Location: Imperial F
Date: Tuesday, July 31
Time: 3– 5 PM

Presider: Francis Tam, Frostburg State Univ., 301-687-4165, ftam@frostburg.edu

DJ01: 3 PM Pre-service Teachers Work on Electric Circuits Concepts: Hands-on and Computer-based Approach

Dominguez Angeles, ITESM, Campus Monterrey, 512-923-2700, angeles.dominguez@itesm.mx

Adem Ekmekci

High school pre-service teachers in math and science work on an activity about electric circuits from a vocational approach for an education course in their curriculum. The focus of the activity was centered on the concept of vocationalism rather than on electric circuits. However, this activity gives us the opportunity to observe the benefits and disadvantages of hands-on and computer-based approach in terms of the learning environment and student learning. To this end, one group of students works using Physlets and another group using real equipment (i.e., batteries, bulbs switches, sockets and wires). To approach electric circuits from a vocational perspective, students in both groups were asked different tasks on real-life applications that required a simple understanding of circuits. The results of the different performances of the two groups and its consequences will be reported.

Sponsored by: Genaro Zavala

DJ02: 3:10 PM Do Future Teachers' Views About Science Change After a Single Course?

N. Sanjay Rebello, Kansas State Univ., 785-532-1539, srebello@phys.ksu.edu

In fall 2006 we administered EBAPS (Epistemological Beliefs in the Physical Sciences) and VNOS (Views of the Nature Of Science) at the beginning and end of a physics course for future elementary teachers. The course was taught in a learning cycle format and involved hands-on activities and active learning in the classroom. We recently[1] reported on the EBAPS results. Here we report on results of the VNOS and compare them with our earlier EBAPS results. We also compare students' scores on these two survey instruments with scores on other traditional measures of assessment such as tests and exams.

1. N. S Rebello, "Future elementary teachers' epistemological beliefs and views of the nature of science" talk presented at the American Association of Physics Teachers 2007 Winter Meeting, Seattle, WA, 2007.

DJ03: 3:20 PM The Impact of an Inquiry-based Physics Course on Teachers' Practices

Danielle B Harlow, Univ. of Colorado Boulder, 303-579-5887, danielle.harlow@gmail.com

Elementary teachers who teach science with methods consistent with inquiry are required to use their science knowledge in new ways—such as when responding to student comments that cannot be scripted or fully planned for. Compared to traditional courses, inquiry-based physics curricula appear to improve learning gains on tests of conceptual understanding. However, less is understood about what teachers actually transfer from such courses into their teaching practices. I investigated how a professional development course based on the Physics and Everyday Thinking (PET) curriculum affected the teaching practices of five case study elementary teachers. The findings of this study show that the each teacher transferred different content and pedagogical aspects of the course into their science teaching. The range of transfer is explained by considering how the individual interacted with the learning context and their initial ideas about teaching science.

DJ04: 3:30 PM Active Engagement in Science for Elementary Teachers: Views of Faculty *

Charles B. Mamolo, Kansas State Univ., 785-532-1612, cbmamolo@phys.ksu.edu

Dean A. Zollman

For about 30 years Kansas State Univ. has offered a conceptual level physics class—Concepts of Physics [1] for future elementary school teachers. In contemporary language this course is a reform class. That is, it engages the students in "hands on" and "minds on" activities. Other science courses taken by elementary education majors range from traditional to active engagement. As part of a larger study we recently interviewed faculty involved in these courses to understand better their views toward preparing teachers and the role of engagement in that process.

1. D.A. Zollman, "Learning cycles for a large-enrollment class," *Phys. Teach.* **28**(1), 20-25 (1990).

*Supported by the National Science Foundation under grant 0554594

DJ05: 3:40 PM Female Persistence Factors: Female Physicists' Views on High School Influences

Zahra Hazari, Harvard Smithsonian Center for Astrophysics, 617-496-7581, zhazari@cfa.harvard.edu

Philip M. Sadler, Gerhard Sonnert

On the path toward science careers, a critical transition point lies between high school and college where disproportionate numbers of young women opt out of the possibility of science careers, particularly within physical science. In a project funded by the National Science Foundation (entitled "Persistence Research in Science and Engineering (PRiSE)"), we plan to study this issue by collecting and analyzing data from approximately 4,000 college freshmen at 20 institutions with the goal of identifying the factors that strengthen the interest to pursue science in college, particularly for female students. The initial phase of the project generated testable hypotheses about factors influencing young women's persistence in the sciences. In addition to the existing hypotheses in the scholarly literature, we surveyed students, teachers, and scientists, including approximately 150 female physicists, about their views on this issue. This talk will present some of the results.

DJ06: 3:50 PM The Effect of the PET Curriculum on Physics Students' Attitudes

Kara E. Gray, Univ. of Colorado, 303-718-4544, kara.gray@colorado.edu

Valerie Otero

Previous studies in physics education research have shown that student attitudes toward physics and learning decrease over one semester of physics instruction. Pre-service elementary teachers typically have very novice-like attitudes toward physics. The Physics for Elementary Teachers (PET) curriculum is designed especially for this audience. In addition to content, the PET curriculum explicitly addresses issues of learning about learning physics as well as issues in the nature of science. From previous small studies and PET student reports, we hypothesized that PET students will make significant gains on physics attitudinal surveys. To test this hypothesis, we administered the Colorado Learning Attitudes about Science Survey (CLASS) to approximately 200 students from eight universities and measured pre/post learning gains. We will present the results of our study and compare CLASS gains from the PET students to CLASS gains of students from other types of physics courses.

DJ07: 4 PM Toward More Effective Dissemination: Lessons From the Modeling Physics Project

Eric Brewe, Hawaii Pacific Univ., 808-236-3575, ebrewe@hpu.edu

Melissa H. Dancy, Charles Henderson

The dissemination of proven reforms in physics teaching is a problem currently facing the Physics Education Research (PER) community. One of the most successful examples of the dissemination of PER-based reforms is the Modeling High School Physics Project at Arizona State Univ.. More than 2000 high school teachers nationwide have participated in at least one 15-day Modeling workshop. Of the teachers who participated in the full two-summer program, more than 90% indicated that it had a highly significant influence on the way they teach. This talk will present the preliminary results of a case study designed to better document and understand the reasons behind the success of the modeling approach to dissemination. Data sources include interviews with key personnel and written documentation of the program. Appropriate connections will be made to relevant theories of personal and systemic change.

DJ08: 4:10 PM Bringing Relevant Physics Education Research to High School Physics Teachers *

Mojgan Matloob-Haghanikar, Kansas State Univ., 785-532-7167, mojgan@phys.ksu.edu

Brian Adrian, Dean A. Zollman

The Physics Teaching Web Advisory (Pathway) is facilitating teacher education via state-of-the-art Web technology. The primary component of Pathway is the Synthetic Interview, in which teachers can interview experienced teachers about pedagogical issues. While much of Pathway is devoted to "how-to-do-it," we also wish to make the teachers aware of physics education research and research-based instruction related to their questions about teaching. We started with a collection of teachers' questions and associated relevant resources to these questions. When a teacher submits a question to Pathway, references to these resources are displayed as part of the Synthetic Interview response. Examples may be viewed at http://www.physicspathway.org.

*Supported by the National Science Foundation under grants 0455772 & 0455813

DJ09: 4:20 PM Supporting Diagnostic Learning Environments in Pre-college Classrooms *

Lane Seeley, Seattle Pacific Univ., 206-281-2011, seelel@spu.edu

Lezlie DeWater, Eleanor Close, Stamatis Vokos, Pam Kraus

The Department of Physics and the School of Education at Seattle Pacific Univ., together with FACET Innovations, LLC, are in the second year of a five-year NSF TPC project, Improving the Effectiveness of Teacher Diagnostic Skills and Tools. We have used several extensive (N~2300) surveys of local middle school students to identify and categorize facet clusters of productive and unproductive modes of reasoning in the topical areas of Properties of Matter, Heat and Temperature and Physical and Chemical Changes. Once identified, the facet clusters serve as a framework for constructing web-based diagnostic tools for pre-college teachers. Through intensive, content rich professional development workshops we are helping teachers transform their classrooms into better diagnostic learning environments.

* Supported in part by NSF grant #ESI-0455796, The Boeing Corporation, PhysTEC, and the SPU Science Initiative.

Session DK: Undergraduates' Roles in Improving Education

Co- Sponsors: Committee on Physics in Undergraduate Education, Society of Physics Students (SPS)
Location: Imperial A
Date: Tuesday, July 31
Time: 3–5 PM

Presider: Jack Hehn, American Institute of Physics, jhehn@aip.org

Co-Presider: Gary White

DK01: 3 PM Tutor Roles Where Physics Studies Are Taken Outside The Classroom

Invited *– Bryndol Sones, United States Military Academy, 845-938-4512, bryndol.sones@usma.edu*

Robert Ryan

The Department of Physics at the United States Military Academy has taken a strategy to bring the study of physics outside of the science building. Implementation of this strategy involves the use of technology, interdepartmental collaboration, and support from the Academy's Center for Enhanced Performance (CEP). The use of technology centers on web-based course management tools for delivery of simulations and applets for virtual experiments and video analysis in student rooms. Interdepartmental collaboration brings academic relevance and strengthens continuity of the undergraduate experience. Our Math and Physics Departments have exchanged instructors and in our English Department students are reading and writing about physics in their freshman composition course. The CEP tutoring programs are our enabler. The tutoring program unites counseling professionals, the physics faculty with subject matter expertise, and gifted undergraduates willing and capable of instructing peers. These methodologies open undergraduate feedback mechanisms for curriculum design and improvement to the physics educational experience.

DK02: 3 PM How a Learning Assistant Program Can Transform a Physics Department into a Dynamic Learning Community *

Invited *– Andrea Vermeer, Seattle Pacific Univ., 206-281-2011, AndreaVe@spu.edu*

Lane Seeley, Eleanor Close, Stamatis Vokos

Four years ago the physics department at Seattle Pacific Univ. received an NSF CCLI grant to transform the introductory physics courses. Department faculty adapted research based curriculum and instituted a Learning Assistant (LA) program to create introductory courses in which the majority of class time is devoted to interactive, small group learning experiences. As an SPU student I have participated in the LA program for three years. During this time, I taught in a variety of courses, led an SPS outreach project to local high schools, developed curriculum and did research for a pre-service teacher program. My poster will describe these experiences in the life of a physics student.

* Supported in part by NSF grant #ESI-0455796, an SPS Marsh White Award, PhysTEC, and the SPU Science Initiative. AAPT Sponsor - Lane Seeley

DK03: 3 PM Transforming Undergraduate Physics: The Colorado Learning Assistant Program *

Invited *– Portia Wolf, Univ. of Colorado at Boulder, 303-883-8017, portia.wolf@colorado.edu*

Nicole A. Duncan, Valerie Otero, Steven Pollock, Noah D. Finkelstein

We present a new model activity system designed simultaneously to: improve undergraduate courses in science and mathematics, increase the number and quality of teachers in STEM disciplines, and transform Univ. faculty practices and beliefs about education. The Colorado Learning Assistant program [1] brings together a coalition of faculty from five science departments with faculty in the school of education to achieve these goals. We report on the implementation of the LA program in the physics department which has: (a) supported the transformation of the introductory sequence, resulting in student learning gains as great as three times the national average for non-transformed courses; (b) increased the number of physics majors enrolling in teacher certification programs; and (c) engaged departmental faculty who have changed their beliefs to support these transformed educational practices. We additionally present an examination of the transformation of one course, Modern Physics for Engineers, and provide perspectives from the faculty, students, and learning assistants involved.

1. V. Otero, N.D. Finkelstein, S.J. Pollock and R. McCray (2006). *Sci.* **313**, 445.

*This work is sponsored by NSF and the AAPT/AIP/APS PhysTEC program.

DK04: 3 PM Learning to Teach

Poster – Jessica A. Clanton, Univ. of Arkansas at Fayetteville, 870-391-6148, jaclant@uark.edu

As a learning assistant, I have had the opportunity to hone my teaching skills in three pedagogically sound undergraduate courses: Univ. Physics I, an introductory classical mechanics course; Univ. Physics II, the subsequent electricity and mechanics course; and Physical Science and Everyday Thinking, a physical science course designed for elementary teachers. Assisting in these courses has not only taught me concrete skills like how to write a comprehensible lesson plan and how to plan a functional lab activity, but it has also taught me less tangible lessons. For instance, through teaching, I have found that inquiry and experimentation, the very roots of scientific discovery, are the most effective methods available to assist students in learning today.

DK05: 3 PM Physics Majors Teaching Future Teachers: Learning Assistants in Preservice Teacher Education

Invited *– Frank Hicks, California State Univ., 916-278-5802, hicks@csus.edu*

In order to 1) create an early, meaningful teaching experience with limited resources and 2) demonstrate that our physics department values teaching as a career, the author piloted a learning assistant program in Spring 2006. A survey given to active members of the local SPS chapter indicated strong student interest in teaching as a career, and from this pool of candidates, two undergraduate physics majors were chosen to serve as learning assistants (LAs) in Physics 107, an inquiry-based physics course for future K-8 teachers. In addition to assisting in the classroom, the LAs read assignments about education and kept a weekly reflection journal. At the end of the semester, the LAs planned and team-taught a lesson, and each wrote a "training" essay describing classroom strategies for working with students and groups. This presentation will describe the project, including the lessons learned, keys to implementation, and benefits to the learning assistants.

DK06: 3 PM An Undergraduate Teaching Assistant Study: Impact of Inquiry at FIU

Poster – Laird Kramer, Florida International Univ., 305 3486073, Laird.Kramer@fiu.edu

George O'Brien, Priscilla Pamela, Jeffrey Saul

We present results of an undergraduate teaching assistants case study, comparing experiences in inquiry classes to those in more traditional classes. The Center for High- International Univ. (FIU) provides physics undergraduate with rich learning environment based on the Hestenes et al. Physics Modeling approach and materials. [1] Undergraduate CHEPREO Fellows serve as learning assistants in studio-style modeling-based introductory physics course sections and as leaders of Treisman-style tutoring sessions for math and physics classes. CHEPREO Fellows and traditional undergraduate TAs were interviewed using the small focus group protocol developed by Morgan & Saul [2] to compare their perceptions of the role they play in classroom instruction and how they approach teaching in general. The case study includes teaching assistants from modeling classes and traditional courses including TAs who have taught both styles of courses.

1. M. Wells, D. Hestenes, and G. Swackhamer, "A modeling method for high school physics instruction," *Am. J. Phys.* **63** (7), 606-619 (1995) and D. Hestenes, "Modeling methodology for physics teachers," in E.F. Redish and J.S. Rigden, Proceedings of the ICUPE: AIP Conf. Proc. 399 (AIP Press, College Park MD, 1996), 935-958.

2. A. Morgan and J.M. Saul, "Focus Group Interviews as a course evaluation and Improvement Tool," Poster presented at Summer 2005 AAPT meeting in Salt Lake City. Work supported by NSF Award #0312038

DK07: 4 PM Questions and Answers

***Invited** – Gary White, American Institute of Physics, gwhite@aip.org*

Session DL: Physics Teaching Around the World

Sponsor: Committee on International Physics Education
Location: Imperial B
Date: Tuesday, July 31
Time: 3–5 PM

Presider: Gordon Ramsey, Loyola Univ. Chicago, 773-508-3540, gpr@hep.anl.gov

DL01: 3 PM Teaching and Learning Physics in Perspective

Colin A. Gyles, Univ. of Technology, Jamaica, 876-414-2376, cgyles@utech.edu.jm

Physics seeks to describe the basic nature of matter and the forces and interactions that determine its state and behavior and the generalizations of physics form the basic premises that are applied in other physical sciences. Physics provides descriptions of physical things, processes and relationships by means of physical quantities (that is, numerical systems for quantifying the characteristics being described). Quantities and symbols are used as a means of communication as they facilitate brevity and provide for accuracy and precision in making descriptions. The generalizations of physics are developed and modified by testing and observation. Teaching and learning physics within the context of its fundamental aims and methods, as stated, facilitates a conceptual link with everyday modern technology, enhances student interest in the physical sciences, leads to an appreciation of the inter-relatedness of all the natural sciences and provides grounding in the scientific method for present and future application.

DL02: 3:10 PM Interpreting Physics Concepts Using Quotients and Units

Antonio Lara-Barragan, Universidad Panamericana campus Guadalajara, 31 25 49 68, anlabago@hotmail.com

In the Mexican academic environment our students don't generally know what is meant by interpreting (giving the physical meaning) a physics concept. For instance, when a student is asked to interpret speed, the typical answer is: "distance divided by time", but they do not really know what is actually meant by "distance" or "time"; to them, they're just symbols and numbers to look for in the problem statement. We have then tried a simple method to make our students understand meanings, which consists of four steps. First, we tell them that knowing all of the names of a bird don't mean you know something about the bird; then we proceed to interpret quotients. Next step is stressing the fact that units keep the core of physical meanings, and then we proceed to physically interpret the concept based on units. This procedure also accounts for the importance of units.

DL03: 3:20 PM Video Based Motion Analysis in the Mechanics Course for Engineering Students

Tetyana Antimirova, Ryerson Univ., 416-979 5000 x 7416, antimiro@ryerson.ca

Selected homework assignments developed within LivePhoto Project were adapted for the use as small-group mini-projects in a calculus-based Mechanics course for 90 students enrolled in various Engineering Programs (Mechanical, Aerospace, Industrial and Chemical Engineering). This course includes some topics that are not typically covered by the introductory physics courses. For those mini-projects, some typical end-of-chapter problems were turned into the activities where the students were required to perform calculations using the motion data obtained from the movie clips. As an illustration, Projectile Motion movie (Galileo's Projectile) was used to teach the topics of normal and tangential acceleration in curvilinear motion. The students' feedback and preliminary data on the effectiveness of Video Based Motion Analysis will be presented. The author would like to thank the staff of the Activity Based Physics Faculty Institute (Summer 2006) for introducing her to Video Based Motion Analysis. Life Photo Physics website http://livephoto.rit.edu/

DL04: 3:30 PM Theoretical Projects: A Taste of Research without Fancy Equipment

Michael J. Ponnambalam, Univ. of the West Indies, 876-927-2480, michael.ponnambalam@uwimona.edu.jm

In many Third World countries, financial constraints make it very difficult to buy the expensive lab equipment needed at the advanced Undergraduate level. To solve this problem, as well as to give our students a taste of research, we have developed several Theoretical and Semi-experimental Projects. In this paper, a Theoretical Project on Lattice Specific Heat at the Senior level Solid State Physics will be discussed.

DL05: 3:40 PM Meaningful Learning through Test Preparation Activities

Edit M. Yerushalmi, Weizmann Institute of Science, 972-507-877904, ntedit@wisemail.weizmann.ac.il

Ester Bagno, Zehorit Kapach

"I blacked out, I couldn't figure out what it was all about"; "The test was unfair, it was full of trick questions." Many students, when facing an unfamiliar problem during a test, find it difficult to retrieve physics concepts and principles relevant to solving the problem. Students also frequently fail to apply these concepts and principles carefully. Research shows that appropriate organization of concepts and principles, as well as awareness to their possible misinterpretations, characterize successful problem solvers and advance meaningful learning. Accordingly, we constructed test preparation activities in various topics that focused on organizing students' knowledge (i.e. categorizing problems according to their underlying principles) and on developing awareness of common misconceptions. Each activity includes several web based worksheets, accompanied with self assessment tools. Such activities take advantage of students' motivation to learn when preparing for the test. We shall describe the activities and preliminary findings.

DL06: 3:50 PM A Report of People to People Ambassador's Recent Trip to China on Physics Education

Celia Chung Chow, CSU, Simsbury, CT, 860.888.8209, cchungchow@comcast.net

Where physics education becomes more and more international, a group of AAPT's members visited China in June. A comparison of physics education will be made on both high-school and college levels. Further international cooperation will be continued. Some slides will be shown.

DL07: 4 PM Helping Tibetan Monks Develop a Domain Model of Ferromagnetism.*

Andy P. Johnson, BHSU Center for Math and Science Education, 605 642-6508, andyjohnson@bhsu.edu

Mel Sabella

In January we taught inquiry-based lessons on magnetism to a group of 50 Tibetan Buddhist monks and nuns at the Sera Monastery in southern India. This was part of the 2007 Science Workshop for Monks (http://www.scienceformonks.) Our goals were that the monks would develop a coherent, evidence-based model of ferromagnetic materials and that they would gain experience with western scientific inquiry and reasoning. We used a modified version of the CPU materials in these lessons. We will describe what it was like to teach in this very different culture, our sense of what the monks may have learned, and a few things that we learned from this experience.

*Supported by the Library of Tibetan Works and Archives and the Sager Family Foundation.

DL08: 4:10 PM A Collaborative Physics-Education Project with the Univ. of Zacatecas, Mexico

Perry A. Tompkins, Samford Univ., 205-726-4121, patompki@samford.edu

Samford Univ. 's Physics department held an undergraduate-collaborative course with the Physics Department of the Univ. of Zacatecas, Zacatecas, Mexico in January 2007. Participating Samford students registered in a course titled "Physics Education Experience". This program was originally designed with the Physics Department of The Univ. of Havana, Havana Cuba as a direct result of recommendations from the 8th meeting of the Inter-American Conference on Physics Education, Havana Cuba, 2003. Travel to Cuba was restricted for a program of this type in 2004 and an alternate collaboration was established in Mexico. This program was organized and funded and allowed four Samford undergraduates to work in Zacatecas for two weeks of computer-instrumented physics experiments in collaboration with peer undergraduate Mexican students. Details of the results of this project including schedule, structure, funding and experiences will be described during this talk.

DL09: 4:20 PM Physics Is Fun

Rafal Jakubowski, Szkolna 31, Ostrow Wielkopolski, 0048 62 734 74 18, festiwal@osw.pl

Grzegorz Karwasz

The program we designed "Physics is Fun" proposes a new approach to teaching physics, and science divulgation, in general. Objectives of the program were obtained by identifying fun and clever objects that illustrate laws of physics and examples of applications of those laws. We presented to a broad public audience a series of exhibitions in five European Union Countries: Slovenia, Italy, Germany, France and Poland. We produced virtual versions of these exhibits in the form of CDs and on websites. The project produced objects and descriptions at two levels: Physics of everyday objects that also could capture the interest and imagination of those using them most of these were table-top gadgets and toys. These objects were used to show laws of Mechanics, Thermodynamics, Electricity and Optics. Walking though Modern Physics we identify and comment on some achievements, but even more we are able to ask students and adults to focus and imagine open problems in contemporary Physics. The focus of this presentation will be to review the CD Physics and toys showing all our work in this European Union funded Project Physics is fun.

DL10: 4:30 PM International Year of Physics Activities in Central and South American Countries

Patsy Ann Johnson, Slippery Rock Univ. of Pennsylvania, 724-738-2317, patsy.johnson@sru.edu

Margarete Allen

Many Central and South American countries encouraged public awareness about and enthusiasm for physics as part of celebrations of the International Year of Physics in 2005. Some of these activities were reported at the 2006 Inter-American Conference on Physics Education held in Costa Rica. Posters, brochures, and other products produced for the International Year of Physics were displayed at the conference. What was learned at the Costa Rica conference and elsewhere about these efforts will be shared in this oral presentation.

Session DM: Laboratory Improvement: NSF-CCLI Projects

Sponsor: Committee on Laboratories
Location: Auditorium I
Date: Tuesday, July 31
Time: 3–3:40 PM

Presider: Greg Puskar, West Virginia Univ., 703-292-4630, gpuskar@mix.wvu.edu

DM01: 3 PM An Overview of Physics Activity in the NSF-CCLI Program

***Invited** – Duncan McBride, National Science Foundation, 703-292-4630, dmcbride@nsf.gov*

The NSF Course, Curriculum, and Laboratory Improvement (CCLI) program makes grants for development of undergraduate courses, labs, and curricula. Projects range from small grants to try out interesting ideas that might be important to others, to comprehensive projects that can affect how physics is taught everywhere. I will talk about the CCLI program, its current directions, and some areas that may change. I will also give an overview of current physics projects that will provide an introduction to the papers that follow in the session.

DM02: 3:30 PM Improving Intermediate Optics for Greater Conceptual Understanding *

Mark F. Masters, IPFW, 260-481-6153, masters@ipfw.edu

Timothy T. Grove

We are in the second round of improvements and revisions of our intermediate optics course and laboratory curriculum. Our in-class approach utilizes directed derivations and interactive engagement approaches that require the students to apply the physics through challenging questions. The optics requirement must be challenging to both students who have just completed a two semester introductory physics sequence and to senior physics majors as well. We will describe the approach we adopted (a concentration on geometrical optics, detailed direction at the beginning of a laboratory session with diminishing direction as the semester progresses). We present details of our approach and results of our initial trials.

*Supported by NSF Grant # DUE 0410760

Session DN: Physics Olympics as Student Outreach

Co-Sponsors: Committee on Apparatus,
Committee on Science Education for the Public
Location: Oak B-C
Date: Tuesday, July 31
Time: 3–5 PM

Presider: Stephen Irons, Yale Univ., 203-432-3664, stephen.irons@yale.edu

DN01: 3 PM Yale Physics Olympics, 10 Years of Student Outreach

Poster – Stephen H. Irons, Yale Univ., 203-432-3664, stephen.irons@yale.edu

Since 1997, Yale has conducted an outreach program for local high school physics students. Taking the form of an Olympics with five distinct events plus a Fermi quiz, 50 teams (of four students each) from many different schools compete to perform an experiment, solve a problem or complete a task. Event prizes are awarded, and there is also a prize for best overall performance. Our Olympics has expanded to include a demo show, a tour of Yale's Wright Nuclear Structure Laboratory and a teachers' activity room. We have found this event an excellent way to generate excitement within the high school physics community, as well as raise the profile of the physics department within the university and the city at large. I will present details on how we run our Olympics and give some tips and advice on how to organize a successful event.

DN02: 3 PM The Evolution of Northern Illinois Univ.'s Physics Olympics Outreach

Poster – Patricia A. Sievert, Northern Illinois Univ., 815-753-6418, sievert@physics.niu.edu

Northern Illinois Univ.'s Physics Olympics has evolved over the past four years. I'll share what has worked and what has not worked for us. Our Physics Olympics have included quiz bowls, department tours, demo shows, bridge building, Rube Goldberg style competitions, Pringles mailing challenges and of course the on-site hands-on challenges. www.physics.niu.edu/frontier.

DN03: 3 PM The Richmond Physics Olympics

Poster – Emory F. Bunn, Univ. of Richmond, 804-287-6486, ebunn@richmond.edu

Cornelius Beausang, Ovidiu Lipan, Matthew Trawick, Mirela Fetea

To stimulate interest in physics among high school students and to provide support for physics teachers in the region, the Univ. of Richmond has hosted the Richmond Physics Olympics Competition for the past three years. Similar competitions are held annually at Yale Univ., the Univ. of Liverpool, U.K. and Univ. of Western Australia, Perth. Teams of high-school physics students from all over Virginia compete in five half-hour events. Each event is a measurement or task to be performed with simple, familiar equipment, requiring the students to apply basic physics principles in fun and unexpected situations. Surveys of participants show that students overwhelmingly enjoy the competition. Along with faculty members, Univ. of Richmond undergraduates play a major role in developing, testing, and supervising the events. About 40 undergraduates are involved each year. The event generates a great deal of enthusiasm among our students and raises the visibility of physics campuswide.

DN04: 3 PM Physics and Society Education

Poster – Kathleen M. Geise, Univ. of Denver, 303-803-6906, kgeise@du.edu

Steven Iona, Robert Stencel

The Department of Physics and Astronomy helps host an annual outreach event at a local amusement park for students in grades 6-12. The Physics Night Program is made up of several parts primarily focused on having students apply physics principles and estimate measurements at the park. That evening, DU sponsors undergraduate student volunteers in queue lines to discuss physics concepts with students, and the Society of Physics Student (SPS) chapter stages a more elaborate collection of physics demonstrations at a central gathering place. In 2006, we expanded our outreach efforts to include interactive data collection and on-site interpretation of data. A team of graduate and undergraduate DU SPS students outfitted high school volunteers with vests and hardware designed to return three-axis acceleration information. Students wore the sensors on the rides, returned the equipment to the staging area, and received immediate feedback about the accelerations their hardware recorded.

Session DO: Best Practices in Teaching with Tech.

Sponsor: Committee on Educational Technologies
Location: Imperial C
Date: Tuesday, July 31
Time: 3–5 PM

Presider: Andy Gavrin, IUPUI Department of Physics, 317-274-6909, agavrin@iupui.edu

DO01: 3 PM Promoting Excellence in the Teaching of Physics Through Technology

Robert J. Lambourne, The Open Univ., +44 1908 606722, r.j.lambourne@open.ac.uk

In its largest ever teaching and learning initiative, the Higher Education Funding Council for England has funded the creation of a number of Centres for Excellence in Teaching and Learning. The Physics CETL (piCETL) is based at the UK's largest Univ., the Open Univ.; a predominantly distance teaching university with about 200000 students enrolled in its undergraduate and postgraduate programmes. piCETL is a collaborative CETL that also involves two medium sized conventional institutions, the Univ. of Leicester and the Univ. of Reading. This talk will describe the CETL initiative, the work of piCETL, and some of the outcomes of piCETL projects in e-learning, on-line experimentation and problem based learning. The talk will also explore the challenges and benefits of collaboration between radically different types of physics department.

DO02: 3:10 PM The Classroom in Transition: Latest Results from Georgia Southern Univ.

Cleon E. Dean, Georgia Southern Univ., P.O.B. 8031, 912-681-5616, cdean@GeorgiaSouthern.edu

The physics classroom is in transition at Georgia Southern Univ. The Physics Department is in the process of transforming its classrooms to the Studio Physics model. One model classroom, capable of serving up to 48 students at once, has already been converted at some expense and is already in use. Because of budget restraints and construction time considerations it is estimated that full conversion of all physics classrooms will not take place until 2010. In the meantime, the majority of the classrooms remain in the traditional format. A hybrid method, intermediate to the full Studio Physics model, is presented that brings interactive engagement to the traditional classroom. This method uses an overhead projector, transparencies, a laptop hooked up to a radio transceiver, student response clickers, and web-based homework system to implement Peer Instruction with Just in Time Teaching. New results from the completed Spring 2007 semester will be discussed.

DO03: 3:20 PM Easily Recording Lectures and Tutorials

Taha Mzoughi, Kennesaw S. Univ., 1000 Chastain Rd., #1202 678 797 2152, tmzoughi@kennesaw.edu

Lecture recordings offer many benefits to students taking introductory physics classes. The least of which is the ability of a students to easily go over the lecture again when needed. For us, they have even proven useful to students with some types of disabilities. During the presentation, we will describe the simple method we use for providing lecture recordings, and we will discuss its impact on our classes.

DO04: 3:30 PM Teaching Modern Physics in Technology-Rich Classroom Environment

Zdeslav Hrepic, Fort Hays State Univ., 785-628-4500, zhrepic@fhsu.edu

In order to fully capitalize on opportunities provided by pen-based computing and wireless technology, starting with the fall semester of 2005, Fort Hays State Univ. has been piloting and implementing Tablet PCs and the DyKnow software package in teaching. In this paper we report on modalities and results of DyKnow usage in a calculus-based sophomore level modern physics course for physics majors. The study was conducted in fall semester of 2006. DyKnow was used to facilitate note taking, to maximize interaction among all participants and to enable synchronous collaborative problem solving. The software features several effective, nontraditional venues for student feedback and formative assessment which were also regularly used during the semester. The effectiveness of the approach was measured through the test scores comparisons, students' end of the semester teacher/course evaluations and through multiple surveys eliciting students' input and feedback related to the instructional value of the utilized software and hardware.

DO05: 3:40 PM An Analysis of Student Learning Using the Andes Homework System

Brett van de Sande, Univ. of Pittsburgh, 412-624-7464, bvds@pitt.edu

Robert Hausmann

Andes is an intelligent tutor homework system designed for use in a two-semester introductory physics course. Previous research shows that students who use Andes learn significantly more than students who complete the same graded homework assignments using pencil and paper. One of the features of Andes is that students enter each step when solving a problem. Students are given immediate feedback as to the correctness of each step as well as hints on request. Andes records all details of the student's solution as well as any hints they have received. One can use this information to make fine-grained measurements of student learning across an entire semester. We use both chronometric and accuracy measurements to assess how long it takes students to master concepts, skills, and problem-solving strategies. The resulting cognitive models of student learning can be used to improve instruction.

DO06: 3:50 PM Correlations Between Student Discussion Behavior, Attitudes, and Learning

Gerd Kortemeyer, Mich. State Univ., 517-282-6446, korte@lite.msu.edu

An important result of physics education research is that students' learning and success in a course is correlated with their beliefs, attitudes, and expectations regarding physics. However, it is hard to assess these beliefs for individual students, and traditional survey instruments such as the Maryland Physics Expectations Survey (MPEX) are intended to evaluate the impact of one or more semesters of instruction on an overall class and improve teaching. We investigate the possibility of using the analysis of online student discussion behavior around randomized online homework as an indicator of an individual student's approach to physics. These discussions are not tainted by the effects of self-reporting, and are gathered in authentic non-research settings. We find that on an individual base, student discussions are a stronger predictor of success than MPEX outcomes. We also suggest how feedback from these online discussions can be used to improve in-class and online teaching and identify students-at-risk.

DO07: 4 PM Conceptual Learning in a Studio Setting

Stan Jones, Univ. of Alabama, 205-348-3791, stjones@bama.ua.edu

James W. Harrell, Charlotte E Horton

An integrated lecture/laboratory setting, sometimes called "studio physics," offers many direct advantages. Students and faculty alike are more engaged in all aspects of the learning process. Labs, problem-solving activities, simulations and lectures are intertwined so that each builds on the others. Setting alone, however, does not guarantee enhanced learning. Students must actively participate, and ultimately are responsible for their own learning, as in any setting. In order to improve conceptual learning in first-semester physics, we have modified our assessment methodology so as to give students frequent and immediate feedback about their mastery of key concepts. We make extensive use of technology both in and out of class for assessments, both before and after experiments and other in-class activities. We report here the results of including these frequent assessments in the studio framework to encourage students to confront their misconceptions and reconstruct their understanding of introductory physics.

DO08: 4:10 PM Restructuring Introductory Physics Courses by Integrating Modern Educational Technologies

Delena Bell Gatch, Georgia Southern Univ., 912-681-5292, dbgatch@georgiasouthern.edu

Currently the introductory physics courses at Georgia Southern Univ. consist of three-hour lecture courses taught independent of two-hour laboratory courses. Four different introductory lecture courses are offered: Introduction to Physics I and II (trig-based) and Principles of Physics I and II (calculus-based). Two different introductory laboratory courses are offered: Physics Lab I and II. We have recently begun piloting new classes that integrate the lecture and laboratory courses into a single course in which most of the class time is devoted to active, inquiry based learning. Developing these new integrated courses has provided the opportunity to take advantage of many modern educational technologies not previously available in our department. We have been systematically assessing effects of the use of computer interfaced lab apparatus, web-based simulations, clickers, and online homework systems on student learning outcomes through administering the Force Concepts Inventory and the Conceptual Survey of Electricity and Magnetism.

DO09: 4:20 PM Department Adaptation of Tablet PCs in the Introductory Physics Course.

Jon Campbell, United States Military Academy, 845-938-7828, Jonathan.Campbell@usma.edu

Bryndol Sones, Cory Gerving, Dave Palazzo, Todd Viar

Last fall, the Department of Physics at the United States Military Academy fielded IBM ThinkPad tablet PCs to all faculty teaching in the introductory physics courses required of about 1,100 students each year. Coupled with a campus-wide wireless network driven by Odyssey software protocols and hardwire connections to classroom projectors, the tablet PC had changed the landscape of the physics classroom. Instead of multi-colored chalk and several chalkboards, faculty presentations that model physical concepts and demonstrate problem-solving have migrated to the projections screen and some efficient use of neighboring chalkboards. Through employment of 20 faculty members and two semesters of instruction in mechanics and electricity and magnetism, our faculty has discovered several pedagogical lessons from the implementation of tablet PCs. This presentation analyses needs and desires of today's student, longevity and span of presented information, and proposes an optimized paradigm for use of both projected information and long-lived chalk board information.

DO10: 4:30 PM Wave Speed Using Video Analysis Software

Duane B. Merrell, Brigham Young Univ., 801-442-2255, duane_merrell@byu.edu

Using video analysis, the complexities of a wave sent down a sewer tape will be evaluated and discussed. Can you calculate the wave speed? What happens when waves are sent from two directions and meet in the middle? Can you view interference in the wave as the waves collide with each other? Can we take measurements using video the help teach the concepts of waves?

DO11: 4:40 PM The Study of Motion through Film and Digital Photography

Hector L. Lopez, Rutgers Univ., 732-445-2326, hlopez1@rutgers.edu

In this presentation a series of film and digital photography images will be used to demonstrate how the technology is utilized to study motion, and collision of objects. It will describe the use of motion diagrams, energy chart bars, as well as utilizing readily available word processing, spreadsheet, and image-editing software to analyze motion.

DO12: 4:50 PM Learning Electromagnetism in a Field of Visualizations*

Carolann Koleci, WPI, 508-754-8323, ck@wpi.edu

John Belcher, Sahana Murthy, Peter Dourmashkin

We are working on the development of a set of educational materials to be used in conjunction with a suite of electromagnetism visualizations created by researchers and computer developers at MIT. Using MasteringPhysics as our platform and questions extracted from Griffiths' popular text on electrodynamics, we provide a set of problems which feature integrated visualizations in the context of electromagnetism. Are students able to make effective use of the visualizations? Our preliminary findings, in addition to WPI Student impressions of these problems will be addressed and discussed.

*This work is supported by NSF DUE-0618558

DO13: 5 PM Creating Guided Inquiry Activities Using PhET Simulations

Trish Loeblein, Univ. of Boulder/ Evergreen High School, 303-982-5093, ploeblei@jeffco.k12.co.us

Do you want to help your students make sense of Physics and Physical Science? The Physics Education Technology (PhET) Project has developed over 60 simulations for teaching and learning introductory physics at the middle school, high school, and college levels. These research-based simulations create animated, interactive, game-like environments that are designed to engage students in active thinking, encourage experimentation, and help develop visual and conceptual models of physical phenomena, emphasizing their connections to everyday life. The simulations are free, and can be run from the PhET website (http://phet.colorado.edu) or downloaded to a local computer for off-line use. The PhET team has designed a set of guidelines that help teachers integrate the simulations into lessons using guided inquiry. This session will help you design effective, inquiry-based lessons using these guidelines to provide activities for students to construct their own understanding of physics and physical science ideas.

Session DP: PER: Leadership Organizing Council Meeting (Closed)

Location: Cedar
Date: Tuesday, July 31
Time: 1– 2 PM

Presider: TBD

Wednesday, Aug. 1

Poster Session III *Exhibit Hall*	8–9 AM
Great Book Giveaway *Exhibit Hall*	8–9 AM
AAPT Teaching Awards *Imperial D*	11 AM–12 noon
PERC Banquet *Victoria (ticket)*	6–8 PM
PERC Poster Reception	8–10 PM

Session EA: A Road Less Traveled: Exploring Teaching Assistant Training Programs

Co-Sponsors: Committee on Research in Physics Education, Committee on Graduate Education in Physics
Location: Cedar
Date: Wednesday, Aug. 1
Time: 9–11 AM

Presider: Cathy Ezrailson, Texas A&M Univ., 979-458-1544, cezrailson@tamu.edu

Panel – Noah Finkelstein, Pat and Ken Heller, David Hammer, Valerie Otero, Rachel Scherr

In this panel discussion, panelists will give a brief synopsis of their experience and unique perspectives in training Tas, answer questions posed by the moderator and audience, and suggest solutions to problems they and others have encountered while developing significant and relevant TA training programs. The expertise of the panelists runs the gambit from providing exemplary programs and definitive techniques to designing research that examines practice and motivates improvement of TA instruction. As a group, the panelists have pushed the envelop of instructional design for Tas and elevated the role of TA teaching to new importance. The audience is asked to bring their challenges, important questions and their own solutions to be examined and discussed during this panel's discussion.

*Supported in part by the National Science Foundation Grant No. REC 0440113

Session EB: Professional Concerns of Solo PER Faculty

Co-Sponsors: Committee on Professional Concerns, Committee on Research in Physics Education
Location: Maple
Date: Wednesday, Aug. 1
Time: 9–11 AM

Presider: Paula Engelhardt, Tennessee Tech Univ., 931-432-1537, engelhar@tntech.edu

Co-Presiders: Dean Hudek

Participants will interactively discuss matters of professional concern to people who are the solo PER faculty in their department. Please come prepared to tell us your situation, exchange ideas, ask questions, offer solutions, etc.

Session EC: Introductory College Physics Courses

Location: Imperial A
Date: Wednesday, Aug. 1
Time: 9–11:10 AM

Presider: Marina Milner-Bolotin, Univ of British Columbia, 604-822-4891, milnerm@phas.ubc.ca

EC01: 9 AM What Makes You Think You Can Take Physics Anyway?

Richard Zajac, Kansas State Univ. at Salina, 785-826-2693, rzajac_nospam@sal.ksu.edu

Introductory physics students themselves recognize that they suffer from deficiencies in math prerequisites. With this recognition each student develops an expectation for how to manage one's deficiencies and persevere in the course. Pre/post-testing was used in the algebra/trig course to categorize students according to these expectations and, by correlating with various aspects of the course, to track the performance of different categories of students. The results highlight a category of students who are trapped (presumably) by curricular constraints into completing a course they know they are not adequately prepared for. Students in this category are characterized by a high degree of accuracy at self-assessment relative to peers. Characteristics of this and other categories are also examined. Curricular implications may be of interest to two-year colleges.

EC02: 9:10 AM Mastering Physics Study Skills *

Nouredine Zettili, Jacksonville State Univ., 256-782-8077, nzettili@jsu.edu

We want to discuss the methods of efficient study habits and how they can be used by students to help them improve learning scientific subjects such as physics. In particular, we focus on topics such as the skills of how to develop long term memory, how to concentrate, how to take class notes, and how to study scientific and engineering subjects, notably physics. We argue that the student who conscientiously uses the methods of efficient study habits will be able to achieve higher results than the student who does not; moreover, a student equipped with the proper study skills will spend less time to learn a subject than a student who has no good study habits. The underlying issue here is not the quantity of time allocated to the study efforts by the student, but the efficiency and quality of actions.

*Supported by the Alabama Commission on Higher Education as part of a NCLB grant

EC03: 9:20 PM Peer-Assessment of Homework Using Rubrics: Continuing Past the First Semester

Sahana Murthy, Massachusetts Institute of Technology, 617-253-7698, sahana@mit.edu

Peter Dourmashkin

In an introductory, calculus-based physics course at MIT, students peer-assess each other's homework. Students use rubrics as a guide through the peer-assessment process. The rubrics have descriptors for various criteria that each problem is assessed on, such as, physics content, relevant representations, modeling the situation, problem-solving strategy and reasonableness of answer. In a previous AAPT meeting we presented preliminary results from the first semester (mechanics) that showed that students were able to reliably assess each other's homework, and improved in evaluation abilities. Students are continuing the peer-assessment during the second semester of the course (electricity and magnetism). In this talk, we explore the following questions: How does the quality of peer-assessment get affected if students struggle with conceptual issues in a given content area? Are there correlations between students' performance on conceptual/analytic questions (measured by standardized tests and exam performance) and their progress of evaluation abilities?

EC04: 9:30 AM Problems, Problems, and Problems

A. James Mallmann, Milwaukee School of Engineering, 414-277-7317, mallmann@msoe.edu

I will present examples of three types of problems: Problems with surprising answers that are assigned both for entertainment, and to challenge problem solving skills; optimization problems, where the goal is to not just find a solution but to find the best possible solution; and problems similar to but much more difficult than problems frequently assigned in introductory physics courses.

EC05: 9:40 AM Introducing Lab-Based Problems in Classical Mechanics

Larry Robinson, Austin College, 903-813-2345, lrobinson@austincollege.edu

It is not uncommon for instructors to perform classroom demonstrations with physical systems that illustrate theoretical models developed in classical mechanics courses. These demonstrations are welcome change-of-pace activities that sometimes serve to point out differences between real systems and ideal theoretical models. I have attempted to carry some of my demonstrations to another level by developing lab-based problems that do not require students to spend time setting up equipment and actually performing measurements in the laboratory. Most frequently, but not exclusively, they are required to analyze digital movies, an activity our students have performed in previous courses. I will discuss examples I have used and show a few short movies made for this purpose. I also hope to talk with other instructors who can suggest possible additional examples.

EC06: 9:50 AM Linking Conceptual and Numerical Aspects in an Introductory Physics Course

Gerald Feldman, George Washington Univ., 202-994-6489, feldman@gwu.edu

Cornelius Bennhold, Raluca Teodorescu

We use Peer Instruction extensively in our introductory physics classes for developing the conceptual foundations of our students. While the importance of a sound conceptual background is clear, the students regard the numerical exercises in homework or recitation as disconnected from the conceptual components of the course. They fail to recognize the utility of this conceptual framework for numerical applications insofar as an improved understanding of the physics concepts can enhance the problem-solving skills that they are practicing through numerical problems. To break down this apparent separation in the students' minds, we have created "ConcepModules" which establish explicit linkages between classroom conceptual questions and numerical examples. The results of a ConcepTest are brought directly to bear on a computational problem whose setup and solution might otherwise have caused trouble if the problem had not first been examined from a conceptual perspective. We present some examples of "ConcepModules" (linked conceptual/numerical sequences) that we have used in class.

EC07: 10 AM Pedagogical Coherence and Consistency in an Introductory Physics Course

Cornelius Bennhold, George Washington Univ., 202-994-6274, bennhold@gwu.edu

Raluca Teodorescu, Gerald Feldman

A common student complaint in introductory physics courses is that the various course elements, such as textbook readings, lecture materials, homework problems and lab exercises, appear disjointed and unrelated to each other. In order to elucidate an obvious pedagogical thread from the students' perspective, we have created a coherent framework that explicitly links the various course elements for individual physics concepts. Based on a new taxonomy of physics problems being developed by Teodorescu et al., students experience the same physics concept with increasing cognitive complexity across the curricular units, such as reading quizzes, ConcepTests and numerical examples in class, cooperative group problem solving in recitation, lab activities and homework problem solving. We will discuss this framework and present examples of such sequences from our introductory course.

EC08: 10:10 AM Physics for Engineering Students, The Old Fashioned Way

William H Bassichis, Texas A&M Univ., 979-845-3137, bassichis@physics.tamu.edu

We have designed and implemented a course specifically for freshman engineering majors. The laboratory portion is aimed at helping the students with engineering projects, giving them hands-on experience with the new concepts, and hopefully convincing them that physics is relevant for engineers. The course content and philosophy is also aimed specifically at preparing the student for following engineering courses. As such the course differs significantly from the one-size-fits-all standard approach. The students have benefitted in a number of ways, not the least of which is improvement in first year calculus.

EC09: 10:20 AM 3D Collaborative Learning of Faculty and Students in Introductory Courses

David Pundak, Ort Braude College and Kinneret College, Israel, +972-50-8652404, dpundak@ort.org.il

Shmaryahu Rozner

This paper describes a two-year study in the development of team work of faculty and students in introductory courses. The study focused on three dimensions of collaboration: between faculty and faculty, between students and students, and between faculty and students. Relying on PER, we developed a workshop for active learning (WAL) in Ort Braude Four Years Engineering College. Three subjects were learnt in WAL: physics, mathematics and chemistry. The WAL's environment encourages students to learn in teams with a supportive network, and demand instructors to decrease lecture time. The movement from traditional classroom to WAL caused reluctances among both students and faculties. The college management adopted the Rogers' model for introducing innovations into an organization. We'll describe some characteristics for successful faculties, who were able to better relate to students difficulties, to create collaborative work with their colleagues and a team building atmosphere with students.

EC10: 10:30 AM How Much Have They Retained? Making Unseen Concepts Seen in Electromagnetism Course at MIT

Yehudit Judy Dori, Technion, Israel Institute of Technology, +972-4-8293132, yjdori@technion.ac.il

Erin Hult, Lori Breslow, John W. Belcher

The introductory freshman electromagnetism course at MIT has been taught since 2000 using a studio physics format entitled TEAL—Technology Enabled Active Learning. TEAL has created a collaborative, hands-on environment where students carry out desktop experiments, submit web-based assignments, and have access to a host of visualizations and simulations. These tools help students visualize unseen electromagnetic concepts and develop stronger intuition about related phenomena. This longitudinal study focuses on (a) the extent to which the TEAL and the traditional groups retained conceptual understanding about 15 months after the course, and (b) students attitudes about the teaching format's contribution to their advanced courses. Our research indicated that the long-term effect of the TEAL course on students' retention of concepts was significantly stronger than that of the traditional course. This research is significant because it documents the long-term impact of the TEAL studio physics format on learning outcomes of MIT students.

Sponsored by John Belcher, MIT

EC11: 10:40 AM Fifty Year Review of Collegiate Cheating with Applications to Physics Teaching

David J. Palazzo, MIT, 845-938-3241, david.palazzo@usma.edu

David E. Pritchard

A review of 88 self-reported (SR) collegiate cheating studies conducted between 1955 and 2005 shows little evidence that overall SR cheating is increasing across college campuses. Only "unauthorized collaboration" between students evidenced a statistically significant increase between 1955 and 2005. Of the remaining 10 forms of cheating behaviors reviewed, no statistical significance can be attributed to their change from 1964 to 2005—in fact seven of these were observed to have decreased since 1964 (but without statistical significance). While the correlation of "general cheating" with time between 1964 and 2005 ($r = .07 \pm .21$, $p < .70$) showed no increase, 56.7% of all students reported some "general cheating" during their collegiate experience, and in only one of the 11 forms of cheating reviewed did less than 20% of students report cheating ("Turned in Work by Another"). From a moral perspective, this high rate should continue to alarm the educational community at-large. However, most surveys only ask whether, but not how frequently, students engage in academic dishonesty, so it is not possible to fully extrapolate the threat to educational effectiveness or grade integrity.

Sponsored by David E. Pritchard

EC12: 10:50 AM Superstrings: A Theory of Everything for Everyone?

Steven H. Mellema, Gustavus Adolphus College, 507-933-7306, mellema@gustavus.edu

Sylvester J. Gates, Jr.

This spring we team-taught a course entitled "Superstring/M Theory: The DNA of Reality" in an attempt to use string theory as the vehicle to explain the nature and significance of physics to a general audience of undergraduates. Based around a series of commercially available video lectures bearing the same title, we added lectures, experiments, and computer simulations in order to provide additional background, history, and context. Although originally envisioned as a course strictly for non-science majors, the topic and title of the course recruited an audience split about 50-50 among physics majors and students from outside the sciences. By adapting the material to this dual audience, we ended up with an interesting course that attempted to bridge the "two cultures" and to be of value to both audiences. We are eager to share what we have developed, and to find others interested in developing it further.

EC13: 11 AM The Old "New Movement" Among Physics Teachers

Amanda M. Gunning, Teachers College, Columbia Univ., 914-589-8008, amg2150@columbia.edu

Keith Sheppard

One hundred years ago, it was a very exciting time in the world of physics—not only were advances being made in the field, but physics education seemed to be at a turning point. From its beginnings as "Natural Philosophy" to its evolution into the technical course of "Physics," the efforts to reform the course at the turn of the 20th century are strikingly similar to current sentiments. Despite the fervor of discourse taking place through scholarly journals, the system in place in the early 1900s seems to have become frozen in time. Our current physics curriculum looks very much the same as what was taught 100 years ago. How did today's traditional physics course come about and how did it stop evolving? How can the past inform today's reform efforts?

Session ED: Panel Discussion: Introductory College Physics Textbooks: Current Role and Future Possibilities

Sponsor: Committee on Physics in Undergraduate Education **Location:** Imperial F
Date: Wednesday, Aug. 1
Time: Panel 9–10 AM & Discussion 10–11 AM

Presider: Peter Lindenfeld, Rutgers Univ., 732-445-2536, lindenf@physics.rutgers.edu

ED01: 9 AM How and Why Are Textbooks Used in a Physics Course?

Invited *– Suzanne White Brahmia, Rutgers Univ., 732-445-3914, brahmia@rci.rutgers.edu*

The role of the textbook is quite different as seen by the student, the instructor, and the textbook author. In addition the text is likely to be used differently in a college classroom and in a high school classroom covering the same material. Why do we assign a textbook at all? Is the goal to enhance students' learning of the topics covered? Is it for the students to become better and more confident in reading scientific material? Or is the book primarily a problem-solving guide to supplement the lecture? We explore these different perspectives in an effort to clarify the current role of the textbook in learning physics, and to pose questions about its future role.

ED02: 9 AM An Editor's Perspective

Invited *– Stuart Johnson, J. Wiley & Sons, 201-748-6000, sjohnson@wiley.com*

I will present some thoughts about the current economics of textbook publishing, and about the way textbooks can (and perhaps should) change in the near future.

ED03: 9 AM Self-Publishing

Invited *– Elisha R. Huggins, Dartmouth College, 603-643-2877, Elisha.R.Huggins@Dartmouth.edu*

Imagine an introductory chemistry text that ends with a chapter on "Modern Chemistry", i.e., a chapter on Mendeleev's discovery of the periodic table. Or an introductory biology text that does not quite get to DNA. Now look at our standard introductory college physics texts. Need I say more? In the mid 1990s, when I submitted a proposal to a number of publishers for an introductory physics text that incorporated 20th century physics by starting with special relativity, the universal reply was that "we can't sell that book." If that had been the mid 1980s or earlier, that would have been the end of the project. But with Pagemaker and Acrobat computer programs, we could create and publish the text ourselves. The result is the Physics2000 text available for $10 on a CD and $25 in a complete printed version. This compares with over $200 for a text and CD from the established publishers.

ED04: 9 AM What Can We Expect from the Textbook of the Future? *

Invited – Edward F. Redish, Univ. of Maryland, 301-405-6120, redish@physics.umd.edu

The textbook presently seems to be the core element in the large introductory Univ. physics course, determining the content, pace, and approach taken by the instructor and students. Yet there are a number of trends that seem to portend deep change in how the text is conceived and used. Few students actually read the text. Research has increasingly demonstrated that "active learning" is much more effective for students than the "transmissionist telling" that seems the model for most texts. And an upcoming generation of students seems much more comfortable with obtaining their information on-line, often with active game-like components and video. I consider whether web documents with interactivity will lead to the textbook's just "withering away" despite its apparent current vitality.

*Work supported in part by NSF grants REC 04-40113 and DUE 05-24987.

Session EE: Physics and Society Education

Sponsor: Committee on Science Education for the Public
Location: Auditorium I
Date: Wednesday, Aug. 1
Time: 9–11 AM

Presider: John Roeder, Calhoun School, 212-497-6500, jlroeder@aol.com

EE01: 9 AM Roadmap for a Zero-CO_2 Emissions Economy in the United States

Invited – Arjun Makhijani, President, Institute for Energy and Environmental Research (IEER), 301-270-5500, arjun@ieer.org

A zero-CO_2 economy can be created in the United States at reasonable cost in about 50 years or less at reasonable cost, without resort to large-scale use of energy from nuclear fission. The presentation will address the roles of (i) energy efficiency, (ii) key energy storage approaches, standby capacity, and optimization of the mix of power sources in providing reliable supply from renewable but intermittent energy sources (solar and wind mainly), (iii) biofuels (food crops, cellulosic biomass, microalgae, aquatic plants, photosynthetic hydrogen) as replacements for oil and natural gas, and (iv) CO2 capture other than carbon sequestration. Technology contingencies to ensure that the goal is achieved are discussed. Two examples of energy transitions are provided—the increase in energy efficiency in the 1973-1985 period in the United States, and the French electricity sector transition from oil, coal, and hydroelectricity to mainly nuclear electricity between 1973 and the 1990s. An argument is made for a mix of market approaches for internalizing cost for large users of fossil fuels (greater than ~10 terajoules per year) and regulatory approaches for appliances and passenger vehicles.

EE02: 9:30 AM The Physics Bus—A Physics Experiment on Wheels

Erik A. Herman, The Physics Factory, Tucson, AZ, 520-400-0980, physicsbus@yahoo.com

Chris Discenza, Bruce Bayly

The Physics Factory is bringing physics into the limelight with our vegetable-oil-powered Physics Bus. During the summer of '06, a handful of Physics and Math instructors and students traveled round trip from Tucson, AZ, to Boston, MA. We visited every major science museum along the way to network and steal ideas for how to best present physics concepts and we also did some performances. To fuel up our bus for free, we stopped at potato chip factories. Needless to say, the trip and the bus itself, was one big experiment on wheels!

EE03: 9:40 AM Social Benefit of Teaching Modern Physics: The Post-Newtonian Worldview

Art Hobson, Univ. of Arkansas, 479-575-5918, ahobson@uark.edu

The Newtonian worldview is atomistic (the world is made of particles that determine everything else), objective (objects are independent of methods used to study them), deterministic (the present determines the future), and reducible (phenomena can be separated into components without essentially changing the components). Briefly, the universe is mechanical, like a clock. The quantum universe is the antithesis of this: The world is made of "wholistic" fields, objects' properties depend on the observation process, the future is not determined by the present, and phenomena cannot be "disentangled" without essentially changing them. The quantum universe is nothing like a machine. This difference is socially and culturally important. For example, the "mechanistic" element of evolution, rather than evolution itself, might be the source of creationists' fears. The deep differences between Newtonian and post-Newtonian physics are an important reason to include lots of modern physics, especially quantum physics, in all introductory courses.

EE04: 9:50 AM Teaching Physics and History in a College Learning Community

Frederick M. Bingham, Univ. of North Carolina-Wilmington, 910-962-2383, binghamf@uncw.edu

Paul A. Townend, Kemille S. Moore

As part of a campus learning community, we teach Liberal Arts Physics, Western Civilization and an integrative seminar to a group of freshmen. The courses emphasize the connections between science and the development of Western civilization, so that students can understand that physics, far from being a value-free subject, has a rich historical background, that the people involved in the development of physics had quirks and passions, and that developments in science were often key in advancing western civilization. We assign a paper where the students study historical physicists, their discoveries and the historical context of their science. We stop in the middle of every physics class and take 5-10 minutes to learn about of the life history of some important physicist. Students also read a book on the history of science and discuss such subjects as the social context of the scientific revolution in 17th century England.

EE05: 10 AM Addicted to Placebos: A Cross-Disciplinary, Physical Science Book

Alan J. Scott, Univ. of Wisconsin-Stout, 715-232-2401, scotta@uwstout.edu

This talk will present the main concepts and themes contained in the recently published textbook "Addicted to Placebos: Understanding Science and Society" (www.lulu.com/scotta). It is a physical science book with significant physics content. It embodies a critical spirit of using science for the public good. It engages the student to think critically about basic science principles, the misuse of numbers in society, and the evaluation of unusual claims in all aspects of life ranging from obtuse product marketing to political rhetoric. The cross-disciplinary nature of the book sends readers through the science and societal connections with biotechnology, risk analysis, global environmental concerns, energy needs, psychotropic drugs, mind/body interactions, along with the overwhelming concern about war and nuclear weapons.

EE06: 10:10 AM Some Comments on the Pseudoscientific Beliefs of the Public

Costas J, Efthimiou, Univ. of Central Florida, 407-823-0179, costas@physics.ucf.edu

Ralph Llewellyn

In August 2006, C.E. posted on the physics archives a fun article discussing ghosts, vampires, and zombies. The article was based on some popular talks he had given previously and it was intended to show that unscientific topics appear silly as soon as simple logic rules and elementary physics principles are applied to them. We never expected that the content of the article would become a major topic of discussion in the news media and by the public. In this talk, we will make some comments about the pseudoscientific beliefs of the public as were revealed through this paper.

EE07: 10:20 AM The Global Environment

Randall D. Knight, California Polytechnic State Univ., 805-756-1663, rknight@calpoly.edu

I have been involved for several years in developing and teaching an interdisciplinary, team-taught, upper-division capstone course titled "The Global Environment." The course satisfies a general education requirement for all students except those in the College of Engineering, so students represent all majors from math and science at one end of the spectrum to art and business at the other. Environmental topics of global significance include population and resources, energy use and climate change, and biodiversity. These issues are considered from both a scientific/technical perspective and a social/political/economic perspective. Faculty teams have ranged in size from two to four, always with at least one "technical instructor" and one "social science instructor." I'll give an overview of the course and my perspective on the challenges and opportunities for a physicist to be involved in a course such as this.

EE08: 10:30 AM Exploring the Impacts of Environmental and Social Pressures on Populations

Roger Miller, State Univ. of New York College at Potsdam, 315-267-2282, millerrs@potsdam.edu

The goal of this project is to develop a simple pedagogical tool to enable students to explore and visualize how different factors affect the size, demographics and evolution of populations. The simplest application automates the "Population Games" (Hobson, *TPT*, April 2003). This application is an effective tool to explore exponentially growing populations and to explore population momentum; the delay in a population's response to changes in the birth rate. A second application enables the students to set up and run realistic population models with age and time dependent parameters. The parameters might include the birth rate, the death rate and the immigration rate. The students can see how a population will evolve starting with real demographic information that is included with the application or by setting up their own hypothetical distributions and parameters.

EE09: 10:40 AM Envisioning a Post-Carbon World for Our Students

Louis A. Schwartzkopf, Minnesota State Univ., Mankato, 507-389-5745, louis.schwartzkopf@mnsu.edu

Current thinking in the scientific community is that the world must reduce its greenhouse gas emissions significantly (some say by 90%) by mid-century in order to prevent catastrophic climate change. Although this seems a daunting task, strategies exist in the literature for achieving such reductions, such as the wedge strategy of Pacala and Socolow (Science 305, 968, 13 August 2004). But what will a world look like that burns only 10% of the fossil fuels that we do now? In teaching global warming, we should construct an end point, so that our students can envision a possible outcome of a reduction in emissions of greenhouse gases. Monbiot does this in his recent book, *Heat: How to Stop the Planet Burning*. His and other visions of a post-carbon world will be discussed.

EE10: 10:50 AM What the 2007 Reports of the IPCC mean

Gordon J. Aubrecht, II, Ohio State Univ., 740-369-0992, aubrecht@mps.ohio-state.edu

The Intergovernmental Panel on Climate Change (IPCC) subgroups are releasing reports this year. Already, the February Summary for Policymakers has generated intense opposition by industry shills who are being paid to place anti-IPCC op-ed pieces. This talk will discuss the major recommendations from the subgroups that will have been released by July and the enduing controversies.

Session EF: Mathematics in Physics

Location: Colony B-C
Date: Wednesday, Aug. 1
Time: 9–10:30 AM

Presider: Stanley Jones, Univ of Alabama, 205-348-5050, stjones@bama.ua.edu

EF01: 9 AM Symbols: Weapons of Math Destruction

Eugene T. Torigoe, Univ. of Illinois, Urbana-Champaign, 217-333-0272, torigoe@uiuc.edu

Gary E. Gladding

In studies involving nearly 1000 students we have found that numeric versions of certain questions have averages of almost 50% higher than equivalent symbolic versions.[1] Analysis of students' Written work as well as student interviews has revealed that the explanation for a large portion of the effect is not related to algorithmic symbolic manipulations, but instead to a confusion of the meaning of the symbols used. Common confusions found in the symbolic version were rarely observed for the numeric version of the same problem. In this talk we will describe a theoretical framework we have been using to describe this numeric/symbolic effect. The framework highlights cultural assumptions physicists make about the meaning of symbols and also describes factors that influence the numeric/symbolic effect. We will also discuss the connections between the numeric/symbolic effect and success in physics.

1. E. Torigoe & G. Gladding, *PERC Proceedings 2006*, **883**, pp. 153-156 (2007).

EF02: 9:10 AM Challenges and Benefits for Students in Learning How to Scale a Physics Equation

Dawn C. Meredith, Univ. of New Hampshire, 603-862-2063, dawn.meredith@unh.edu

Students in a sophomore/junior level classical mechanics course are unfamiliar with the procedure or reasons for scaling an equation (that is, expressing the equation in terms of scaled, unitless variables). Yet this procedure can make it easier to infer consequences and gain insight into the story that the equation tells. Scaling is also essential when equations need to be coded for the computer or Taylor expanded. We discuss our students difficulties and insights in the context of scaling.

EF03: 9:20 AM Investigating Mathematical Fluency Among Upper-Division Physics Students *

Donald B. Mountcastle, Univ. of Maine, 207-581-1016, thermostatprof@yahoo.com

Brandon R. Bucy, John R. Thompson

In a research study of student learning in upper-division thermal physics at the Univ. of Maine, we have identified several disconnects among students as they employ mathematical models and calculations to solve physics problems. These conceptual disconnects are evident even though our students have successfully completed the appropriate mathematical prerequisites, primarily multivariable calculus. Common confusions include the precise roles of dependent and independent variables, differences between variables and functions, exact and inexact differentials, partial derivatives, etc. Many of these difficulties are subtle, yet are often glossed over by both textbooks and instructors. Examples taken from student work on pre-tests, homework, and exams will be presented. We will use our findings to guide development of curricular materials designed to help students construct the conceptual scaffolding necessary to apply their formal mathematics appropriately in thermal physics. Similar strategies could be beneficial throughout the physics curriculum.

*Supported in part by NSF Grant #PHY-0406764

EF04: 9:30 AM An Example of Multiple Mathematical Justifications in Student Thinking

Thomas J. Bing, Univ. of Maryland, 301-405-6185, tbing@physics.umd.edu

Ayush Gupta, Edward F. Redish

With mathematics use in physics classes, different modes of reasoning can serve as sufficient justification. Sometimes a physical argument is made to defend the validity of a mathematical expression. Other times a derivation is considered. Even then, the level of mathematical detail that is treated as sufficient can vary widely. The ability to easily transition among these various modes and levels of detail when using mathematics is an important component of expertise in physics. We present an example from the work of upper level physics majors where this often subconscious choice of where to search for justification has especially noticeable effects. This example is drawn from a larger study aimed at extending the use of epistemic games from describing introductory students' thinking to the mathematical work of upper level physics majors.

EF05: 9:40 AM An Integrated Programming and Simulation Course

Shafiqur M. Rahman, Allegheny College, 814-332-533, srahman@allegheny.edu

In a liberal arts institution, students majoring in the sciences have to take many courses outside the sciences. Consequently, it becomes difficult for them to fit in a sufficiently large number of science courses. A solution is to combine essential elements from several courses into a single teaching unit. We followed this model to develop a computational physics course (Programming and Simulation) at Allegheny College. At this time, it combines five different areas? (i) an operating system (Unix), (ii) a programming language (Fortran), (iii)some elements of Numerical Analysis, (iv)simulational work that doesn't require programming, and (v) a general purpose computational package (Mathematica). The talk will discuss how these five areas are weaved into a single course to give a coherent experience to students in computational work.

Sponsored by Karim Hossain, Edinboro Univ. of PA

EF06: 9:50 AM What's Wrong with the Calculator?

Thomas A. Dooling, UNCP, 910-521-6595, tom.dooling@uncp.edu

After 10 years of teaching introductory physics, I have come to the conclusion that the overall effect of the calculator, in the introductory classroom, is negative! Students lose their "feel" for correct answers and instead, come to believe that they cannot even remotely guess correct answers without "their" calculator. The calculator also produces and overall weakness in algebra skills, producing students who falter when confronted with more complex problems. Anecdotal evidence will be presented to support my thesis. In addition, textbook problems will be shown that can be solved using gross approximations and still yield fairly good answers.

EF07: 10 AM Maxwell's Equations in Differential Forms in Introductory Physics

David Keeports, Mills College, 510-430-2162, dave@mills.edu

Calculus-based general physics textbooks routinely present Maxwell's equations only in their integral forms. However, recently I have presented these equations in my introductory course only in their differential forms. Factors that have influenced my decision include my student audience consisting of some mathematics majors but no physics majors, my elimination of problem solving using Gauss's law and Ampere's law from my two-semester course, and my belief that no general physics course is complete without at least an overview of Maxwell's equations. The cost of my approach is that my students must accept some properties of divergences and curls that I merely state without proof. On the other hand, a single lecture on Maxwell's equations presented in the language of diverging and curling electromagnetic field lines provides a thorough descriptive summary of the natures and causes of field lines. I will discuss student reaction to my coverage of Maxwell's equations.

EF08: 10:10 AM The Quadratic Stark Effect Revisited

Walter S. Jaronski, Radford Univ., 540-831-5274, wjaronsk@radford.edu

The second-order Stark effect for the ground state of the hydrogen atom is reconsidered. Although the total second-order energy shift is well known, the division of this shift into contributions from the discrete and continuous parts of the spectrum is not. These contributions are separately evaluated in a nearly analytic fashion, yielding a sum in agreement with the known result and revealing that the discrete contribution is approximately 81.4% of the total effect. A partial-wave expansion of the continuum Coulomb wave functions is used to evaluate the contribution from the continuous spectrum. In addition to the value of this result for its own sake, the direct calculation of the continuum contribution provides a useful pedagogical exercise. Most students do not have a great deal of experience using the unbound Coulomb wave functions. This calculation provides a nice opportunity to develop some facility with these functions.

EF09: 10:20 AM Canonical Transformations

Domingo Louis-Martinez, Univ. of British Columbia, 604-8220911, martinez@phas.ubc.ca

Canonical transformations and their generating functions are defined in a manner that shows their complete independence of the Hamiltonian.

Session EG: Physics Teacher Preparation Around the World

Co-Sponsors: Committee on International Physics Education, Committee on Teacher Preparation
Location: Imperial B
Date: Wednesday, Aug. 1
Time: 9–10:10 AM

Presider: John Fitzgibbons, 213 Juanita Dr., Liverpool, NY, 315-451-0854, jdfitzgi@physics.syr.edu

EG01: Training In-service Teachers in Teaching Methodologies for the Active Learning of Physics: A PER-based Magister Program in Physics Teaching

***Invited** – Julio C. Benegas, Universidad Nacional de San Luis, +54-2652-422803, jbenegas@unsl.edu.ar*

Myriam E. Villegas

During the last 30 years there have been great advances in the understanding of how people learn basic physics and, subsequently, on the development of appropriate and very successful physics teaching methodologies. Nevertheless, little of all these materials are reaching the classrooms of most countries. In this presentation a PER-based Magister Program on Physics Teaching will be described. The program is aimed at introducing the advances obtained by PER to physics teachers and university professors of the Central-West region of Argentina. It has been designed under the premises that efficient teaching of physics requires that in-service teachers have a good working understanding of both, content and pedagogical knowledge, and that this goal can be achieved by exposing the participants to highly specific methodological courses complemented with disciplinary courses where they can apply the teaching concepts learned in the former. The structure of this program and preliminary results will be shown.

EG02: 9:30 AM Implementing PER-based Short Professional Development Courses in Latin-America

***Invited** – Genaro Zavala, Tecnologico de Monterrey, +52 81 83582000, genaro.zavala@itesm.mx*

Hugo Alarcon, Julio Benegas

We have had the opportunity to design and implement training courses based on Physics Education Research, as short professional development courses for high school teachers and physics faculty.[1] The main objective of this practical course is to provide the in-service teachers a first contact with an active learning teaching strategy. The courses have been implemented in two countries: Chile and Mexico. This work will present the structure of these short professional development courses as well as some results in their implementation not only as to introduce teachers to active learning strategies but also as to their use as a learning environment.

1. G. Zavala, H. Alarcón, and J. Benegas, "Innovative training of in-service teachers for active learning: A short teacher development course based on Physics Education Research," In Press by *Journal of Science Teacher Education.*

EG03: 10 AM Active Learning in Optics and Photonics (ALOP): A UNESCO Teacher Enhancement Project

Invited – Priscilla Laws, Dickinson College, 717-245-1242, awsp@dickinson.edu

David Sokoloff, Minella C Alarcon

Aimed at introducing physics teachers in developing countries to active learning and enabling them to teach optics more effectively, the UNESCO Active Learning in Optics and Photonics (ALOP) project, now in its fourth year, has held five-day workshops in Ghana, Tunisia, Morocco and India. About 150 teachers from 25 countries have participated. An ALOP Training Manual[1] has been developed, along with a Light and Optics Conceptual Evaluation for assessment of conceptual learning. Regional follow-up activities have commenced, including translation of the manual into French for use in locally organized workshops in Tunisia and Morocco. Recruitment and training of new workshop resource persons is an important part of the project. The 2005 World Conference on Physics and Sustainable Development endorsed ALOP as a model for pilot active learning workshops in Asia, Africa and Latin America. ALOP workshops planned for 2007 include Tanzania, Brazil and Mexico. This paper will discuss the project and its outcomes.

1. *Active Learning in Optics and Photonics Training Manual*, David R. Sokoloff, ed. (Paris, UNESCO, 2006).

EG04: 10:30 AM Utilizing Popular Scientific Lectures for Teaching Contemporary Physics

Shulamit Kapon, Weizmann Institute of Science, Israel, 972-8-9342298, shulamit.kapon@weizmann.ac.il

Uri Ganiel, Bat Sheva Eylon

Have you ever heard a popular scientific lecture, enjoyed it, and yet could later recall only the title, and perhaps a few jokes? Have you ever wondered how to incorporate contemporary physics into high school physics? The National Center of Physics Teachers in Israel conducted a distance learning in-service course for 22 teachers on early 20th century physics, which recently has become obligatory in the high school physics syllabus. Three excellent popular physics lectures were integrated into this course as enrichment in contemporary issues: high energy particle physics, quantum mechanics, and contemporary astrophysics. Each lecture was accompanied by activities supporting the teachers in the learning process (using analogies, knowledge integration etc). The activities were based upon an analysis of explanations in popular physics lectures. We shall present the intervention, some of the activities and preliminary results of its impact on the teachers.

Session EH: The Advanced Physics Laboratory I

Co-Sponsors: Committee on Teacher Preparation, Committee on Physics in Undergrad. Education
Location: Oak B-C
Date: Wednesday, Aug. 1
Time: 9–11 AM

Presider: Paul Hickman, 23 Rattlesnake Hill Road, Andover, MA, 978-470-1823, hickmanp@comcast.net

EH01: 9 AM Lighting Fires in Advanced Labs

Invited – Richard W. Peterson, Bethel Univ., 651-638-6465, petric@bethel.edu

Whether in a stand-alone course or as the lab component of upper division courses, the advanced lab instructor must anticipate, stimulate and nourish those creative moments with students that can "light a fire".[1] Students are quick to detect when novel and interesting approaches to apparatus, procedure, and analysis are sought and anticipated, and it can radically change the "What do you want us to do next"? atmosphere that too often prevails in undergraduate labs at all levels. While such a spirit of research may be difficult or disingenuous to seek for rather constrained advanced lab exercises, it should be laid-out as a desired outcome for more open-ended projects. In optical physics and metrology (Fourier optics, Faraday effect, sonoluminescence, high-speed interferometry, Schlieren, and holographic measurements), I will highlight examples where student experimental physics has blossomed within our advanced labs, and subsequently morale and career choices have been impacted.

1. W. B. Yeats—"Education is not the filling of a pail, but the lighting of a fire."

EH02: 930 AM The Univ. of Florida Advanced Physics Laboratory

Invited – Robert DeSerio, Univ. of Florida, 352-392-1690, deserio@phys.ufl.edu

Our graduating seniors consistently cite the advanced physics lab as one of the most rewarding experiences in the undergraduate program. I will present aspects of the administration, organization, and content for this course. The use of the Excel spreadsheet for nonlinear regression, including error estimation, will also be discussed. Any remaining time will be used to showcase experiments such as the chaotic pendulum, cosmic ray muons, and dynamic light scattering.

EH03: 10 AM A Biophysics Experiment for the Advanced Physics Laboratory *

Poster – Thomas Colton, Univ. of California Berkeley, 510-642-5515, tcolton@berkeley.edu

Steven Wasserman, Jan Liphardt

How can a physics instructional lab without the infrastructure to maintain cell cultures and to perform cell/molecular biology procedures bring modern experimental biophysics to students' Berkeley Physics does it by having students investigate the Brownian motion of nanoparticles, employing the same particle-tracking techniques used to study intracellular transport, motor molecules, and DNA biomechanics. Students record videos of gold and polystyrene beads, 100nm-2 micrometers in size, in various solvents on an inverted microscope. Image filtering, particle discrimination, tracking and analysis are largely automated in Matlab. Students analyze particle trajectories and velocities to explore the relationship between particle size, solvent viscosity, and diffusion coefficient in Brownian motion. They then apply these techniques to a biological system: intracellular transport in onion cells. Two types of transport, cytoplasmic streaming and directed transport of granules along microtubules, are analyzed and compared with motions of synthetic nanoparticles undergoing Brownian motion.

*Supported in part by a donation from Stanford Research Systems

EH04: 10 AM An Undergraduate Low-Mass Balloon-Borne Cosmic Ray Experiment*

Poster – R.D. Dietz, Univ. of N. Colo., 970-351-2950, rdietz@unco.edu

Kendall E. Mallory, Ryan D. Marshall, Patricia A. Mills, Julie C. Smith

A balloon-borne cosmic ray detection experiment built, tested and mainly designed by undergraduate students will be described. Two photomultiplier tubes were encased in sealed PVC tubes each vacuum epoxied to a piece of scintillator material sensitive to charged cosmic ray secondaries. The pressure inside the PVC tubes was kept at 1 atm. This novel approach eliminated possible coronal discharge. Output signals went to a coincidence counting circuit board then to a data logger. The data showed the expected count profile throughout the 2.5 hour flight which reached an altitude of around 100,000'. The total mass of the experiment was only 2.43 kg. The project provided not only an outstanding learning opportunity for the students involved but also experience in teamwork and problem-solving.

*Funded in part by NASA through the Colorado Space Grant Consortium. The coincidence counting circuit was provided by the Lawrence Berkeley National Laboratory.

EH05: CANCELLED

Poster – Krishna M. Chowdary, Bucknell Univ., 570-577- 3767, kchowdar@bucknell.edu

EH06: 10 AM Quantitative Measurements of Non-Newtonian Fluid Properties

Poster – Daniel P. Bowen, California State Univ., Chico, 530-898-6967, dbowen2@mail.csuchico.edu*

Eric Ayars

We present a simple apparatus for measuring the viscosity of a non-Newtonian fluid over a range of shear rates, with potential application to other quantitative measurements as well. The apparatus is then used to explore the properties of the non-Newtonian fluid resulting form a mixture of cornstarch and water.

*sponsored by Eric Ayars

EH07: 10 AM Investigating Light Bulb Emissions Using the Ocean Optics Spectrometer

Poster – Jennifer J. Birriel, Morehead State Univ., 606-783-2924, j.birriel@moreheadstate.edu

Light spectra observed with inexpensive, hand-held spectroscopes are visually appealing but are qualitative and limited only to the visible portion of the spectrum. It is useful for more advanced students to examine a plot of intensity versus wavelength and evaluate the spectra of continuous sources in terms of blackbody radiation. The advent of relatively cheap spectroscopes such as the Ocean Optics Fiber Optics spectroscope make such studies accessible to upper level students. We examine a variety of commercially available light bulbs and compare these to a standard incandescent bulb emission using an Ocean Optics spectroscope. The absorption properties of bulb coatings are discussed in terms of the observed light color. Additionally, we examine some of the claims made by manufacturers regarding the properties of the bulbs. Such studies can be coupled with visual observations through hand-held spectroscopes and enable students to examine the UV and infrared emission from such bulbs.

EH08: 10 AM Integration of Laboratories and Computation within the Lecture Physics Courses

Poster – Ulrich Zurcher, Cleveland State Univ., 216-687-2429, u.zurcher@csuohio.edu

Petru Fodor, Miron Kaufman, Kiril Streletzky, Ted Wood

The interplay between theory and experiments is central to physics. However, theory and experiments are taught separately: the theory is covered in lecture courses, while experimental skills are taught in advanced lab courses. We report on our efforts to integrate labs into core courses [Modern Physics, Electricity and Magnetism, Thermal Physics, Solid State Physics], to better convey to students the connection between experiment, computation and theory. We incorporate several experiments per course as a minor component of a predominantly lecture based curriculum. The experiments teach students crucial laboratory skills (such as design, critical analysis of experiments, error analysis), which are rarely developed in "cookbook" style introductory labs. Computer lab projects helping students understand the physics concepts by using graphs and animations are also incorporated. This gives students modeling skills by showing them how to set and solve complex problems that cannot be solved at the blackboard or on paper.

EH09: 10 AM Nonlinear Damping of the LC Circuit Using Antiparallel Diodes

Poster – Edward H. Hellen, Univ. of North Carolina–Greensboro, 336-334-3233, ehhellen@uncg.edu

Matthew J. Lanctot

We investigate a simple variation of the series RLC circuit in which antiparallel diodes replace the resistor. The result is a damped harmonic oscillator with a nonlinear damping term that is a maximum at zero current and decreases inversely with the current for currents far from zero. Unlike the standard RLC circuit, the behavior of this circuit is amplitude dependent. The transient response makes a transition from underdamped to overdamped behavior, and the resonance response of the steady-state driven oscillator becomes sharper as the source amplitude increases. A set of nonlinear differential equations is derived for the circuit and integrated numerically for comparison with measurements. The equipment is inexpensive and common to upper level physics labs. This research was supported by an award from the Research Corporation.

EI: Excellence in Physics Teaching Awards

Location: Imperial D
Date: Wednesday, Aug. 1
Time: 11 AM–12 noon

Presider: Kenneth Heller, Univ of Minnesota, heller@physics.umn.edu

Jan Mader

Steve Manly

Those Who Can Teach (11 AM)
– *Excellence in Pre-College Physics Teaching Award*

Jan Mader, Great Falls High School, jan_mader@gfps.k12.mt.us

With increasing emphasis on the need for a scientifically literate society, the need for highly qualified teachers of physics and physical sciences surpasses the number of students choosing to enter the teaching profession. What as educators can we do to encourage our best and brightest to consider education as a career? Physics was my career of choice pre-high school. Who and what events shaped my decision to pursue the continual learning experience for me and my students? After all, my students will tell you that a day without physics doesn't exist.

Experiences in Collaborative Learning at the University of Rochester – It's All in the Shoes (11:30 AM)
– *Excellence in Undergraduate Physics Teaching Award*

Steven L. Manly, University of Rochester, steven.manly@rochester.edu

This talk describes experiences surrounding the implementation of a collaborative student-assisted learning environment at the University of Rochester to support introductory and selected advanced physics courses, as well as core courses in other disciplines. The program and some of the positive results stemming from it are described. In addition, system implementation and institutionalization issues at the course, departmental, and college levels are discussed.

Session FA: Professional Concerns of PER Graduate Students and Residents

Co-Sponsors: Committee on Professional Concerns
Committee on Research in Physics Education
Location: Cedar
Date: Wednesday, Aug. 1
Time: 12–1 PM

Presider: Thomas Bing, Univ. of Maryland, 301-405-6185, tbing@physics.umd.edu

Participants will interactively discuss matters of professional concern to PER Graduate Students. Please come prepared to tell us your situation, exchange ideas, ask questions, offer solutions, etc.

Session FB: Professional Concerns of Four-Year College and University Physics Faculty

Sponsors: Committee on Professional Concerns
Committee on Physics in Undergraduate Education
Location: Imperial B
Date: Wednesday, Aug. 1
Time: 12–1:30 PM

Presider: Dean Hudek, Brown Univ., 410-863-2062, Dean_Hudek@Brown.edu

Participants will interactively discuss matters of professional concern to Four-Year College & University Physics Faculty. Please come prepared to tell us your situation, exchange ideas, ask questions, offer solutions, etc.

Session FC: Professional Concerns of PER Faculty

Co-Sponsors: Committee on Professional Concerns
Committee on Research in Physics Education
Location: Cedar
Date: Wednesday, Aug. 1
Time: 1–2 PM

Presider: John Thompson, Univ. of Maine, 207-581-1030, thompsonj@maine.edu

Dean Hudek

Participants will interactively discuss matters of professional concern to PER Faculty. Please come prepared to tell us your situation, exchange ideas, ask questions, offer solutions, etc.

FE: Bridging Session: Cognitive Science and Physics Education Research

Sponsor: Committee on Research in Physics Education
Location: Cedar
Date: Wednesday, Aug. 1
Time: 3–5 PM

Presider: Chandralekha Singh, Univ. of Pittsburgh, 412-624-9045, clsingh@pitt.edu

FE01: 3 PM Making Physics Learning Inviting — A View from Cognitive Science

***Invited** – Janet L. Kolodner,* Georgia Institute of Technology, 404-894-3285, jlk@cc.gatech.edu*

It's hard to learn physics, and it is not always clear to students why they should want to learn. In the past dozen years, my research group and I have been using foundations from cognitive science to create an approach to science education for middle schoolers called Learning by Design (LBD) that (1) fosters excited engagement through a context of design, (2) fosters establishment and sustainment of a culture of participation in rigorous science thinking and collaborative meaning making through "launcher" activities that introduce scientific practices and their value, (3) fosters competence in scientific reasoning through repeated deliberative and public practice of such reasoning in contexts of interest created through the design challenge, and (4) fosters deep understanding of underlying science through repeated application of the science in more and more difficult contexts. We began with the cognitive model inspired by case-based reasoning as our guide, but we soon found the need to bring in findings from socio-cognitive and cultural-historical approaches to learning as well. While design has many affordances for such learning, we have recently been learning how to apply LBD's foundations more broadly to project-based science. Guidelines from LBD form a foundational core for a three-year comprehensive middle-school science curriculum called Project-Based Inquiry Science that will be published and broadly available for upcoming school years.

* Invited by Chandralekha Singh

FE02: 3:30 PM Cognitive Science: Problem Solving and Learning for Physics Education

***Invited** – Brian H. Ross, Beckman Institute/Univ. of Illinois, 217-244-1095, bhross@uiuc.edu*

Much research has been conducted in cognitive science that might be applicable to physics education. I will focus on some general principles of problem solving and learning, as well as a number of basic findings and their implications, including the improvement of problem solving. The areas of research to be discussed include the use of examples and analogies, the learning of abstract knowledge, the role of explanations, and schemas In addition, I will review some different methodologies that might be useful for examining the learning of physics.

FE03: 4 PM Naive Physics/Savvy Science: Causal Learning in Very Young Children ... and the Rest of Us

***Invited** – Laura E. Schulz, MIT, 617-253-7957, lschulz@mit.edu*

Considerable evidence suggests that children's (and adults') understanding of particular physical mechanisms is impoverished. Moreover, children are poor at designing informative experiments and there has been little evidence for any systematic patterns in children's spontaneous exploratory play. Nonetheless, children understand a remarkable amount about the causal structure of the world by age five. Here I will suggest some processes that might support such rapid and accurate causal learning. In particular, I suggest that children, like scientists, assess the causal structure of events by jointly integrating the statistical evidence they observe with their prior causal beliefs. Additionally, I will suggest that children systematically engage in more exploration when the interpretation of evidence is uncertain, thus they tend to isolate relevant variables and spontaneously generate informative evidence. Finally however, I will suggest that the same processes that support rapid, accurate induction from minimal data make children's (and adults') causal beliefs resistant to potential counter-evidence.

FE04: 4:30 PM Panel Discussion

Presider: TBA

Session FF: Scientific Reasoning

Sponsor: Committee on Science Education for the Public
Location: Auditorium I
Date: Wednesday, Aug. 1
Time: 3–4:20 PM

Presider: Gordon McIntosh, Univ. of Minnesota, 320-589-6342, mcintogc@morris.umn.edu

FF01: 3 PM Scientific Literacy: Are We Really Training People in Scientific Reasoning?

***Invited** – Michael Dennin, UC Irvine, 949-824-2995, mdennin@uci.edu*

Most science courses for breadth at universities focus on teaching the concepts of a particular science. Real scientific literacy is more about teaching students to appreciate science. An ideal analogy is with art and music appreciation courses versus art or music courses for nonprofessionals. The two types of courses are very different. In this talk, I will discuss efforts undertaken by John White and myself to develop a "Physics Appreciation" course. Two issues addressed by this course are (1) What is the influence of a person's "world views" on people's interaction with science and scientific reasoning? (2) What distinguishes a scientific theory from other forms of knowledge? It is more important for people to have a really good idea what a scientific theory is, than to know any particular theory. This skill allows people to recognize scientific versus non scientific reasoning as applied to issues in daily life.

FF02: 3:30 PM The Gorilla in the Room: Physics?

Invited – *Nathan Balasubramanian, 651 Homestead St., Lafayette, CO, 720-747-3842, nathanbala@gmail.com*

Why is physics worth teaching and learning? How could we sustain students' excitement for learning physics? In particular, even before the start of the course, 73% of students in one high-needs secondary school highlighted physics' real world connection in the Colorado Learning Attitudes about Science Survey. What do high school students think learning physics does to their problem-solving ability? Their thinking ability? Their ability to make decisions using a process of reasoning? Their ability to use math to solve problems? What is the role of guided-inquiry hands-on learning activities in nurturing these four "higher literacy skills?" Could our students be recognized as co-creators of knowledge in the classroom and build on their existing knowledge? In this session, participants will explore the findings from one physics educator's middle and high school web-enhanced applied technology, physics, and physics engineering technology classes.

FF03: 4 PM "Scientific Thought and Method"— Improving Student Scientific Reasoning Skills *

Kathleen M. Koenig, Wright State Univ., 937-775-3139, kathy.koenig@wright.edu

Doug Bradley-Hutchison

As a means of increasing motivation, success, and retention of first-year students intending to major in science, we are developing an introductory course "Scientific Thought and Method" to be piloted fall 2007. The course will provide students the opportunity to explore the physical and natural sciences through several modern-day interdisciplinary thematic units. The development of critical thinking and basic math skills will be emphasized. Within each unit the students will practice scientific reasoning by evaluating evidence surrounding the topic. The practice of making decisions and determining positions on scientific issues will be modeled. Students will gain an appreciation for the veracity of information from different sources such as the internet, newspaper, magazines, and journals. The talk will provide specific information about the pilot course and the studies that will be implemented to determine the effectiveness of the course at meeting its objectives.

* Supported through NSF grant number DEU-0622466

FF04: 4:10 PM Alternative Energy Projects for Service Learning in Science

Barbara L. Whitten, Colorado College, 719-389-6579, bwhitten@coloradocollege.edu

Sally Meyer, Mark Morgenstern

Service learning is an effective tool in the social sciences for teaching students to apply knowledge to "real world" problems. Fewer people have applied these techniques in the sciences. We are implementing service learning projects involving alternative energy and conservation in courses in Physics, Chemistry, and Environmental Science. In the Energy Retrofit Project, students study the physics of convective, radiative, and conductive heat transfer and analyze a home near campus to determine the most cost-efficient way to reduce energy bills. We visit the home and install the changes we have proposed. Students learn to apply their scientific knowledge to practical problems and gain additional analytical and experimental skills. Nonprofit organizations, poor residents, and the community of Colorado Springs benefits from a more efficient energy system. We will describe how we organize these projects, how we integrate them into a science course, and what we believe students gain from participation.

FD: Plenary III: The Dance of the Fertile Universe: Cosmic and Human Evolution

Location: Imperial D
Date: Wednesday, Aug. 1
Time: 2–3 PM

George Coyne

George V. Coyne, University of Arizona, gcoyne@as.arizona.edu

Did we come about by chance or by necessity in the evolving universe? The first thing to be said is that the problem is not formulated correctly. It is not just a question of chance or necessity because, first of all, it is both. Furthermore, there is a third element here that is very important. It is what I call the "fertility" of the universe. This is the dance of the fertile universe, a ballet with three ballerinas: chance, necessity and fertility. What this means is that the universe is so fertile in offering the opportunity for the success of both chance and necessary processes that such a character of the universe must be included in the search for our origins in the universe. In this light I am going to try to present in broad strokes what I think is some of the best of our modern scientific understanding of the universe, and then ask the question at the end: What does this say about the God who loves us and who made this universe?

Session FG: Laboratories

Location: Imperial A
Date: Wednesday, Aug. 01
Time: 3–4:20 PM

Presider: Karie Meyers, Pima Community College, W. Campus, 520-206-6695, kameyers1@pima.edu

FG01: 3PM Recurrent Studies: Physics Labs with Flavor

Mikhail M. Agrest, College of Charleston, 843-953-1359, agrestm@cofc.edu

The ballistics "shoot for your grade" idea was expanded into related recurrent methodology.[1,2] This methodology of studying a phenomenon or a device enhances the learning process by exciting students with the visualization of the results of their work. Students examine the phenomenon in the forward performed study to use results of direct measurements to calculate unknown parameters. In the backward study students use the magnitude of those parameters to predict measurable parameters. Visual assessment of students' prediction of the results emotionally involves them and makes the learning process more effective, brings popularity into the discipline because it involves hands-on experience, using and testing the students' results during their lab work. The recurrent approach enhances learning and helps students comprehend the material by using what they learned to predict new results and to check them within the same lab. This proposed approach is applicable to wide range of disciplines.

1. M. Agrest, *Lectures on Introductory Physics I and II,* 249 pp. and 252 pp. with illustrations (Thomson Learning, 2007).
2. M. Agrest, *Lectures on General Physics I and II*, 257 pp. and 237 pp. with illustrations (Thomson Learning, 2005).

FG02: 3:10 PM Understanding Difficulties with Forces Through Research-based Labs

Sergio Flores, Univ. of Ciudad Juarez, 915-584-4794, sergiflo@hotmail.com

Many students come to introductory physics courses with a wrong idea about the way the world works. Their first exposure to physics is in the context of forces as vectors. An understanding of how this topic relates to the real world requires the ability to reason about vectors that represent these forces. A set of research-based labs designed to confront these wrong ideas about vectors as forces would help to improve their performance in the numerical section of the second part of the labs. Results are obtained to measure the efficiency of this learning technique through the comparison of the results of the first part based on a conceptual perspective.

FG03: 3:20 PM Rocketry Across the Curriculum at Mitchell Community College

Doug Knight, Mitchell Community College, 704-978-5432, dknight@mitchellcc.edu

Concepts and applications related to rocketry are applied across the physics curriculum at Mitchell Community College and used as an outreach tool to local schools. Rocketry themed labs and design projects (both computational and hands-on) used in a conceptual, technical, freshman and sophomore level physics class will be presented. A new club on campus has been created related to rocketry and "pumpkin chunkers." Rocketry as an outreach to the local public and private schools will be presented. Legal and safety related issues along with feedback from administration and students will also be discussed.

FG04: 3:30 PM Investigation of the Magnetic Field in Helmholtz Coils

Stephen Luzader, Frostburg State Univ., 301-687-7072, sluzader@frostburg.edu

Jason Michael

In an earlier report[1] the on-axis and off-axis magnetic field produced by Helmholtz coils was calculated in an effort to discover why one particular e/m apparatus used by our students tends to give poor results. The calculations suggested the error was caused by the electrons moving through the off-axis field, which is weaker than the value predicted at the midpoint of the coil geometry. We mapped the field using a Vernier magnetic field sensor and determined an average value for the field across the entire diameter of the coils to confirm a value given to us by Andrew Tomasch. Using this average value for the field improves the accuracy for the apparatus. We also investigated the effect of the noncircularity of the electrons' orbits and found that was not a significant source of error.

1. S. Luzader, *AAPT Announcer* **36** No. 2, 110 (2006).

FG05: 3:40 PM Discrepancy in Trajectory by Anthropometry

Saami J. Shaibani, Instruction Methods, Academics & Advanced Scholarship (IMAAS), 434-237-6775, shaibani@imaas.org

The discharge of a handgun from the opening of a drive-through window into a fast-food establishment was captured on videotape by an indoor security camera. Although the camera characteristics were not sufficient to pinpoint the location of the gun, the posture of the person struck in the chest by a bullet from the gun could be identified. Reports from others in the immediate area gave more specific information on how various body segments of the shot person were oriented. Subsequent experiments with an exemplar person standing in the actual location were conducted to obtain even more detailed data on both the subject person and the subject environment. Careful calculations with physics produced anthropometric measurements that were then combined with the bullet trajectory inside the body to evaluate all possible shooting scenarios. Only one of these had a bullet trajectory from the gun that matched all the known circumstances.

FG06: 3:50 PM Going WILD While Staying Sane — Wandering Interactive Laboratory Demonstrations *

Dave J. Van Domelen, Kansas State Univ., 785-532-1605, dvandom@phys.ksu.edu

In 2006, Kansas State Univ. received an HP grant of tablet PCs, with the intent to expand computer-based laboratories into courses not already equipped with them. The project, "Wandering Interactive Laboratory Demonstrations," was intended to get students out of the classroom at least part of the time, using tablet PCs and data collection equipment to measure things found out in the environment. In Spring 2007, WILD was implemented for Physical World Lab, a conceptual physics course, with the usual amount of growing pains. This talk will briefly discuss the kinds of things to watch out for in such an effort, plus present some student survey data regarding the program.

*Supported by Hewlett-Packard Technology for Teaching Leadership Grant 2006

FG07: 4 PM Labs a la PER!

Taoufik Nadji, Interlochen, 231-276-6089, nadjit@interlochen.org

In this information sharing session, the speaker will illustrate how he has used PER literature effectively and specifically to enhance the lab experience of his physics students. In addition, the session will feature samples of students' work, sample lab ConcepTests developed by the speaker, and additional suggested lab and/or project activities that have been used by the speaker throughout the years.

FG08: 4:10 PM Experimental Marshmallow Physics: Young's Modulus and Speed of Sound

Kenneth Pestka, II, Dalton State College, 706-272-4468, kpestka@daltonstate.edu

In this work a simple, fun and inexpensive experiment for measuring Young's modulus and determining the sound speed of marshmallow will be presented. Unlike typical Young's modulus experiments, which often require complex and expensive equipment, this exercise can be accomplished with minimal equipment including calibrated masses, rulers and marshmallows. The experiment exposes students to the essentials of elastic theory and sound propagation at a level suitable for AP physics or introductory university courses, as well as an opportunity to explore more advanced topics pertaining to nonlinear elastic phenomena and physical acoustics.

Session FH: The Advanced Physics Laboratory II

Location: Maple
Date: Wednesday, Aug. 1
Time: 3–5 PM

Presider: Randolph Peterson, Univ. of the South, 931-598-1550, rpeterso@sewanee.edu

FH01: 3 PM Expanding the Educational Experience in Advanced Physics Lab Using Gamma-Scout

Ignacio Birriel, Morehead State Univ., 606-783-2178, i.birriel@moreheadstate.edu*

Dustin S. Hinds

The Gamma-Scout is a versatile radiation measurement instrument. While it can take measurements similar to that of a standard Geiger-Muller Counter, counts per time, it has abilities that go beyond. One feature of this device is its ability to measure the biological effects of given radioactive sources. The data is collected in microsieverts per hour. In addition, Gamma-Scout can be linked to a computer through a USB port; the collected data can be downloaded via the software program Gamma-Toolbox, included with the device. The program automatically organizes the data into labeled tables, which can be converted into 2-D or 3-D graphs. The device can be set to measure in intervals up to one week. Gamma-Scout is currently been implemented in an advance physics lab to supplement and expand the education of physics, biology, and chemistry students at Morehead State.

*Sponsored by Jennifer Birriel

FH02: 3:10 PM Investigating High-Temperature Superconductivity through Data Acquisition with LabVIEW

Andra Petrean-Troncalli, Austin College, 903-813-2355, atroncalli@austincollege.edu*

We have developed a few experiments that investigate superconductivity phenomena, such as magnetic levitation, vanishing of electrical resistivity, and magnetic susceptibility. Initially, the experiments involved manual data acquisition. Subsequently, the students provided modification of the experiments by implementing data acquisition through LabVIEW software and DAQ and GPIB hardware.

Students did this work either as final class projects in an upper-level undergraduate laboratory, or as semester-long projects in a research experience course. The experiments studied the high temperature superconductor $YBa_2Cu_3O_7$. Some of the samples were available commercially, while others were home built. One experiment involved placing the sample in a cryogenic system that can be cooled to 10 K, while the others used liquid nitrogen to cool the samples.

* Sponsored by Larry Robinson

FH03: 3:20 PM Implementing LabVIEW in an Intermediate Physics Laboratory *

Steven C. Sahyun, Univ. of Wisconsin–Whitewater, 262-472-5113, sahyuns@uww.edu

LabVIEW is a widely used graphical programming environment for data acquisition and instrument control. Several universities now have a dedicated course for learning the program or incorporate it into their advanced laboratory or electronics courses. [1, 2] This talk will describe the structure of a three-week module for learning LabVIEW with the use of a low cost USB interface unit for basic data acquisition and device control in the context of an intermediate laboratory course. In this course module, students develop skills needed to acquire and record data from external sources and to send signals to control devices. The course module is used as an introduction to data acquisition and is part of a broader structure for the laboratory course. [3] In addition, this talk will describe experiences with resource procurement, installation of the program, and implementation of the course module.

*Supported in part by a National Instruments equipment grant.

1. P. J. Moriarty et al., "Graphical computing in the undergraduate laboratory: Teaching and interfacing with LabVIEW," *Am. J. Phys.* **71**, 1062-1074 (2003).
2. T. F. Colton, "LabView Programming in an Advanced Physics Laboratory," 2006 AAPT Summer Meeting.
3. S. C. Sahyun, J. M. Polak, C. M. Moore, "Undergraduate student laboratory experience at the Synchrotron Radiation Center," *Am. J. Phys.* (2006)

FH04: 3:30 PM Neutron Room Return

Hector R. Vega-Carrillo, Universidad Autonoma de Zacatecas, 52-492-922-7043 Ext. 118, fermineutron@yahoo.com

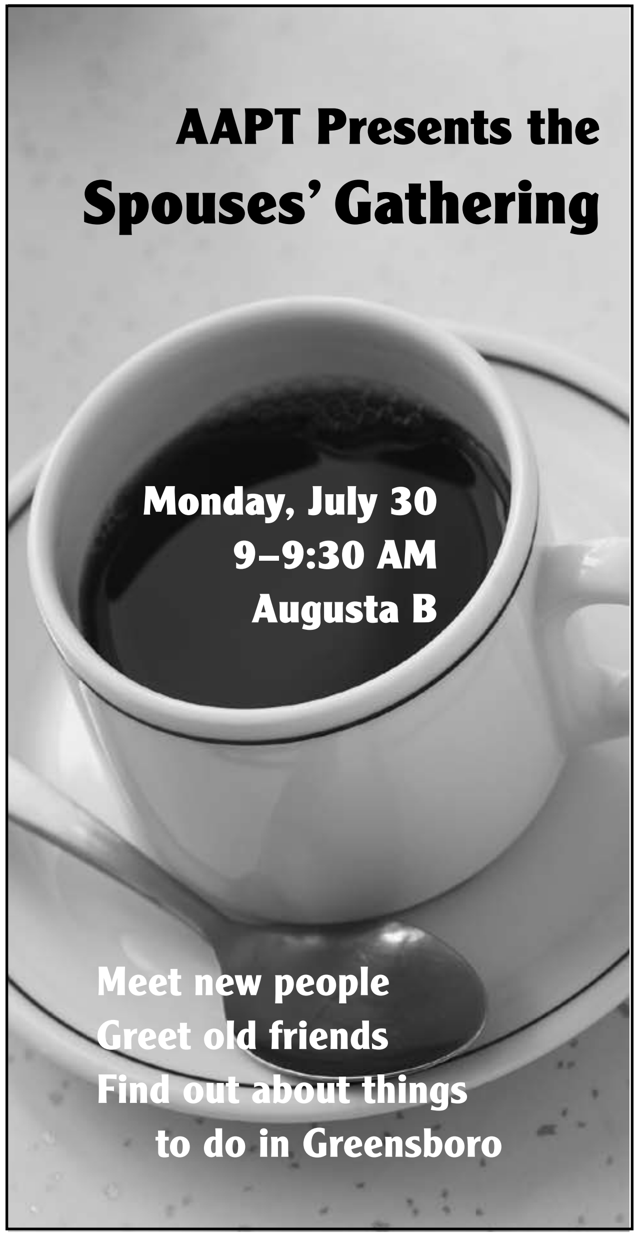
Eduardo Manzanares-Acuña, Victor M. Hernandez-Davila, Miguel A. Salas-Luévano

Using Monte Carlo methods, the neutron spectra produced by 239PuBe, D2O-moderated and bare 252Cf neutron sources has been studied in concrete wall spherical rooms with different diameters. In was found that the thermal neutron fluence rate is practically constant in every site inside the room regardless the distance to the source; this is the "room return." Three experiments were carried out using 239PuBe, D2O/252Cf and 252Cf sources were the neutron spectra was obtained in two different rooms. Count rates were obtained with a Bonner sphere neutron spectrometer with a 6LiI(Eu) scintillator and 2, 3, 5, 8, 10, and 12 inches-diameter polyethylene spheres; the neutron spectra were unfolded using the BUNKIUT code and the UAZLiI4 response matrix. Experimental results agree with Monte Carlo calculations, thus knowing the room return of the actual rooms proper corrections can be done during calibration on neutron measuring apparatus. This work is part of SYNAPSIS research project supported by CONACyT (Mexico) SEP-2004-C01-46893

FH05: 3:40 PM Anharmonic Oscillator, Demonstration and Quantification of Potential Energy

Yogesh Kumar Vijay, Univ. of Rajasthan, Jaipur, 9314889180, yk_vijay@sancharnet.in

A bar pendulum is a harmonic oscillator up to 15-20 degree of amplitude of oscillation. The time period is independent of amplitude. It oscillates only due to gravitational interaction. When a bar magnet is clamped at bottom and another magnet placed on a table, one gets additional restoring force due to magnetic interaction. Combined effect of magnetic and gravitational interaction leads to anharmonic character in oscillation within 15–20 degrees of amplitude of oscillation. This can be demonstrated using following apparatus, and a laboratory experiment could be performed.



FH06: 3:50 PM Advanced Labs at ECU-More than Experiments

Karen A. Williams, East Central Univ., 580-310-5394, kwillims@mac.com

Like many of you, I teach the Junior Physics Lab, the X-ray and Nuclear Physics Lab, and an Ultrasound Lab. These are all upper-level laboratories that require purchasing equipment, finding or writing a lab manual, all while keeping a keen eye on preparing the student for a career or graduate school. I have implemented design labs. I require formal lab reports from LabWrite (http://labwrite.ncsu.edu/). LabWrite teaches the writing of a lab report by asking questions of the student. I modified the LabWrite rubric and use it to grade reports; so I hear no more complaining about grades. I also grade the students on teamwork points so they are all forced to work together as suggested by employer surveys and assessment reports. These are not all my novel ideas, but I have implemented the combination that I think best suits my labs, the students, and the survey research.

FH07: 4 PM Experiment on Diffusion in Aqueous Solutions

Steven K. Wonnell, Johns Hopkins Univ., 410-516-5468, wonnell@pha.jhu.edu

Microfluidics is a new technology with many applications in biophysics. I will talk about a laboratory exercise developed for our junior-level biophysics course that can be performed in two 50-minute lab sessions. It combines the concepts of microfluidics, laminar flow, diffusion, and the Einstein-Stokes diffusion relation. In this experiment, students create parallel adjacent streams, one containing pure water, and the second containing an aqueous solution with a molecule of interest (we used Brilliant Blue FCF, 790 u in molecular weight). Where the streams are in contact, the molecule diffuses into the pure water. Using a microscope, students measure an intensity profile at successive sites along the contact interface, and fit these profiles to a formula based upon an error-function solution to the diffusion equation. From the appropriate analysis, a value for the diffusion coefficient is obtained that compares favorably with that predicted from the Einstein-Stokes relation.

FH08: 4:10 PM Electronics Instrumentation: Sensors to Computers Taught Using the Learning Cycle

Paul W. Zitzewitz, Univ. of Michigan-Dearborn, 313-593-5158, pwz@umich.edu

How do you select the content for a one-term course in electronic instrumentation for junior physics majors? I have organized my course around the problem of obtaining signals from laboratory quantities (temperature, position, magnetic field, light intensity, etc), conditioning them and acquiring them in a computer both for analysis and for output back into the laboratory (voltage, position, heat, light, etc.). Through this process dc and ac circuits, op-amps, discrete devices, Schmitt triggers, digital gates and counters, and A/D or D/A converters are encountered. We use the NI USB-based DAQ 6009 and LabVIEW. Students do a two-week project. The course is taught in a combined lecture/laboratory with laboratory exploration proceeding explanation. I have written a combined laboratory manual and textbook. Successes, failures, future directions, and student responses will be discussed.

Session FI: Report on IACPE Meeting In Costa Rica, 2006 Posters

Sponsor: Committee on International Physics Education
Location: Oak B-C
Date: Wednesday, Aug. 1
Time: 3–5 PM

Presider: Gordon Ramsey, Loyola Univ., 773-508-3540, gpr@hep.anl.gov

FI01: 3 PM International Year of Physics Activities in Central and South American Countries

Poster – Patsy Ann Johnson, Slippery Rock Univ. of Pennsylvania, 724-738-2317, patsy.johnson@sru.edu

Many Central and South American countries encouraged public awareness about and enthusiasm for physics as part of celebrations of the World Year of Physics in 2005. Some of these activities were reported at the 2006 Inter-American Physics Conference held in Costa Rica. Posters, brochures, and other products produced for the International Year of Physics were displayed at the conference. What was learned at the Costa Rica conference about these efforts will be shared in this poster presentation.

FI02: 3 PM A Summary of the IX Inter-American Conference on Physics Education

Poster – Patsy Ann Johnson, Slippery Rock Univ. of Pennsylvania, 724-738-2317, patsy.johnson@sru.edu

Elizabeth Chesick

Oral and poster presentations were given at the IX Inter-American Physics Education Conference held in Costa Rica during July of 2006. Workgroups wrote recommendations based upon their discussions. These and other conference activities will be summarized in this poster presentation.

FI03: 3 PM The World Year of Physics in Costa Rica

Poster – Elizabeth B. Chesick, The Baldwin School – Retired, 610-642-6381, echesick@aol.com

This poster will show some of the activities accomplished by the Physics community in Costa Rica to commemorate The World Year of Physics in 2005.

Index of Advertisers

Index of Meeting Participants

J

K

L

M

Stokes, Harold T., BN
Stonebraker, Stephen, BE08, PST2-10
Strand, Michelle, BL, CA
Streletzky, Kiril, EH08
Sundquist, Andreas, BH04

T

Tai, Robert H., BW12
Tam, Francis, DJ
Tarara, Richard W., AJ04
Taylor, Ben, SUN05
Taylor, Jack W., PST2-15, AG02, AG03
Teese, Robert B., CD02., W01
Tejeda, Santa E., CI06
Teodorescu, Raluca E., PST2-27, EC06, EC07
Thacker, Beth, BM03
Thaden-Koch, Tom, AE12, PST2-42, PST3-19
Thoennessen, Michael, DI, DI01
Thompson, John R., BN07, BW07, PST1-40, PST1-41, PST2-44, EF03, FC
Thompson, Nancy L., DG01
Thornton, Ronald, W24
Timberlake, Todd K., AG01
Timbie, Peter, PST3-16
Titus, Aaron P., AC03
Tompkins, Perry A,. DL08
Torigoe, Eugene T., EF01
Torres-Isea, Ramon, W31
Townend, Paul A., EE04
Trawick, Matthew, DN03
Treacy, Donald, PST3-22
Trout, Joseph J., BV07
Turley, Steve, AN
Turner, Mike, AC04
Turner, Raymond C., W38
Turpen, Chandra A,. AG06, PST2-20, PST3-20, AG07, BN03, PST2-19
Tyson, Neil D., BA01

U

Underwood, Bret, PST3-16
Uragami, Takuyuki, PST2-47

V

van de Sande, Brett, DO05, PST3-22
Van Deventer, Joel C., PST1-13
Van Domelen, Dave J., FG06
Van Heuvelen, Alan, AG08
Van Heuvelen, Alan, AG09, AG10, BW03, PST2-13, PST2-14
Vanlehn, Kurt, PST3-22
Vega-Carrillo, Hector R., FH04
Velarde, Juan J., CI06, PST3-30, CI04
Venable, Demetrius D., BG01
Vermeer, Andrea, DK02
Vetrone, Jim, BX03
Viar, Todd, DO09
Viele, Pat, T01
Vijay, Yogesh Kumar, FH05
Villegas, Myriam E., EG01, CI09, AF06, DJ09, DK02, PST1-21
Voroshilov, Valentin, PST3-06

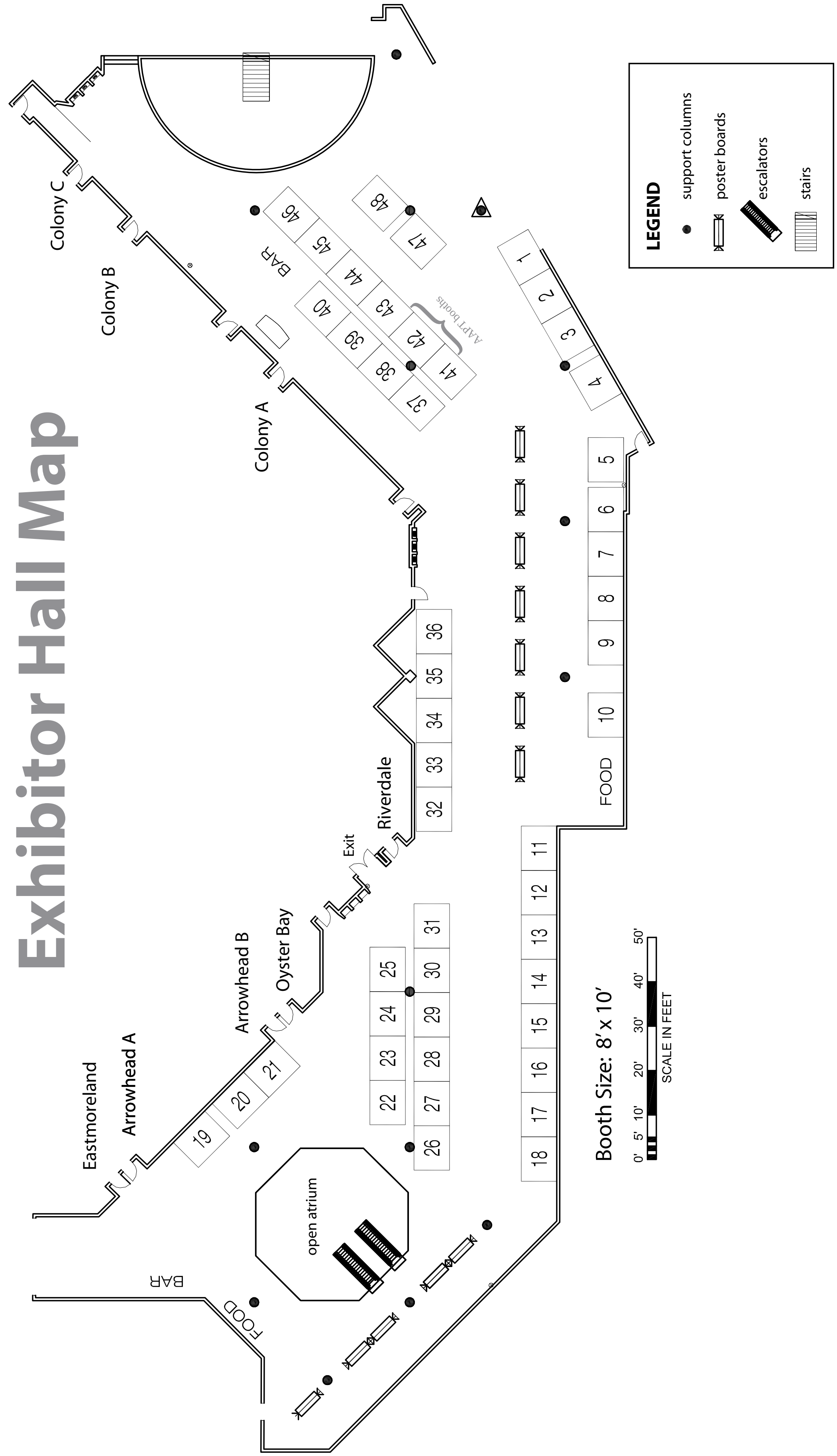
W

Wagner, D.J., PST1-34
Walling, Charlotte P., PST1-44
Walsh, Laura, CI10
Wang, Jing, BE09, BL08, BL09, CI11, PST2-10, PST2-36, PST2-37, PST2-43, PST3-27
Wang, Lawrence, SUN04
Keith Warren, W02
Wasserman, Steven, EH03
Weatherford, Shawn A., AC02
Weaver, David, AK04
Weiner, Adam, PST2-09
Wenning, Carl J., CH02
West, Meghan M., PST2-22
Wheeler, Gerry, AM01
Whelan, Kris, BL01
Whitaker, Robert J., CE04
White Brahmia, Suzanne, ED01
White, Gary, DK
Whitten, Barbara L., FF04, PST1-02, CG
Whitworth, Christi, PST2-01
Wick, David P., PST2-32
Wiebe, Eric W32
Wiegert, Craig C., BH02, BN02
Wieman, Carl E., BH03, BW08, PST1-46, AE10, PST2-24, PST2-25, PST3-26, W36
Wiesner, Hartmut, BL07
Williams, Elvira S., AI04, BG03
Williams, Jeffrey J., BE
Williams, Karen A,. BH09 FH06
Williams, Kyron M., BG02
Williams, Paul, AD04, AK05
Willis, Courtney W,. PST3-07
Willis, Maxine C., W12, W01
Wimbish, Wallis A., AN03
Winters, Loren M., CD03, BB03
Wintersgill, Mary C., PST1-24, PST3-22
Wittman, Michale C., AB01, BN07, BN08, PST1-13, PST1-38, PST1-39, PST1-42, PST2-30, PST2-31, PST2-44, PST3-09, DB
Wolf, Portia, DK03
Wolter, Michael D., AF02
Wonnell, Steve, W31, FH07, PST3-15
Wood, Jeremy, BF03
Wood, Ted, EH08
Yerushalmi, Edit M., DL05

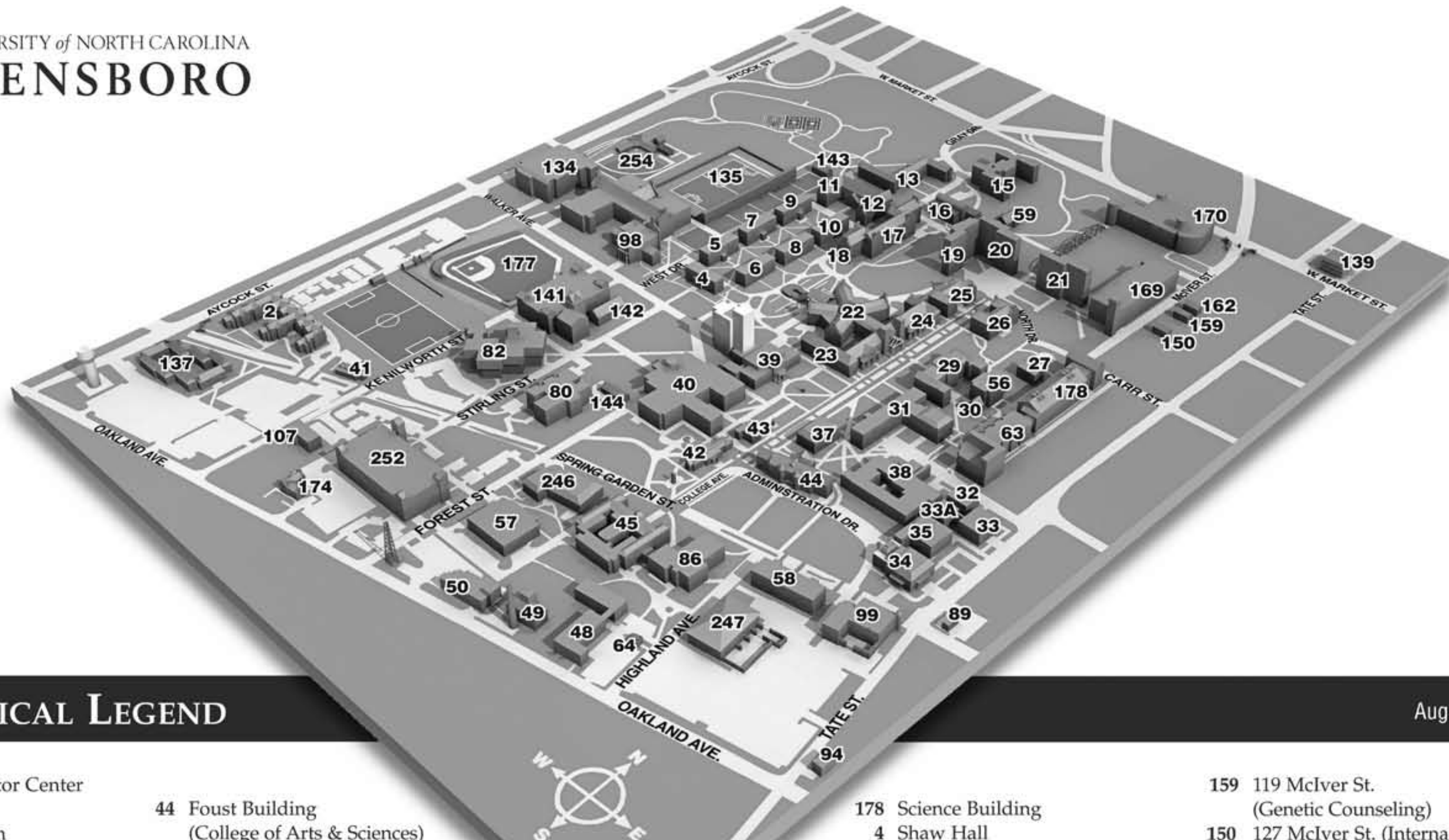
Y-Z

Yoo, Junehee, BB04, PST3-05
Zajac, Richard, EC01
Zani, Gerald A., AL02
Zavala, Genaro, CI, CI03, CI04, CI06, EG02, PST3-30, PST3-35
ZETTILI, Nouredine, EC02
Zhou, Feng, BB09, PST1-27
Zhu, ChunYan, PST3-31
Zitzewitz, Paul W., FH08
Zollman, Dean A, BD04, BE01, BL07, BW09, DJ04, DJ08, W35
Zou, Jie,
Zurcher, Ulrich, BM01, EH08
Zwart, John W., AE03

Exhibitor Hall Map



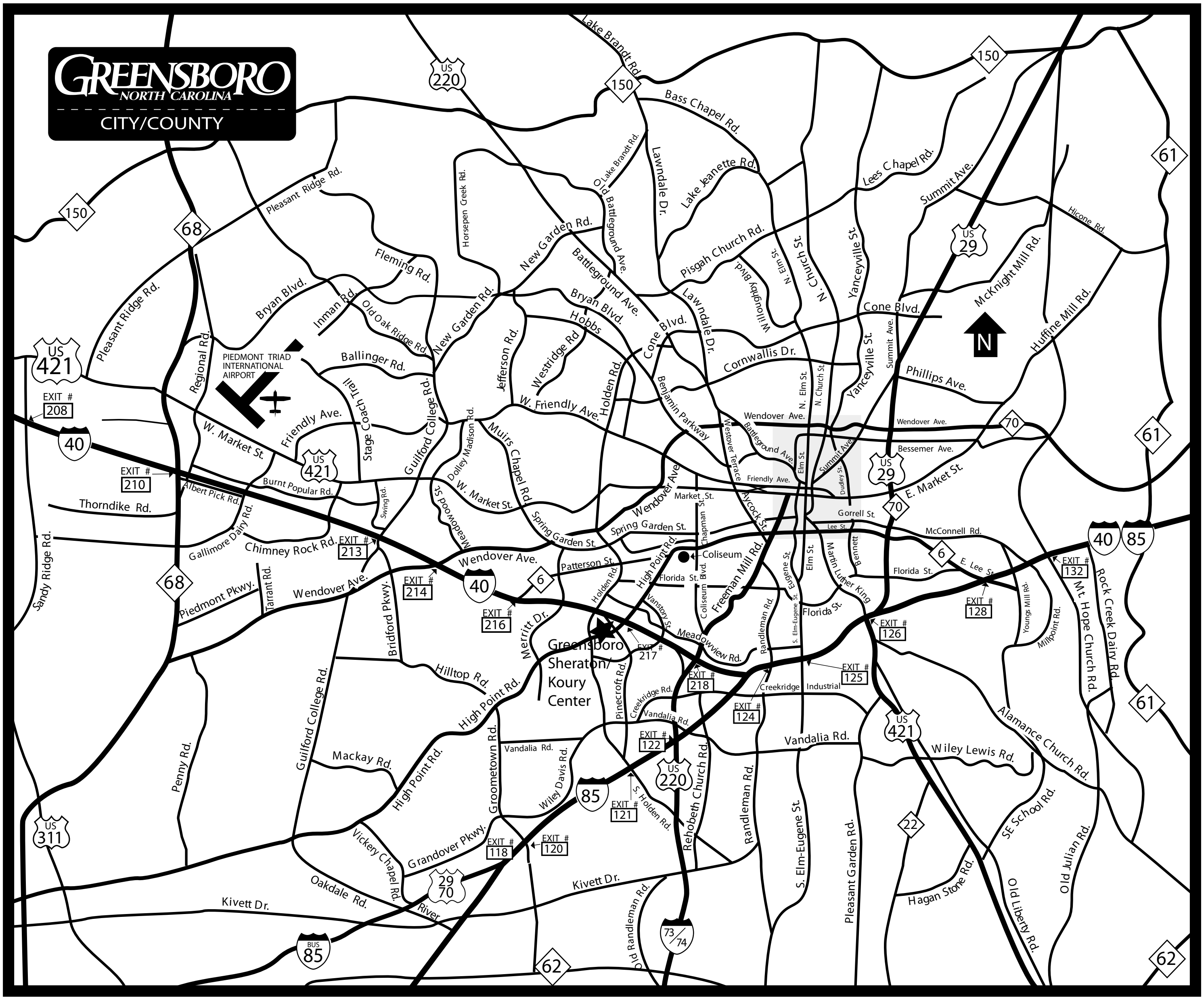
THE UNIVERSITY *of* NORTH CAROLINA
GREENSBORO



ALPHABETICAL LEGEND

August 2006

41 Admissions & Visitor Center
42 Alumni House
34 Aycock Auditorium
7 Bailey Hall
177 Baseball Stadium
33 Brown Building
82 Bryan Building (Bryan School of Business & Economics)
50 Campus Supply Store
32 Carmichael Building
174 Chemical Safety Facility
10 Coit Hall
21 Cone Hall
99 Cone Building
8 Cotten Hall
45 Curry Building (School of Education)
22 Dining Halls
63 Eberhart Building
40 Elliott University Center
43 Faculty Center
86 Ferguson Building
37 Forney Building
44 Foust Building (College of Arts & Sciences)
247 Gatewood Studio Arts Center
16 Gove Student Health Center
58 Graham Building
6 Gray Hall
59 Gray Home Management House
20 Grogan Hall
143 Grounds Maintenance Building
25 Guilford Hall
98 HHP Building (School of Health & Human Performance)
5 Hinshaw Hall
39 Jackson Library
9 Jamison Hall
26 Mary Foust Hall
38 McIver Building
169 McIver St. Parking Deck
57 McNutt Building
18 Mendenhall Hall
56 Moore Building (School of Nursing)
246 Moore Humanities & Research Administration
13 Moore-Strong Hall
80 Mossman Building (University Administration)
170 Music Building (School of Music)
24 North Spencer Hall
252 Oakland Ave. Parking Deck
29 Petty Building
15 Phillips-Hawkins Hall
17 Ragsdale Hall
2 Residence Hall (future)
19 Reynolds Hall
178 Science Building
4 Shaw Hall
48 Sink Building
142 Smith Campus Ministries Building
135 Soccer Stadium
254 Softball Stadium
23 South Spencer Hall
2 Spring Garden Apartments
49 Steam Plant
31 Stone Building (School of Human Environmental Sciences)
134 Student Recreation Center
35 Taylor Building
137 Tower Village
141 Walker Ave. Parking Deck
99 Weatherspoon Art Museum (Cone Building)
12 Weil Hall
11 Winfield Hall
162 117 McIver St. (Carter Child Care Center)
159 119 McIver St. (Genetic Counseling)
150 127 McIver St. (International Programs Center)
27 310 McIver St. (Child Care Center)
30 320 McIver St. (Nursing Annex)
144 500 Forest St. (University Relations)
94 525 Tate St. (University Graphics & Printing)
64 536 Highland Ave. (Family Research Center)
107 723 Kenilworth St. (Financial Aid)
89 996 Spring Garden St. (University Police)
139 1100 West Market St. (University Offices)


GREENSBORO
NORTH CAROLINA
CITY/COUNTY
PIEDMONT TRIAD INTERNATIONAL AIRPORT
Greensboro Sheraton/ Koury Center
Coliseum
N
Lake Brandt Rd.
Bass Chapel Rd.
Lawndale Dr.
Lake Jeanette Rd.
Lees Chapel Rd.
Summit Ave.
Hicone Rd.
McKnight Mill Rd.
Huffine Mill Rd.
Pleasant Ridge Rd.
Horsepen Creek Rd.
Old Lake Brandt Rd.
Old Battleground Ave.
New Garden Rd.
Fleming Rd.
Battleground Ave.
Bryan Blvd.
Pisgah Church Rd.
Willoughby Blvd.
N. Elm St.
N. Church St.
Yanceyville St.
Cone Blvd.
Inman Rd.
Old Oak Ridge Rd.
Regional Rd.
Ballinger Rd.
Stage Coach Trail
Guilford College Rd.
Jefferson Rd.
Westridge Rd
Hobbs
Holden Rd.
Benjamin Parkway
Cornwallis Dr.
Phillips Ave.
W. Friendly Ave.
Friendly Ave.
W. Market St.
Muirs Chapel Rd.
Dolley Madison Rd.
Wendover Ave.
Westover Terrace
Bessemer Ave.
E. Market St.
Burnt Popular Rd.
Albert Pick Rd.
Thorndike Rd.
Swing Rd.
Meadowood St.
Market St.
Chapman St.
Aycock St.
Gorrell St.
Lee St.
McConnell Rd.
Spring Garden St.
Gallimore Dairy Rd.
Chimney Rock Rd.
Sandy Ridge Rd.
Patterson St.
High Point Rd.
Coliseum Blvd.
Freeman Mill Rd.
Eugene St.
Elm St.
Martin Luther King
Bennett
Florida St.
E. Lee St.
Rock Creek Dairy Rd.
Mt. Hope Church Rd.
Youngs Mill Rd.
Millpoint Rd.
Piedmont Pkwy.
Tarrant Rd.
Bridford Pkwy.
Merritt Dr.
Vanstory St.
Meadowview Rd.
Randleman Rd.
S. Elm-Eugene St.
Hilltop Rd.
Pinecroft Rd.
Creekridge Rd.
Creekridge Industrial
Vandalia Rd.
Alamance Church Rd.
Wiley Lewis Rd.
Mackay Rd.
Groometown Rd.
Wiley Davis Rd.
S. Holden Rd.
Rehobeth Church Rd.
Penny Rd.
Vickery Chapel Rd.
Grandover Pkwy.
SE School Rd.
Old Julian Rd.
Hagan Stone Rd.
Old Liberty Rd.
Pleasant Garden Rd.
Kivett Dr.
Oakdale Rd.
River
Old Randleman Rd.
EXIT # 208
EXIT # 210
EXIT # 213
EXIT # 214
EXIT # 216
EXIT # 217
EXIT # 218
EXIT # 124
EXIT # 125
EXIT # 126
EXIT # 128
EXIT # 132
EXIT # 122
EXIT # 121
EXIT # 118
EXIT # 120
US 220
150
US 421
68
40
US 29
70
61
6
85
US 311
22
29 70
BUS 85
62
73/74

We'll See You in Baltimore!

AAPT Winter Meeting
January 19-23, 2008
Marriott Convention Center
at the Inner Harbor

and in Edmonton, Alberta, Canada next summer!

AAPT Summer Meeting
July 19-23, 2008

Please note:
a passport will be required

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