American Association of Physics Teachers
Arkansas-Oklahoma-Kansas Section
October 27-28, 2006 – Emporia State University, Emporia KS
notes by Dave Van Domelen, Kansas State University

I don't always go to the AOK section meeting, because I generally teach on Fridays until mid-afternoon, so if the meeting isn't fairly close I stay home. However, Emporia's just an 80-90 minute drive, so this time I went. And, as usual, I took copious notes. Friday night was a banquet and a public lecture (which I took only scattered notes at), and the meat of the meeting was Saturday. There were five contributed paper sessions, two of which (3 and 4) were parallel, so I did not attend all five. There was also a poster session mainly presenting student work (no notes on that, sorry) and a keynote address before lunch by the public lecture's speaker. Thanks to the proximity, Kansas State's PER group was pretty strongly represented in the contributed talks.

There were no official session labels, but for my own convenience I have labeled the contributed sessions as C1 through C5, with individual talks being numbered things like C2.3 (third talk in session 2). Just so you know. As is my usual practice, any personal comments or asides will be in square brackets.

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Friday, October 27

Jones Distinguished Lecture

"The View From Space: What's It Like, Does It Change Your Perspective, and Why Do We Go?" – Dr. George "Pinky" Nelson, Western Washington University (former Space Shuttle Mission Specialist).

[Nelson got his nickname because of a (mostly faded now) pink birthmark. This came up during the keynote on Saturday, but why keep you all in suspense?]

Nelson was too young for Apollo, and regrets that it looks like he's too old to have a shot at going back to the moon. He was on the flight right before the Challenger disaster, and admits things looked a little shabby on the shuttle at that time. Debris always floats up when they hit freefall (and is cleaned up with duct tape), but apparently it was worse than usual.

Solid rocket separation wreaths the shuttle in flames, quite scary.

The shuttle hits about Mach 25 or so during launch. One time, some shuttle pilots saw a bunch of SR-71 Blackbird pilots in a bar wearing their "Mach 3+" patches, and got themselves some "Mach 25+" patches made.

The first 24 hours in freefall is unpleasant. The body needs to adjust to the lack of gravity, resulting in swollen faces (the blood is no longer being pulled down to your feet), vomiting, and a lot of passing of fluids. After about a day, though, things stabilize, your blood drops in volume by about 20%, and things are great.

However, sleeping can be a problem. Orbiting every 90 minutes means there's no useful day/night cycles for your Circadian rhythms to cue off, so you end up having to sleep by the checklist, wearing a mask. Some use the sleeping bags provided to tether themselves to the wall while sleeping, but others just duct tape a foot to the wall and drift. The natural sleeping position in freefall is less than dignified, a sort of semi-squatting pose with arms stretched out like a zombie.

Regarding the view of the planet from space, Nelson joked, "It's not obvious from orbit that there's intelligent life on Earth, but it is obvious there's engineers."

The Nile Delta is lit up with blue mercury-vapor lights at night, and looks like some sort of glowing blue lotus. Shift a little east and all the lights are yellow. Different nations have different lighting standards.

The view from up there encourages a sense of stewardship...you can see the large-scale damage wrought by human activity. The burning forests, the polluted flows into the oceans, the shrinking lakes.

Saturday, October 28

Contributed Session C1

C1.1: Online Support for New Physics Teachers – Brian Adrian, Kansas State University, badrian@phys.ksu.edu

Report on ongoing work with the PATHWAY project (Physics Teaching Web Advisory...yeah, the acronym's a bit of a stretch), a joint project between Carnegie Mellon University (providing the code) and Kansas State (providing the content).

CMU has developed the "informedia" digital library engine, a metadata extractor that can search through video clips and other media to search out keywords. The clips are also given transcripts, allowing quick scanning to see if the keyword search turned up a useful result or not. There are currently about 100 non-downloadable (copyrighted) clips of physics demos and the like. A series of workshops given by Hewitt will also be added in the future.

In addition to the clip library, KSU is creating synthetic interviews for the system. In a synthetic interview, experts are taped answering various questions, and then a search system is used to let users type in their questions in natural language. The system matches the question to the best-fit interview segment. There's also an iterative "was this helpful?" system that lets them refine the question-matching system. There are currently

4 experts, and 1000 interview segments. The content is mostly kinematics, with some dynamics being added now.

The system has been live for a while now, and most of the questions are asked by pre-service and in-service teachers (plus calibration questions asked by the developers). 70% of the questions ask for pedagogical help (i.e. "How do I teach this?"). 12% are about content knowledge, 8% are simple keyword searches (i.e. "Force") that kinda miss the point of the engine, 6.3% are off-topic, 2% ask for demos, 1.4% ask for activities, and 0.2% ask about assessment. Those last two are considered the most important by PER, but it's possible that most teachers are still in need of basic pedagogical help right now, and will move on to activities and assessment once they've got their feet under them.

There are still many features left to add that they'd like to have.

C1.2: Probing and Improving Student Understanding of Common Electrical Devices – Jacquelyn Haynicz, Kansas State University, haynicz@phys.ksu.edu

This project is an attempt to bring more real-world applications into the classroom. The first phase involved asking students what electrical devices they were interested in learning more about, but that didn't work out too well. Students tended to bring up electronic devices instead, such as computers and DVD players, and were more interested in functionality ("How do I get it to work?") than underpinnings ("How does it work?"). Nor was there any clear favorite.

For phase 2, a simple electric blender (just on-off, no speed controls) was chosen, as it was fairly simple, familiar to the students, and relevant to the lecture on electric motors taking place around that time in the semester. The format was a teaching interview (a small-scale classroom simulation) that used several simplified demos, tying each one back to the blender. The demos included the magnetic railgun experiment (showing how current and magnetic fields could get things to move), a simple canister motor with permanent magnets, an "exploded" version of that motor with more accessible parts, and a similar motor that used coils rather than permanent magnets.

Analysis of the interviews indicated that students tended to work mainly in the "Knowledge is self-constructed" epistemic mode, rather than the "Knowledge comes from authority" mode or the "Pulled out of thin air" mode. Phenomenological primitives such as "closer is stronger" and "reversing input will reverse output" were commonly seen in use.

Students tended to focus on surface structures rather than function when comparing things. They also tended to confuse electric charge and magnetism. Those who were interviewed after motors were covered in class did not differ noticeably in their responses from those interviewed beforehand.

The following spectrum of concepts emerged from the work to date. At one end, you have students with a very mechanical view of magnetism, explaining it as the process of charges physically bouncing off of things to move them around. In the middle of the spectrum is a more electrostatic view, in which charges still do all the work, but do so via static fields. At the other end is the correct electromagnetic explanation. It is worth noting that there is no evidence as yet that there is any sort of trajectory across this spectrum, all there is right now is a series of snapshots of various students. Further work will be needed to see how and even if students move from one end to the other, as well as how to encourage this.

C1.3: Using a Web-Based Classroom Interaction System to Enhance Student Learning – Sanjay Rebello, Kansas State University, srebello@phys.ksu.edu

As part of a grant from HP a couple of year ago, the PRS "clickers" used in KSU's "Concepts of Physics" class aimed at Preservice teachers were replaced by palmtop computers. As these are normally not handed out by manufacturers and are an order of magnitude more expensive than clickers, it was deemed necessary to find as many new ways to use them as possible, rather than just having them be slightly more flexible multiple choice response systems. Using their ability to access webpages allowed for a wider variety of items, including branching questions (i.e. answering "A" to question 1 sends you to question 2, but answering "B" sends you to question 3, and so forth), short answer or essay questions, and also two-way feedback. While palmtop browsers have significant limitations compared to full-featured browsers, they still offer many possibilities.

To take advantage of those possibilities, the "K-State InClass" system was written, using web development tools. It allows instructors with limited computer skills to create pages and items, while also making sure that everything works within the limitations of the palmtop browsers.

Three research questions were asked, comparing the 2005 class with palmtops to the 2003 class with PRS clickers where comparison was necessary. Both classes were taught by the same lecture instructor and with the structure of the course otherwise remaining the same. Students were elementary education majors, and the course used peer learning techniques and learning cycles in the course design. Student overall GPAs and backgrounds were comparable for the two groups. Data pre-PRS was not available, as some form of clicker has been in use for this course for nearly a decade.

1. Did course performance improve? Based on course grades, yes, with a statistical significance of $p < 0.036$.

2. Did course performance correlate positively with frequency of palmtop use in class (which was optional for 2005, it was made mandatory in 2006)? Again, yes. Frequent users outperformed infrequent users in course grades.

3. Did students like the palmtops? A survey administered to the class indicated that about 60% found the palmtops useful, 80% found the palmtops made for clearer understanding in class, and 65% claimed they would try to implement something like this in their own classrooms once they got out in the field. Transcripts of the palmtop-based feedback were also examined and found consistent results, although most of that data has yet to be analyzed.

Palmtops do seem to be worth the extra expense and effort, but it's necessary to bear in mind that correlation does not equal causation. Further study of both the existing transcripts and future data are needed to see how the palmtops are actually used. Also, not everyone's satisfied with the use of course grades as a measure of student learning, and the fact that there's no non-tech control group to refer to concerned at least one audience member.

C1.4: Exploring the Studio Format in an Upper-Division Course: A First Look – Fran Mateycik, Kansas State University, mateyf@phys.ksu.edu

[I had to duck out of the room at this time to check my blood glucose, so have no notes on this talk, and I also missed the practice version of it because of a doctor's appointment. The subject is the upper-level optics course at KSU, and its recent overhaul into a studio format. The PowerPoint slides should be available at KSU PERG's webpage, at http://web.phys.ksu.edu/talks/index.html by the time you read this. Now, here's the abstract from the conference program.]

"Studio physics classrooms are most commonly used with introductory courses. The Kansas State University Physics Department intends to expand studio implementation to upper division classes, and elected to start with Optics I and II. Studio Optics was designed and completed over the spring of 2006. We chose to investigate how this method will perform with upper division physics majors. Twelve students were given two sessions of teaching interviews. The first interview focused on single slit diffraction. The second interview focused on Poisson's Spot. The initial data sweep afforded us the opportunity to explore students' difficulties with the studio laboratory write-up as well as their conceptual understanding of the topics. We also gained insights [...] into the mindset with which students approached the laboratory activity."

C1.5: Painless Post-Graduation Assessment of the Major – Karen Williams, East Central University, kwillims@mac.com (no, that's not a typo, there's no 'a' in the email ID)

Many university administrations require some sort of post-graduation assessment of students to see how they're using what they learned. However, mailed surveys have a low response rate, compounded by the fact that reliable mailing addresses can be hard to come by several years after someone graduates. In a recent attempt by ECU, only one out of almost thirty surveys sent out was sent back.

The AIP survey of graduates is well-validated, but rather long, which also discourages grads from filling it out (if you want a copy, email kstowe@aip.org). ECU took items from it that were most relevant to the university's requirements, created an online survey and emailed that URL to grads. Email has the advantage of following someone a little more closely...even if they move several times in their first few years out of college, there's a good chance their old email address still works (unless cancelled on account of spam). Online surveys are also more convenient for most these days.

Formsite.com was used for the survey, being reasonably priced and easy to use. Of course, if your university already has a survey system, go with that.

The ECU version of the AIP survey had 16 major items, most of which were broken down into several sub-items, a mix of Likert-like scales and short answer or yes/no questions. And it was fully anonymous, an important factor when soliciting honest criticism of a program (a mailed-in survey can be made anonymous, but not in a way that's necessarily going to be convincing to the responder).

34 invitations were sent out, with 2 emails bouncing (making it very important to get everyone's stable email during the exit interview). Of the remaining 32, after one month and two reminder emails, 27 had responded. There were many helpful suggestions in the open response items, and the Dean was quite pleased.

This system would also make it easier to share results regionally, letting smaller colleges pool data and insights.

C1.6: Some Preliminary Views on Students' Models of the Physics of the Eye – Dyan Jones, Kansas State University, dljones@phys.ksu.edu

This is part of the Modern Miracle Medical Machines (MMMM) project, which uses medical technology as a context for teaching physics.

The work here looked at how students perceive four different models of the eye: an accurate anatomical model with little physics content, a simplified physical model, a slightly more complex physical model, and a computer simulation of the accommodation process (by which the lens flexes to keep an image focused on the retina). The first physical model is used in the algebra-based physics course's lab, and involves a round tank of water with a movable screen (retina) at the back and an assortment of lenses that can be placed at the opening. The second physical model did not have an equivalent of the vitreous humor, but used a liquid-filled lens that could be adjusted by use of a hydraulic system operated by syringe. It also had an adjustable shape, to simulate nearsighted and longsighted eyes.

Phase 1 interviewed undergrads who were present for their REU (Research Experience for Undergraduates) experience as well as physics graduate students. Both groups had very simplified views of how the eye worked, representing it as just a lens and a screen. Less than half of the subjects understood vision defects, mainly those who had the defect in question. Most students thought that vision defects arose from a problem with the lens, rather than with the shape of the eye. [Aside: lens stiffness does result in the sort of farsightedness that comes with age, but none of the subjects were old enough to suffer from that as far as I know.] Many student comments on the first physical model had to do with its appearance, focusing on surface features.

Phase 2 interviewed the students taking the upper level undergraduate studio optics course. The first physical model was replaced by a more recent version available from PASCO, which students found more aesthetically pleasing, resulting in fewer comments about the surface features and more about the function. Some students identified the eye as a two-lens system, with the cornea being the first lens.

There remains much data from phase 2 that needs to be analyzed, which will be followed by curriculum development.

C1.7: Using Optical Analogies While Teaching Physics of X-Rays and CAT Scans – Spartak Kalita, Kansas State University, spartak@phys.ksu.edu

An MMMM project.

Most students have some model of X-rays, unlike other imaging techniques like MRI or PET, so it makes a good starting point for investigation. A clinical interview was performed to look at students prior knowledge and probe for models. This was followed by a teaching interview that attempted to guide students to a reasonably good model of how X-rays work.

Lego bricks were used to simulate a cross-section of a body part. Translucent red bricks were used for the skin and the soft parts of the body, while opaque bricks were used to represent bone. [If you want to try this yourself, brickbay.com is a good source of large numbers of specialty bricks.] A laser was shined through the Lego structure and a PASCO light meter used to see how much light got through. There were two simulated body parts, one with an open top so that students could see the structure, and one closed off as a black box. There was an additional exercise in which students lined up translucent bricks and measured how much light got through, establishing how intensity dropped off with thickness.

Only a few figured out that the intensity dropped exponentially, as p^n (where p is the fraction let through by one brick, and n is the number of bricks). All students did, however, successfully complete the lab (3 of the 13 needed significant prodding), and most could figure out the sources of error.

The next step is to have group teaching interviews, to better simulate the lab classroom experience, and then to follow that by developing a lab based on this.

Contributed Session C2

C2.1: Initiatives in Physics Education Research in India – B.N. Meera, Bangalore University (Visiting Professor at Kansas State University), meera@phys.ksu.edu

Awareness of PER in India has gone from zero to very small in recent years. Unfortunately, existing PER results can't simply be plugged into Indian classrooms, both due to significant differences in social structure, and the fact that school in India follow a rather different sequence. These differences will have to be taken into account before any reforms can be applied.

When entering 11th grade, students need to pick a track, which will largely determine where and if they go to college/university. The tracks are Commerce, Science and Arts. If you don't get into the Science track in 11th grade, you can't get into it later, but you can always get into Commerce or Arts. So, in essence, the filter starts two years earlier in India than in America. After two years on the Science track, students go on to 3 years of a Bachelor's program in college, then a 2 year Masters program at university. Alternately, Science track students can go to a professional school instead of college.

The Masters programs tend to be split into three tracks as well. Some schools specialize in training students to become science teachers (and these are what are generally thought of in India when you say "university"), some focus on research, and some try to do both. [The implication I got was that even the combination schools tend to determine in large part what your career choices will be...if you want to be just a researcher, you shouldn't try to hedge your bets by going to a research & teaching school.]

The curriculum at universities is nationally determined, as is the assessment. If you want to change things significantly, you have to get the national standards changed. Otherwise, you need to find a way to work within the constraints of the structure.

National assessment imperatives are strongly quantitative, relying on test scores and problem-solving. There is very little qualitative or conceptual assessment, although they're starting to recognize the need for it.

There is a strong cultural drive to get an education, even Masters-level courses will have 70 or more students in the room. Thus, any imported materials would have to either be suitable for large classes, or be scaled up. Additionally, despite English being in common use in India, actual proficiency is pretty spotty, so materials would need to be translated to be effective.

PER-based reforms have been implemented at the high school level, using activity-based teaching and new assessment methods. This gives hope that it can be extended to the colleges and universities. Also, while a national curriculum means it's hard to change things, it also means that the baseline for students entering college is well-known, as all the Science-track students had the same coursework in grades 11-12.

In part because of the track system, most college physics courses are aimed specifically at physics majors, with maybe a few engineering majors here and there.

Reformers are in the process of surveying students in an attempt to start working on an effective pedagogy.

[Talk cut off at this point by the moderator.]

C2.2: Making Connections with Non-science Majors – Linda Kondrick, Arkansas Tech University, linda.kondrick@atu.edu

"Twice Upon A Time" is a project designed for a freshman-level general education Physical Science course. The basic idea was to have students do a historical research project in which parallel timelines were constructed. One timeline would involved some fairly specific area of science (such as developments in infrared study), while the other would be any topic that interested the students (such as technological innovations at the White House). They were encouraged to match years, but "close enough" was allowed (especially for events over a century ago).

Students would present both an essay and some sort of graphical representation of their timelines, which went over well with the non-science majors the course was aimed at. They also provided a PowerPoint slide or slides in some cases, and faculty picked a number of outstanding examples for wider presentation. The projects were graded using a rubric (available in a handout provided at the session, or email the speaker for a copy). While the project was not mandatory, the students' scores on them could be used to replace one exam score, so it was a popular assignment.

The hope was to increase the students' intrinsic motivation and give them a better attitude towards science. Also, interest in the non-science topic was expected to bleed over into the scientific topic that was chosen. Given the highly personal nature of some of the non-science topics, there was a lot of interest there to rub off on science.

[Later discussion by audience members tended to agree that while this would work for a very low-level gen-ed course, or perhaps a high school course, it wouldn't necessarily work in anything higher up. I expect that in a calculus-based course, some students might even feel insulted by it, so care would need to be taken in presenting such an assignment to that group.]

C2.3: Physical Science Lab Quizzes: Results from Test Item Analysis – William Gonzales-Espada (presented by Linda Kondrick), Arkansas Tech University

[This was a 30 minute paper, really, if not longer. Kondrick apologized for not being able to speak as quickly as Gonzales-Espada, but frankly, that wouldn't have helped much. It desperately needed trimming and focusing.]

The lab course under study here was part of the gen-ed course mentioned in talk C2.2, a pretty typical "cookbook" lab with lab quizzes. "Assessment is ineludible and important," so good tests are needed. Multiple choice tests were used, and analyzed for difficulty (p, the fraction of students who answered the item correctly) and discrimination ($p_{\text{upper half}} - p_{\text{lower half}}$, where the halves were based on overall performance). Difficulty is considered a criterion reference, while discrimination more of a norm reference. The discrimination was a simple top/bottom halves split, rather than upper quartile and lower quartile.

72 items were analyzed. Most had a high p value, none had negative discrimination (where the better students overall do worse on the item), and 43% had what the author considered to be high discrimination. A graph of difficulty versus discrimination was used to show items that bore further examination...any that clustered in the high-p/low discrimination section were suspect. Not automatically bad, of course...just because everyone can answer a question doesn't automatically mean you ditch it. But they bear looking at to see if they're all getting it for the right reasons. [At least, I think that's what they were saying. A LOT of slides were skipped, and the talk still had to be stopped before the end.]

Keynote Lecture

Speaker: George "Pinky" Nelson, Western Washington University

"I consider myself more an education reformer than an educator...." Nelson takes what he calls an engineering approach to education reform. Don't worry about expanding the boundaries, just get out there in the field and apply the results PER has already given us.

K-12 education is not working for the majority of students, perhaps the vast majority. The system is also very hard to keep changed, relaxing to its initial state very easily. There's no simple fixes, the system must be changed at all levels to combat this relaxation. It also doesn't help that the current preservice and inservice systems support the broken status quo, lacking any long term plan or support.

Any reform plan must evolve, a static fix will just become another broken status quo if it can't change. An iterative solution is needed.

The "Teacher Leader" model is flawed, mainly because it lacks a model for how to use these leaders in reforming at the ground level. [It wasn't really explained in detail, but I gathered that the Teacher Leader program brings in a few educators here and there, and trains them up in all the latest pedagogy and so forth, then sends them back to their schools to be seeds for change] Seeds for change can't grow if sown on rocky ground, you need a plan to plant them.

NCOSP (North Cascades and Olympic Science Partnership) is an example of reform that hopes to evolve. WWU partners with four "local" community colleges and an Indian School [Amerind, not Bangalore et al], all 2 year institutions. "Local" is relative, though, it's a 5-6 hour drive from WWU to one of the partner schools, way out in the "horn" of Washington state. NCOSP is also partnered with a K-8 reform project called LASER [acronym not expanded, a quick Google suggests he's talking about Leadership Assistance for Science Education Reform, http://www.nsrconline.org].

NCOSP's goal is to turn preservice teachers into confident science learners, with field experience that reinforces their academic training (i.e. prepare the K-12 classrooms in advance to allow for use of the methods learned during the academic training, rather than just tossing them into any old classroom to sink or swim).

The new education major at WWU has five quarters of science content, a 1 quarter methods course, a 1 quarter practicum (student teaching) and a 1 year internship. The practicum focuses on content, with the regular teacher of the class continuing to handle management tasks. Hopefully, this will let the preservice teachers focus on learning to teach the material without the distraction of also having to keep discipline.

The content courses start with a 3 quarter sequence of physics, biology and geology. It's not integrated in the sense of all three topics being taught in the same quarter, but it is thematically bound together, and all the instructors try to stay on the same page pedagogically. Next is a more intensive chemistry course as a content "capstone", and a "Physics and Society" course that aims to help teachers use current events as a springboard for instruction.

The physics course uses Goldberg's "Physics Education for Teachers" course (and will be moving to his updated book soon), and they attempted to model the biology and geology courses on that approach as well (similar materials for those topics did not exist as far as they could find). About 25 faculty are involved in total, in a non-hierarchical organization.

The overarching theme for the three-course sequence is interactions, transfer and systems. The flow of matter and energy in various contexts (i.e. "what is food?" in the biology course). The guiding documents for the pedagogy were Goldberg's book, plus "How People Learn" and "Understanding By Design." Learning cycles were used in all three courses. Each classroom has 24-27 students in it, the program currently lacks the resources to scale up to larger classrooms.

They faced many choices in development, such as integrated versus discipline-based courses (they went with discipline-based) and the question of academic freedom versus a common course approach (they ended up with a common course format). In general they worked towards consensus on these questions rather than using a top-down approach, but sometimes Nelson had to make a call and just pick something.

Fall 2005 saw 80 students spread across 4 institutions, and a lot of data was collected. They got excellent gains on various instruments, including attitude surveys like the EBAPs. The HRI observational protocol was used in classrooms and found a notable jump in scores (from 3.2 to 3.9 on a 5 point scale) for the reformed courses. Even students planning to teach outside the sciences said in surveys that they found the reformed sequence helpful, more comfortable and less intimidating.

They explicitly addressed the "Big Ideas" of scientific process and related pedagogy. Not just "How do we do this?" but also "Why do we do this?"

All in-service groups showed improvement, with no gender gap. The biggest gains were in physics, but they also had the lowest pretest scores, so that's not too surprising.

When selling a common course format, it helps to think in terms of "student-centered approach" rather than "stifling academic freedom."

The reform courses are, unsurprisingly, a LOT of work, but team teaching and Lesson Study helps. Lesson Study is an idea brought in from Japan, in which the faculty will get together and pick a topic and a teacher, then everyone else takes the role of student and evaluates how the teacher teaches that lesson. Staff development is key.

They're continuing to revise the sequence based on the feedback they've gotten, but still, you can't do it all. There are some materials they really wanted to cover but couldn't, and a great deal of material had to be cut to make room for the changes in pedagogy. But less can be more, and if you turn out confident, competent learners, they can always pick up on their own any content that you had to skip over.

The materials are not yet published, but they're working on it.

Contributed Session C3

[I did not attend this session, but since there aren't too terribly many talks, I'll just put the abstracts here to cover the gap. Any Kansas State talks will also be available at http://web.phys.ksu.edu/talks/index.html and you can email other authors for copies of their slides.]

C3.1: Energy Mental Models: From the World to the Classroom – Salomon F. Itza, University of the Ozarks

"We investigate mental model(s) liberal studies majors, prospective elementary school teachers, may use for the energy concept in physics, in various contexts. Our research instruments are both pre- and post-instruction surveys, and pre- and post-instruction interviews. We find that initially our students consider the concept of energy with the point of view of colloquial language and everyday experience. After instruction their responses consider several types of energy and the principle of conservation of energy. We present the questions, responses and analysis of the survey results."

C3.2: Transfer of Prior Reasoning in Understanding Positron Emission Tomography – Bijaya Aryal, Kansas State University, bijaya@phys.ksu.edu

"We present college students' prior reasoning and transfer while understanding some of the physics of Positron Emission Tomography (PET). Interactive hands-on activities which serve as analogies to key aspects of the PET process were designed. Teaching interviews were then conducted to investigate the role of the activities in facilitating transfer. This study, which involved students enrolled in an algebra-based introductory level physics class, showed that the use of the analogies does indeed prompt the transfer of relevant physics ideas to PET contexts. In addition, the study showed that the students transfer their prior models that they have constructed through classical physics or everyday life while learning using the analogy activities. Some of the prior models that they transfer while learning in new contexts are inappropriate but very robust. We concluded that the hands-on activities, if they are introduced in the appropriate order, can be very effective in triggering appropriate use of prior reasoning and suppressing inappropriate ones."

C3.3: Diversity Among ASMSA Students – A 3 Year Summary – Shane Thompson, Arkansas School for Mathematics, Sciences, and the Arts (ASMSA).

"Each year approximately 100 students from all parts of Arkansas enroll in Physics classes at ASMSA. For 3 years these students have participated in research projects conducted by fellow students concerning diversity among the population. In particular, the FCI has been administered as a pretest and post test. A study was conducted in 2004 based on 'home-school' size and FCI performance. A second study dealing with normalized gains and gender was completed in 2005. Finally, a current study using the EBAPS and FCI Pretest is discussed. EBAPS measures the 'scientific sophistication' of the student. The results of these studies and other information about ASMSA students will be presented."

[http://www.asmsa.net is the homepage. ASMSA is a school for high school juniors and seniors, and the "home-school" reference in the abstract presumably refers to the high school they were at in sophomore year, not to the home-schooling movement.]

C3.4: Bridging Physics Education Research Into Practice – Mojgan Matloob Haghanikar, Kansas State University, mojgan@phys.ksu.edu

"Pathway [see talk C1.1] is seeking to improve the quality of physics teaching by facilitating additional in-service and pre-service teacher training. The multiple features of Pathway make it suitable for different needs of user. The components of Pathway are Synthetic Interviews and the Informedia Digital Video Library. My contribution to Pathway is providing links to a collection of educational resources and literature. Originally, in this study with teachers' questions, the achievements of research were collected and associated to the relevant questions. The primary focus was mechanics. The output is a collection of different kinds of resources which were matched to teachers' questions.

"These links will be displayed as part of the Synthetic Interview when a teacher submits a question to Pathway."

C3.5: Utilizing Tablet PCs and wireless technology in teaching introductory physical science – Zdeslav Hrepic, Fort Hays State University

"I[n] order to capitalize on educational opportunities provided by tablet PCs and wireless technology, in summer of 2006, FHSU faculty piloted use of DyKnow software application. In this paper we report on results of DyKnow usage in introductory, inquiry based Physical Science course for non-majors. DyKnow was consistently used to facilitate student engagement, collaboration and exchange of results during group investigations. The software also facilitated post-investigation discussions and provided several effective, nontraditional venues for student feedback and formative assessment."

[http://www.dyknow.com for the software, which is not freeware.]

Contributed Session C4

C4.1: Colors of a Rubber Duck and Other Optical Adventures – Jim Johnson, Avila University (Kansas City MO)

This was all inspired by a new hot tub that used red/green/blue LEDs around the rim to light up the water in different colors. Hot tub optics, if you will.

The lights were under the water level, so if you placed an object half in the water, the bottom half would be lit up, but the top half not so much. This is an effect of Total Internal Reflection...while light still comes out at all angles, a significant fraction of the light is TIR'ed, so the light emerging to light an object near the surface is less intense than the light striking the object underwater.

Another observation was that the idea that objects don't have intrinsic color was driven home to the speaker. A yellow object only looks yellow under white light or light that contains red and green. Also, yellow as a single frequency is not the same as yellow as our eyes assemble from red and green.

To explore the colors idea, a "six color world" was established, in which the only colors are red, green, blue, magenta, cyan and yellow, with the last three existing only as combinations of the first three. Further, all objects were divided into those that glowed (light sources) and didn't glow (reflected light only). Students were shown variously colored objects under one or more of the six light colors, and asked to predict what they would look like under white light. A few objects behaved badly, possibly due to translucence or phosphorescence, but overall it worked well.

C4.2: Spherical Rare Earth Magnets (SREMs) in Introductory Physics – Al Adams, University of Arkansas at Little Rock

SREMs are currently available from scientific supply companies that have a typical magnetic field around half a Tesla, and magnetic moments of 3.5 Am^2. They're compressed powdered metal, so prone to crumbling with extensive use and abuse, although getting them with plastic coatings can help a little. [They aren't available with rubberized coatings, I guess they'd shred those. Note, these should not be confused with the spherical "Sizzler" magnets available for two dollars in the toy aisle, those magnets are an order of magnitude weaker, at least.] In any case, they can smack together hard enough to damage skin if you get pinched between them,

SREMs are very good for showing dipole-dipole interactions, since their shape reduces the effects of other forces (such as friction) on them. For instance, a hexagonal shape exploiting local minima is stable. This is better than the usual cylindrical REM in many ways. It's also a bit easier to get them apart, since they only touch at a point (more or less) and it's easier to get a grip on them.

It helps to paint the poles different colors to make the dipole nature more obvious.

If you roll them along on a wooden channel, the interaction with the Earth's magnetic field will produce a measurable wobble. It can be demonstrated that this is a magnetic interaction and not a mass defect in the sphere by repeating the experiment inside a Helmholtz coil tuned to counter $\mathbf{B}_{\text{Earth}}$. Many of the dipole problems from Griffiths E&M text can be done as demonstrations with SREMs.

One of the more impressive demos, now available commercially, is the "Gauss Rifle" setup. An SREM is placed at the bottom of a shallow U-shaped channel with two steel balls of identical size to its left. Then another steel ball is rolled down from the right. The outermost steel ball on the left will shoot off at a greater speed than the right-hand ball impacted at. This is a result of magnetic potential energy being turned into kinetic: the ball-SREM-ball configuration has a lower potential energy than the ball-ball-SREM configuration, so there's extra energy available to convert to kinetic.

C4.3: Bringing Parallel Computation to the Classroom – Chuck Pheatt, Emporia State University

DCEZ is an Easy Distributed Computing project. The idea behind distributed computing aka parallel processing is to set many cheap computers to a task that ordinarily would require one really expensive one. Dual-core processors are an example of a dedicated sort of this thing, and SETI@Home an example of a software solution to it. Most distributed computing requires extensive setup, to the point where students attempting to use it may spend the entire semester just getting it working and have no time to actually do any problems with it. Alternately, money can be thrown at the issue, but few teaching budgets can handle getting a supercomputer.

So, the goal was to create some system that would let students set up at least a simple parallel processing system quickly and easily, so that they could get down to the business of actually using it to solve physics problems.

DCEZ was written as a self-installing client/server that set the client up as a screensaver (much as SETI@Home does), and has a server with reasonably intuitive commands, using the basic principles of a Local Area Network. When a client "wakes up" and has cycles available, it calls the server and asks for work. The setup interface is very simple. It works best at "embarrassingly parallel" problems, those that are easily chopped up into tiny bits that can be handed out to any client asking for work. Ray-tracing programs like POVRay are an example of this sort of task.

A cluster of 45 unremarkable or even crappy old machines were set up in DCEZ and managed to attain a processing rate of 17.8 Gigaflops (flop – floating point operation). By comparison, in 1995 a rate that high was only attainable by the elite of the supercomputer crowd.

The entire system is available at http://dcez.emporia.edu [and I've already passed this on to some raytracing friends of mine who are likely to have crappy old machines sitting around that can be slaved into DCEZ, heh.].

C4.4: IDEAS NEEDED! Undergraduate Research/Projects Assessment – Rudy Eichenberger, Southern Arkansas University

How do you find a good undergraduate research problem, especially at a school where students can opt for variable credit hours on the project? You need something meaty enough to be worthwhile, but doable by an undergrad, and the work needed has to be commensurate with the credit hours chosen.

Most of the talk was a series of transparencies showing photos of various past projects, and a request for ideas to be sent to the speaker (who didn't provide an email address that I caught).

C4.5: Testing Batteries as a Student Project in Industrial Physics – Jorge Ballester and Chuck Pheatt, Emporia State University, http://batmon.emporia.edu

BATMON battery testing software [Never explained, but I think it's short for BATtery MONitor] was developed for a project to be used by a potential Industrial Physics course. Since students love to break stuff, it was decided to try to do some destructive testing of consumer products, and batteries provided a fairly simple and easy to grasp example.

ANSI (the American National Standards Institute) provides the standards documents (for a fee) that students can use in their testing-to-destruction. For instance, most 1.5V batteries are defined as dead when they reach 0.9V. These standards are somewhat vague in places, but are a decent start.

All that the BATMON project needs are batteries, wires, resistors, Vernier LabPro, and the BATMON software (which only works with LabPro, and is not likely to be written to work for PASCO's Data Studio or other loggers).

The results were very illuminating, showing for example that different manufacturers took different approaches to meeting the standards. For instance, there's a standard for how long a battery must last in a particular bench test before hitting 0.9V and being declared dead. Duracell and Radio Shack brand batteries both hit 0.9V in exactly the same amount of time...but the Radio Shack's discharge curve was almost vertical after that, while the Duracell took longer to go from 0.9V to zero.

[No mention was made of trying other destructive stuff, like seeing how batteries performed while heated, or whatever, but those could certainly be done as well.]

Contributed Session C5

C5.1: Teaching General Physical Science Students About Saving Energy – Carl Rutledge, East Central University (Ada OK), crutledge@mac.com

It is important that we take at least some time in our classes to not just explain what energy is, but how it can be conserved. The talk was essentially a 10 minute presentation that Rutledge gives to his students, with commonsense things like, "Smaller cars are better than larger, scooter is better than a car, bike is better than anything," or "Get a programmable thermostat, you don't need to heat/cool the house the entire time you're gone."

C5.2: A Somewhat Unique Video about the Infrared (Primarily for high school science students) – Keith Goering, Chanute High School

As part of NASA's education and outreach budget, they provided Chanute HS with a thermal imaging camera, and Goering (and several students) made a video presentation showing off some of the nifty results. Also, it's possible to see near infrared with most videocameras, even ones without explicit night vision functions. For far IR, though, you do need a thermal imaging camera.

If you hook a simple audio speaker up to an IR-sensitive photocell, you can hear IR pulses emitted by a remote control, showing how each button has its own pattern.

Theatrical gels (colored filters) do not in general block IR, so if you cross two complementary ones and block all visible light, you can still get IR to penetrate. One fun experiment to do with this is to use a big Fresnel lens with all the visible light blocked and focus the IR coming from the Sun onto something, setting it on fire. It can be hard to focus it in, though, so you may want to pre-measure the focal length so you know where to hold it.

The rest of the talk was presenting the (never-to-be-released) video the class made with the thermal imaging camera. Tricks like drawing with ice, gauging the health of plants by their heat output, etc.