

AAPT National Meeting Notes: 1997-99

taken by Dave Van Domelen

(edited 2003)

1997: University of Denver

SESSION AH - Philosophy of Physics

AH1: Kalman (scheduled speaker) couldn't make it, a fill-in speaker discussed Alan Cromer's Connected Knowledge, and spent a good portion of the time attacking "constructivist" straw men or even making ad hominem attacks on constructivists. Cromer apparently did a very in-depth study of a particular program on which he based many of his attacks, but it sounds from what information was given that the program Cromer studied had been implemented incorrectly (given to an age group other than the one it was designed for, for instance).

Kuhn's view of scientific evolution was also presented over the course of the talk. Kuhn's theory is that we don't so much stand on the shoulders of giants as slay them and stand elsewhere.

AH2: David Pushkin's talk. A counterpoint to AH1, Pushkin tried to explain what really was up with constructivism, the abstract in the Summer 1997 Announcer is a pretty good summary of what he said.

AH3: Allen Flora talked about Sokal's hoax. He also defined "hermeneutics," a word bandied about in association with Sokal's hoax. Hermeneutics is the science and methodology of interpretation.

AH4: Stanley Greenspoon pointed out how using original source material from scientific journals has three important benefits. One, it shows students that they can actually follow research papers. Two, it helps cut through the layers of error propagation in modern textbook writing. Three students can see how science is really a process and not a product.

AH5: R.H. Garstag on "scientific geneology," where one's advisor is considered a parent, and so forth. More of a history of science talk.

SESSION BC - Applications of PER to Curriculum Development

BC1: William Gerace et al, "Minds-On Physics." Informal exploration rather than traditional cookbook labs. Didn't really get anything out of this that's not in the abstract.

BC2: Robert Beichner discussed educational technology. Ironically in view of his trouble in setting up his computer for the presentation, one of his points was to never let the technology overwhelm the content.

BC3: Michael Politano and David Hestenes, needless to say, discussed Modeling and its use in fighting against fragmentation of student knowledge. They feel that while it'd be great for students to develop all the models on their own, odds don't really favor this, so at some point the models

need to be explicitly taught. Once this has been done, students should be encouraged to reduce new knowledge to fit existing models where possible.

A reorganization of the college physics course was proposed, and rather than sticking to the current Mech/E&M/Thermo/Waves sort of division, they were trying the following:

- 1) Start with Energy. Introduce the $\Delta U = Q + W + R$ (radiation) as soon as possible, and use it as often as possible.
- 2) Once Energy is firmly established, move on to the Structure of Matter.
 - a) Macroscopic, quantitative treatment
 - b) Microscopic, qualitative reasoning

This merged Mech/Thermo class would lay all the groundwork necessary for later E&M and Quantum classes, and would concentrate on helping students develop a physical intuition.

BC4: Randall Harrington discussed the differences between terminal and nonterminal classes and how to approach them. He suggested that terminal classes (like OSU's 111 sequence or KSU's 113-4) are better served by explicitly introducing models and easy material, since basic understanding comes more quickly and students spend most of the time able to handle the material, although they're hurt later on by having a harder time getting beyond the simple material. Nonterminal classes (like the 131 series at OSU or the EP courses at KSU) should start with observations and build the models only slowly. While this leaves students befuddled for longer, once they start figuring things out more easily, it just keeps improving and they launch into their second year classes with a good forward momentum.

BC5: Dr. Adelson talked about work being done here to help marginal engineering students (especially minorities and women), focusing on OSU's "prep course" for 111 and 131.

BC6: David Jackson presented information on the Workshop Physical Science course at Dickinson, similar to OSU's PBI course. Nothing really struck me enough to put in my notes.

BC7: John Mallinckrodt presented the "Force First" course idea. He pointed out that constant acceleration kinematics is more like geometry than "real" physics, and frustrates students for no good reason. He argued for a course that focused on forces instead. His preferred order starts with Statics, then moves to Conservation Laws and finally brings in Kinematics at the very end, once students have developed more of an intuition. He also thinks that while Integral Calculus is harder to learn than Differential Calculus, in the end it's more intuitive and easy enough to use, so it should be the math of choice for physics courses.

Additionally, given the reality of student focus on end of chapter problems, he stressed the importance of taking extreme care in selecting the problems.

BC8: Joan Makin et al showed ways of using computers in Dynamics courses. They hurled stuffed llamas, and that's all I took notes on. Hey, it was the end of the day.

I attended part of Session CC, where Xueli presented, but I didn't take notes. The D session was awards.

SESSION EB - Research Tools and Methodology

EB1: Jeffrey Adams studied the FCI, comparing student answers on items 6, 11, 13, 21 and 28 of the 29-question version, and found that students often get wrong answers when they have partial understanding of a concept. In other words, students could improve on a particular concept, but the FCI's insensitive to minor improvements and might not pick them up. The FCI showed very few false positives (correct answers from incorrect concept) but quite a few false "semi-negatives" (incorrect answers from partially correct concept).

EB2: Sanjay Rebello did another study comparing FCI items with free-response questions of the same material, but used the newer FCI. They found little real difference in scores between FCI and essay versions (they did a double control, with each group getting half-FCI and half-essay, with the halves switched for the two groups), but unsurprisingly found a greater variety of incorrect answers in the essay portions. Rebello and Zollman also found that the FCI's distractors often drew students away from their own misconceptions and into new ones.

If percent correct is all you're interested in, however, they found the FCI gave comparable results to essay tests.

EB3: David Cole attempted a web-based administration of the FCI, using Javascript and various security features. Once he'd ensured sufficiently similar conditions (including a time limit on test-taking and prevention of retaking for a higher score), he found no significant difference in performance between web and paper versions of the test. An obvious benefit of the web version is that the half hour doesn't have to come out of class time, and by giving points for completion, he got most students to fill it out.

EB4: Dick Hake's talk on controlling for the Hawthorne Effect, presuming it even exists. He's got programs that have run long enough now that novelty effects can be ruled out in the difference between Traditional and Interactive Engagement courses.

EB5: David Pinkerton analyzed the FCI with a Rasch Analysis and what, looking back, was probably Principle Component Analysis (not Factor Analysis). He only found a single factor or principle component, which he said could be considered force concept understanding. He identified something called a "difficulty factor" which he thinks may be what Heller & Heller found...the idea that items of similar difficulty level may correlate simply because of this similarity, and lead to false factors.

EB6: Leith Allen's talk, no notes taken.

EB7: Tom Foster talked about developing a rubric for comparing expertlike and novicelike problem-solving techniques. Four ordinal scales (meaning a 4 isn't twice as good as a 2, just better than a 2) were used:

- 1) General Approach - right physics?
- 2) Specific Applications - used right?
- 3) Logical Progression - planned right?
- 4) Appropriate Math - calculated right?

Reliabilities both within each rubric and between the rubrics were high, better than .8.

EB8: Walter Bisard discussed the results of using "dedicated student teams" which worked together for the entire term. FCI gains using these groups were comparable to those of other Interactive Engagement methods, and Bisard reported that the effects of disruptive student attitudes were minimized.

EB9: Paul Adams, I didn't note anything beyond the abstract.

EB10: Larry Watson discussed whether the effect of course evaluations was dumbing down the curriculum. There's a very slight correlation between good grades and good evaluations, but there was so little real variation in evaluation scores (all quite high) that there wasn't much to plot against.

SESSION FE - Introductory Content and Methodology

FE1: Kastro Hamed introduced KSU's Visual Quantum Mechanics program and its role in introducing the concept of spin to students. A lot cheaper than setting up a good Stern-Gerlach.

FE2: David Cole presented a simplified version of Maxwell's Laws (aside from the no-monopoles one) he used in class, claiming that "Unity and Simplicity Motivate."

E CREATES I

I CREATES B

B CREATES E (later amended to add change and -)

FE3: John McGrath talked about aerodynamics. He claimed that it was better to describe forces like lift using basic Newtonian mechanics with molecules instead of invoking the "magical" Bernoulli Principle.

FE4: Anders Schenstrom talked about teaching an Inquiry-Based batteries and bulbs course at MSOE that made use of the traditional textbooks (because they couldn't afford to switch to the PBI texts).

FE5-end: See abstracts. More anecdotal in nature.

Session GD, which I was part of, was mainly presentations of interesting demos and lab apparatus, not much to say in the way of written notes. Talk GD6 is available at

<http://www.physics.ohio-state.edu/~dvandom/Edu/> .

1998: University of Nebraska at Lincoln (first PERC)

PERC

Opening Session: Dr. G. Schraw - Aspects of Validity in Quantitative Research

Three major areas of quantitative research:

1) Conceptual Change -

"Hot" conceptual change strives to create a lot of cognitive dissonance and directly challenge prior student concepts. A sort of "shock teaching."

"Cold" conceptual change is a gentler approach that doesn't directly confront misconceptions. It's not used as much these days because student preconceptions seem to be too robust to be altered by it.

2) Expert/Novice Differences -

It takes extensive formal training to develop "expert" skills in scientific reasoning (something currently being talked about on PHYSLRNR).

3) Self-Regulation -

The big hot topic these days. Schraw splits learning into two classes, "skill" and "will."

"Skill" involves information/knowledge acquisition, problem solving strategies and so forth. It's very labor intensive, and in physics you generally need 5+ years to really start to put together a good grasp of this side of the equation.

"Will" looks at self-efficacy, goals and desires. Do they think they can do it, do they *wanna* do it?

Both skill and will are necessary, but A) skill takes a long time to really teach and B) students seem to really need help with will anyway. So, rather than focus on skill as is traditional, research is shifting to issues of self-efficacy (helping students come to believe they're capable of learning the material or performing the tasks) and situated learning (embedding instruction in a valid context, a sort of apprenticeship approach).

The remainder of the talk was on the handout he gave everyone.

Opening Session: Dr. J. Creswell - Qualitative Research

This talk had a lot more handouts involved, so my notes are understandably a little more sparse.

He made the distinction that quantitative research is deductive (start from a hypothesis and see if the data bears it out) while qualitative research is inductive (start with the data and try to find patterns).

While Qual research used to be looked down upon, it's gained a lot more respect and popularity over the past generation. Part of this is due to the fact that people have devoted time to developing more rigorous protocols for Qual work, so it's not as "soft and fuzzy" as it once was. In addition fields where Quant didn't really work as well (like anthropology and sociology) have turned to Qual research more and more.

Side note: it was also implied (or I inferred it) that the growing movement against "dead white European men" has helped with the rise of Qual, since Qual is less associated with the DWEM stuff and appeals to those who favor "different ways of knowing."

Qual isn't really meant to be generalizable, rather it looks for the richness of multiple perspectives. In other words, Quant looks for majority viewpoints (or large minorities) and the proportion of those holding such views, while Qual seeks to find all viewpoints regardless of their popularity or lack thereof.

Qualitative research, however, still needs to establish accepted standards for validity. After all, it's not like Qual research will yield t-test results.

"12-20 Contact Hours and Research Too"

Didn't really take any notes on this mostly anecdotal session, but I did come up with the following conclusion at the end of the session.

"Mission Creep" eats up PER faculty time more rapidly than it does in other research areas. It's a lot easier to get sucked into multiple projects unrelated to your research but involving education, and have no time left for anything else. While an AMO Experimental faculty is unlikely to be asked to help out a Nuclear Theory faculty on research, everyone and anyone is liable to ask a PER faculty for help with an educational project.

Plus, of course, there's the assumption that a PER professor wants to teach, which can result in getting more contact hours than other faculty if you're not careful.

"Show Me The Money - Where to Get Grants and How" – Panel Discussion

Zollman:

- Be clear and persistent
- Do it for the research, not the recognition
- Look for funds in weird places (i.e. DoE, Howard Hughes, Exxon, Apple, IBM, Packard, NASA) as NSF will run dry soon.
- PER is product-driven, so be sure to have product to promise
- Be careful what questions you ask of a funding source, lest ye be judged (you may reveal yourself to be ineligible for a grant that you could have gotten if you hadn't asked if you were eligible)

Hestenes:

- Work the system, but try to change it.
- Get to know the people in charge of the system, so you'll know what's likely to go over well.
- Try to serve an underserved group (propose research that will benefit some group not being researched as much).
- If/when rejected, talk to the project manager to try and get feedback on what you did wrong, if anything.

Hehn:

- Put heavy weight on the peer comments you get.
- The NSF is currently gearing up to reorganize, now (well, 1998) is the time to try and influence how it changes.
- "When you circle the wagons, be sure to shoot OUT." In other words, don't close ranks within the field and then start fighting.
- NSF funds emphasize public schools and teacher preparation, keep that in mind when writing a proposal.
- Be proactively cooperative (many people working together on a few good projects).
- Try to include as much of the field as possible in cooperatives, but watch the quality of their work.
- Talk about the impact of your work.
- Organize your research around the learner (back to the NSF priorities).
- Think about goals, specifically common goals in any collaboration.

"Frontiers in PER - Wishlist Research"

The purpose of this session was for panelists to discuss the sort of work they think should be done, and would set out to do immediately given time and funds. Not everyone did this, but oh well.

Mestre:

- Research into assessment, diagnose conceptual understanding beyond what the FCI does.
- Look into how teachers actually USE assessment tools.
- Examine successful curricula (like ALPS) and figure out what makes them so successful.

Sherwood:

- "If it's not worth doing, it's not worth doing well." In other words, if the standard curriculum isn't really what we want students to learn, why waste time trying to figure out how to teach it better?
- Identify traditional topics which aren't really worthwhile or at least not worth the effort (like kinematics) and get more time to spend on the "good physics."
- Opportunity costs in general of various topics. What could we be doing with this time if we didn't have to teach kinematics (or whatever)?

Thornton:

- Devise a tool to find "at risk" students quickly and reliably.
- Figure out what to do with "at risk" students once you've identified them with the tool.

Van Heuvelen:

- Multiple representations.
- Workplace skills.
- Interactive simulations.

AAPT MEETING

MONDAY

Tutorial T03: Teaching Science with Pseudoscience

The basic idea is to use pseudoscientific fads (which try to cloak themselves in the veneer of science) to not only teach students how to be critical thinkers, but also about the real science that runs parallel to the pseudoscience. Statistics also figure heavily in this, since a lot of pseudoscience relies on convincing people that unlikely events are in fact impossible without the presenter's pet theory (i.e. there **MUST** be aliens in the Bermuda Triangle, there's no other rational explanation!).

The contrast between proper scientific method (define success in advance, use control groups, etc) and pseudoscience is also something that can be used to teach students scientific method.

Both of the presenters recommend not using "hot" pseudoscience topics which haven't been thoroughly debunked...this just causes arguments and shouting matches and gets in the way of teaching. The two presenters used two different tactics on this:

1) Use only "cold" topics, ones that no one in the audience is likely to believe in. The examples given were the Bermuda Triangle, 18th Century spiritualism and the older "card-reading" style of ESP.

2) Only use topics you can completely debunk, to the point where even ardent believers will have trouble speaking up in class about it. This can, however, lead to some bitter private arguments after class. The examples used were Astrology (you can prove no physical force like gravity or radiation could possibly generate results, which shifts the onus of proof onto the believer), Homeopathic medicine (concentrations so low that one molecule of the substance has only a tiny chance of being in the entire jar of pills) and "mind reading" parlor tricks (he could show how they worked and that they didn't involve mental powers...mostly good for introducing the seeds of skepticism).

Because many standard pseudoscience tactics make it impossible to totally disprove the claims (i.e. since you can't prove there's no UFOs, you can't prove they aren't involved in the Bermuda Triangle), it's important to instead build a case for the improbability of the claims. Going over the existing data carefully can often eliminate much of the support for the claims (for instance, several ships claimed to have been lost in the Bermuda Triangle were later found to have been in the Pacific, and the news reports just got muddled).

Note that being a good scientist is not total protection against being snookered by pseudoscience claims. Two qualified physicists (Crooks of the X-Ray tube fame and Lodge who helped knock away some of the supports in the aether theory) were suckered in by spiritualism. Physicists do get used to the idea that there isn't deliberate falsification of the data their senses report to them (nature may be tricky, but it rarely lies), making us more susceptible to trickery than we'd like to admit.

Finally, as a side note, both presenters have found that audiences of 7th and 8th graders tend to be very skeptical, but college students seem to have lost that skeptical edge and will often be very gullible regarding pseudoscience. Once they have a belief, they don't want to change it.

TUESDAY

W34: Group Problem-Solving with Interdisciplinary Emphasis

More aimed at the high school student, but usable for freshman college students as well. This workshop presented another way of splitting up a group instead of the Leader/Recorder/etc division of Heller's.

Each problem (which could be described as context-rich) had three tasks attached to it.

- 1) Traditional problem-solving. Do the math, draw the graph, get the result.
- 2) Describe & Defend. A qualitative description of what happened, what principles should be used, and why.
- 3) "Cartoon." A succession of drawings at slices in time showing what happens. Turn the words of the problem into a more visual representation.

Groups of 3-4 would switch off on the tasks so that everyone would do some problems in each of the three ways.

WEDNESDAY

Session AE - Lower Division Laboratories

AE1: F.C. Peterson

Examined what he considered to be effective and ineffective habits of students in doing labs the traditional way. Very focused on things like error analysis, organized formal lab write-ups and so forth. Pretty much of the old "if we can present it to them clearly enough, they'll learn" school.

AE2: Sharon Rosell

Compared "Open Labs" versus "Closed Labs."

Open Lab - Purely exploratory. Give the students the equipment and let them play with it. No goals.

Closed Lab - Cookbook style.

Her comparison found open labs to work slightly better than closed labs, but didn't really consider the large field between the two extremes (TIM is more closed than open by the checklist of properties she gave).

AE3: Janet Seger

Gave semester-long research project labs to the honors underclassmen, and decided to take that experience and turn it into something for the regular labs. The result was a sequence of "Project Labs" where students would spend four weeks on each project. The first week was more of a cookbook lab that just taught them how to use the equipment, then they'd get a research question and have three weeks to plan it, conduct the experiment and present results. An example of these projects was "Determine if there is a relationship between hair color and thickness."

AE4: Lowell Herr

Project PHYSLab II - workshop for teachers to learn how to use various computer data collection and analysis tools. A very broad but shallow workshop, and teachers needed to come in with \$500 to buy all the various devices they'd be trained on.

<http://physlab.catlin.edu/> for more info.

AE5: James Hill

The HOBO Data Logger. He presented a cheap(ish) data collection device called HOBO and showed some of the things it could do, such as take temperature data, light intensity, voltage, etc. It stores the data internally on EEPROMs which can then be downloaded into a computer for analysis, making for a good field-trip device.

<http://www.onsetcomp.com/> for more product info.

AE6 was cancelled. I did not attend the afternoon sessions and did not take notes at the PER Grad Student crackerbarrel that night.

THURSDAY

Session CD: Introductory Physics Labs

This session had very little content related to its stated purpose, and both invited talks started with a disclaimer of "I didn't realize I'd be in this session, or I'd have prepared more material on labs." Lesson learned: be more careful in writing next year's abstracts, so we can all get into the right sessions.

CD1: Beverly "Trina" Cannon - Invited

High school course consisted of four major projects carried out by groups of inner city kids.

- 1) Pumpkin Launch - devise a catapult to launch a pumpkin as far as possible without breaking.
- 2) Cardboard Boat - make a boat for two people out of cardboard, tape, waterproofing and as few other materials as possible.
- 3) Rube Goldberg - use all six Simple Machines in the course of doing something (and the screws had to do something other than just hold the bits together)

4) Physics photoessay - take existing photos from old family albums or magazines and write up explanations of how physics is involved in them.

There were a number of practical problems in getting this to work (especially getting the apparatuses to school once built), but she found that a number of "at risk" students who normally didn't pay any attention in class really applied themselves to these projects. Actually DOING something with the physics knowledge seems to have helped get their interest.

CD2: Patrick Callahan - Invited

Talked about how he had implemented various existing curricula elements such as Active Physics into his classroom of "general science" type students. He also reported getting the interest of normally disinterested students with the more hands-on materials.

CD3: Loren Winters

This one actually fit in the session topic. He described a lab carried out with students to show how air friction can't always be ignored, using two racketballs (one filled with lead shot) and video capture software.

He didn't mention the coffee filter experiment, but I think there's a definite benefit to using this method as well. Students may classify falling objects into ones that "flutter" like leaves and ones that drop like rocks, so of course coffee filters would have air friction. But both balls seem to drop nicely, and students were surprised to see how much difference there was in positions after they'd both fallen about three stories.

<http://phywww1.ncssm.edu/physcal/workshops/aapt98/> for more.

CD4: Me. I think I was covering the TIM loop lab here, but it's been a while.

CD5: Mickey Kutzner

Low cost (under \$300 if you already have a CCD videocamera) digital spectrometer. It lets you show multiple representations of spectra at the same time, by matching up the visible spectral lines or rainbow with a graph of intensity versus wavelength.

CD6: Bill Franklin

Measure the power of the Sun with a soda can. He described a simple apparatus made from a can, black paint and some foamboard which you could dip a digital thermometer into (like a HOBO sensor, for instance) and get a good measure of the rate of energy absorption from sunlight.

CD7: Crispin Butler

Hovercraft kinematics. Spent most of the time discussing the design and building of an improved version of the hovercraft in Altschuler's 1989 TPT article. Students could use the hovercrafts to get a better feel for kinematics and collisions.

I later determined that the hovercraft doesn't work for people of my weight or greater (it keeps tipping over so that friction goes up).

Session DF: Student Approaches to Physics

Long session, lots of people, small room, desks designed for thin people...so apologies if my notes on this one are a bit sparse in places.

DF1: Eric Anderson

Nothing beyond what's in his abstract.

DF2: John Stewart

Developed a computer-readable markup language (DML) in order to codify student solutions on tests and homework and measure at least one aspect of how students do problems. DML lets him count occurrences of written explanations for steps, use of symbols versus numbers, diagrams and so forth. DML documents seem to convert back to "real" solutions pretty well.

The benefits of this method are that you can apply a treatment to students and then see if they break their usual habit of being very terse when working problems, and quantify how verbose they have become. An interesting protocol, although Stewart's views did seem to lie more in the traditional lecture/recitation mode.

DF3: Mark Lattery

This guy had a lot of interesting stuff to say, but he went WAY too fast and introduced WAY too many new concepts (for non-Philosophy students) for a 15 minute talk. I barely got anything down in terms of meaningful notes, and take these with a huge hunk of salt because I had trouble processing the input quickly enough to be sure I was taking accurate notes.

His central question is, "What is a concept?" (Side note: as I found in working on what became the PDD, students really don't know what a concept is, and Lattery implies PER people aren't too clear on it either.)

He breaks Knowledge down into three blocks:

- 1) Facts - information, etc.
- 2) Concepts - Language aides, labels for things
- 3) Theories - Ideas and relationships

Facts and Concepts form a sort of background noise to student views, and if we want to know what they REALLY think, we have to get past the noise. For instance, a student may not understand something, but since he's put a label on his view that matches the label normally given to the correct view, we might be tricked into thinking he does understand.

Two ways to get around this:

1) Rigorously train students in the concepts and definitions before you even touch the physics (Concept Grounding). Make sure everyone agrees what a force is, what energy is, etc, before you toss in the first equation relating the concepts.

2) Eliminate the concept-based variables entirely. Describe things only in terms of data variables, things which the students directly sense. For example, replace an abstract force on an

object with a propeller that creates more force the faster it spins. Then just link the rate of spin to acceleration (or whatever other thing you wanted to relate to force). Now the student is comparing two things he can see, like a rate of spin to an acceleration, with no conceptual hurdles between them.

DF4: Valerie Otero

Abstract is incorrect, she changed her topic to "What Kind of Inquiry Do Students Do in a Technology-Rich Collaborative Situation?"

The experiment used the CPU curriculum and lots of computers, mainly on pre-service teachers with little science background. They worked in small groups to develop models to explain various phenomena.

Students often agreed on an answer while holding radically different views on why that was the answer, and the computer models helped them to draw out the underlying ideas. Often all of the students were right for a variety of different wrong reasons, and an example was provided with static charges on a can.

Some students saw an explanation as being whatever was necessary to get the desired result as an initial condition (i.e. put all the charges in the right places to begin with), while others saw explanations more as process descriptions where the initial conditions evolved into the final state.

Knowledge about scientific inquiry was found to evolve in much the same way as knowledge about science itself does. Students start with preconceptions on what constitutes an experiment, an explanation, etc, and then have to have these ideas confronted and changed to more expert-like ones.

DF5: Karen Williams

Another really long talk compressed into 15 minutes. It was really three talks, one on Meaningful Learning Orientation, one on Communication Apprehension, and one on an experiment to determine if there was a link between the two.

Meaningful Learning Orientation is the tendency to learn with connections, want to know why, etc. As opposed to rote memorization. We want MLO from students, but tests are often written in such a way that rote learning is favored (as also found in some of the MPEX results).

Communication Apprehension is the fear of speaking in public, and there's an existing instrument (the PRCA, she was going too fast for me to catch what that stands for) for it.

A correlation of .4 (medium-weak) was found between having a high MLO and low communication apprehension. Students with rote learning tended to have high communication apprehension, a double whammy.

DF6: Apriel Hodari

Retention of female engineering students. Retention means that they at least stay in the engineering/math/science majors, even if they change out of the major they started school with.

71% of A-level female engineers are not retained. They either drop out entirely or switch to a "soft" major like English, History, Philosophy or Business.

Those retained often develop attitudes we might see as unfavorable, getting more cynical, treating the classes as a game, and doing anything and everything necessary to keep high grades, including cheating.

Apriel is currently going over the MPEX data to see if there's any common factor among the non-retained students.

DF7: Jeff Adams

A study of gender-based differences in group work situations in a large classroom setting. Observers went around during discussion and made quick notes of who was in what sort of group role (leader, recorder, passive watcher, ignoring) over the course of the term as groups were shuffled about.

Results showed no statistical difference between genders as far as who took the leader and recorder roles. However, with the "disengaged" roles (watcher, ignoring), women were more likely than men to be in these roles if they were in mixed unequal groups (different number of males and females), but not if they were in single-sex groups or balanced groups. However, while evenly mixed groups seemed to work best, very few groups formed along those lines.

Another result of later interviews and questionnaires is that students tended to report gender-based issues that weren't born out by the data (such as women saying the men were domineering, even though women were just as likely as men to lead the group). This suggests that the perception of gender issues need not be linked to the actual presence of problems.

DF8: Gay Stewart

The University of Arkansas's physics major program is rapidly growing thanks to some changes recently made, adding "tracks" to the major (such as tracks aimed at industry or at astronomy) and working more closely with the math department in a Gateway-like manner. They've also added a dedicated faculty mentor position for undergrads, who does this as his teaching requirement.

The result, aside from a mushrooming major, has been that while female students enter the program with confidence problems compared to male students, they're pretty much equal at the end of the first year (with ability levels starting and ending equal for each gender).

DF9: Hassan Sharifan

Somewhat rambling talk which read from a handout, but the upshot was that they found that students attending CoCos (Community Colleges) with no entrance standards performed as well as students attending CalState and UC schools which have reasonably high entrance standards. Price seemed to be a bigger motivation for many students than prestige or standards.

DF10: Meredith Wills

A study of student behavior in groups as the groups were changed over the course of the term. Students did not settle stably into Heller-like group roles, but rather changed their preferred roles as they changed groups in this PBI course.

Five new categories were found, and they were stable across changing groups:

- 1) Aggressive Confident - Quickly grasped the material, impatient.

- 2) Cooperative Confident - Also a quick study, but felt the need to get feedback from the other group members before forging ahead.
- 3) Cooperative Uncertain - Needs more time to figure things out, but works well with others.
- 4) Passive Uncertain - Lacks self-confidence, easily intimidated into going along with the group answer.
- 5) Previously Knowledgeable - Bored with the inquiry process, try to lecture to the other students or withdraw from the group, they generally get in the way of other students who are trying to learn.

People of type 1 and 4 should not be put together (the 1's will steamroller the 4's), 2 and 3 can work with anyone from 1-4, and people from group 5 shouldn't work with anyone NOT in group 5, as they think they know a lot more than they actually do. Group membership was found to be VERY stable, people rarely if ever switched types during the course (and apparently the 5's didn't mellow out much).

Wells is working on an instrument to categorize students in advance to help in putting groups together.

DF11: Mary Wildemuth

Discussion of the 4-person Optics PBI course from Fall 1997 (Physics 108 at the Marion campus of OSU).

FRIDAY

Session EE: Topics in Physics

I'll say right now, this session was something of a waste of time, and my notes are very sparse.

EE1: Herbert Retcofsky

Spectroscopy as an art form. Probably makes for a fun and educational workshop, but not much of a talk. Mostly he showed slides of various slits his workshop participants had made, and the nifty patterns those slits made when the light was shone through a diffraction grating.

EE2: George Patsakos

Tries to answer the question, "If Magnetic Fields Do No Work, What Drives An Electric Motor?" Unfortunately, his talk was mostly a lengthy differential equation derivation with very little actual answering of the question.

Here's the answer distilled from all the ODEs:

The electrons want to move in circles around the magnetic field lines, but they're confined to the inside of the wire. The electrons being held inside the wire (wire exerts force on electrons, electrons exert force on wire as a reaction) does the work.

EE3: Randy Knight

Visualizing transverse wave motion with pencil and paper activities. Based on Arons's book. Students draw two types of graph for a wavepulse:

1) Snapshot graphs - multiple Amplitude versus position graphs for different times. Show the pulse moving along as a cartoon strip.

2) History graphs - Amplitude versus time graphs for various positions.

Transforming between these two types of graph is tricky, but seems to help students get some grasp of wave motion.

EE4: Frederick Becchetti

Talked about a course outline for a class intended for pre-med type students, a replacement for what we do as 113. More biology-oriented, students seemed to like it, but there's too much content so they're splitting it into two courses. See the abstract for more.

EE5: Anna Bayles

Talked about the various adaptations animals have which let them walk on water. See abstract.

EE6: Saul Minor

Rambling and incoherent talk about a summer course for gifted high school students, which apparently used computer modeling, since he showed a dozen or so slides of computer models.

EE7: Richard Thomas

Talked about the science outreach program in Lincoln, especially Science Day at the Mall. I took a lot of notes on the construction of his LED-coil-stick-with-magnet-dropping-down-inside thing and then found out we already have one now.

Session FA: Student Understanding in Introductory Physics

FA1: Jong-Ah Soh

Discussed work with student measurement concepts, from working with 13 year old students. Some tasks were beyond most of them, especially ones involving decimal fractions.

When confronted with a difference between his measurement and the right answer, a student was likely to claim he made a mistake, even if the difference was within normal error tolerances. But when confronted with a difference between his measurement and that of another student, a student was more likely to claim the other student made a mistake.

13 year old students generally didn't see why we take multiple measurements of the same quantity, and most felt that a machine could take measurements with no error at all, 100% precision.

FA2: Binghua Zhang

Directionality of vectors, specifically velocity and acceleration vectors. While students generally seemed aware that direction was part of a vector, they often misapplied this knowledge, or treated direction as one-dimensional (it hasn't changed direction if it only turned by a few degrees, for instance). And, as we see a lot, students didn't think deceleration was an acceleration.

FA3: Kathy Harper's talk

FA4: Luanna Ortiz

Studied student treatment of static equilibrium of rigid bodies. Students had a lot of trouble with center of mass concepts (as also seen in one of the invited talks on Saturday morning), and tended to equate positions with torques. For example, a body that is currently level is said to have no net torque on it.

A tutorial on center of mass and torque was developed and had some effect, but not enough.

FA5: Curt Higgelke

(Note: my glasses started to fall apart at this point, so I was busier trying to fix them than taking notes, sorry)

More center of mass type problems, using shapes constructed of rigid rods (L, T, H, X, U and I shapes), students were asked to rank torques, moments of inertia, etc.

I think there were results, but I missed them.

FA6: Mel Sabella

(More glasses trouble, I was not a happy camper)

Students tend to apply correct concepts in incorrect contexts.

FA7: Xueli's talk

FA8: Michael Wittman

Tested for student models of wave behavior, especially with interference. He found that students tended to apply mechanical concepts to waves, like "throwing it harder gives it more speed." They also treated waves as particles centered on the maximum amplitude point, treating "the amplitude" as a special point. Waves didn't add until the maxima crossed.

He called this the Particle Pulses Mental Model. Instruction did increase the number of students holding a more accurate model, but tests where students were allowed to pick more than one choice indicated that many simply adopted the correct model in addition to the PPMM, assimilating the new without abandoning the old.

FA9: Michael Loverude

Difficulties in Hydrostatics. Students don't get buoyancy, with two misconceptions being very robust:

1) Buoyant force increases for denser objects (there's more "stuff" there to be buoyed up). This also conflates with student difficulties separating mass and volume (something brought up in FA1).

2) Buoyant force increases with pressure, even in an incompressible fluid. Understandable... more pressure means more force, right? Well, not in this case, but hey.

A buoyancy tutorial was developed and dealt well with #2, but not #1. So a second tutorial was added, and seems to help with #1.

FA10: Chris Border

Vector Superposition difficulties. Again, students have trouble with the concept of direction in a vector...they know it's there, but don't use it correctly. The one-dimensional problem surfaces again...if all of the vectors are pointing within 180 degrees of each other, they're all in the same direction.

FA11: Leith Allen's talk

SATURDAY

No sessions that interested me. Found a slightly more permanent fix for the glasses.

SUNDAY

Hey, conference is over, go home.

1999: Trinity University in San Antonio

There are occasional asides directed to participants in the SEESP (Science and Engineering Education Scholars Program), a week of workshops I attended in July of 1999. As usual, I didn't take notes during the talks of people in my research group. Copies or summaries should be available through the OSU PERG webpage, <http://www.physics.ohio-state.edu/~physedu/>, though.

THURSDAY

Session AG: Student difficulties with electricity & magnetism

AG1: Evaluating the CSEM (Conceptual Survey of Electricity and Magnetism), by David Maloney.

He went a bit too fast through his slides for me to get down much, but I did make the following notes:

Reliability of the CSEM was about .75, which is pretty good.

The CSEM has good face validity, as interviews with experts showed.

No particular "factors" were found, although I suspect he was really looking for principal components. One possible reason for this is that student conceptions are too scattered for any particular pattern to arise.

AG2: Preliminary CSEM Results, Tom O'Kuma.

Another rapid-fire viewgraph talk, ah well. Here's a few bits I was able to write down:

The matched data, where students who took only the pretest or only the post-test were ignored, came out almost the same as raw data, suggesting that going to the trouble of matching up students may not be necessary for the CSEM.

Students in trig-based physics tended to perform better than those in calculus-based classes on certain items. This was probably because certain items lend themselves to rule memorization, something emphasized more in trig-based classes.

Foreign students (I forget which countries were tested) did slightly better than U.S. students.

AG3: Student Understanding of the Electric Potential, Rhett Allain.

He has his talk up at <http://www.ncsu.edu/PER>.

Students prefer to think in terms of forces rather than energy.

Parroting behavior and appeal to the authority of the textbook are common practices.

A common misconception is that electric field is proportional to electric potential, rather than to the spatial derivative of that potential.

Equations and principles for the potential of a point charge are often used out of context.

Students don't see the relationship between change in electric potential and work done on or by a charge. Similarly, electric potential and electric potential energy are often used interchangeably.

AG4: Student Learning in Calculus-Based Electricity & Magnetism, Ray Dagenais.

Dagenais took a 70-item E&M test developed by Jeff Marx (and handed around at the meeting in Denver in 1997) and administered it to two of his classes, then analyzed the heck out of the results. Probably over-analyzed it, I think...and his numbers were too small for any real significance.

AG5: Leith Allen's talk.

AG6: Students' Mental Models in Simple Electric Circuits, Brant Hinrichs. "How do we know what they know?"

Hinrichs treats students as black boxes which we probe with questions, and establishes a feedback loop in order to create better probe-questions. He then defines a model as something that gives information on what is going on in that black box. Novice models tend to be disjoint bags of stuff. But is an expert model necessarily better than a novice model?

His main assertion is that if the data from the expert's black box and the novice's black box agree, then we know what the novice knows.

AG7: Addressing Learning Difficulties with Circuits: An "Aufbau" Approach, David Meltzer.

Aufbau is German for "building up."

Meltzer started by pointing out some student difficulties that he hoped his approach would address:

Students have trouble with basic ideas, like current, charge, potential, change in potential, etc. "Batteries are a source of constant current" is a very robust difficulty in this area.

Students have difficulty with the representations we use.

And, here's a biggie, a lot of the terms we use in E&M to mean different and specific things are treated as synonyms in common language. Power, energy, charge, electricity....

The "Current First" approach of McDermott's Physics By Inquiry is helpful in getting students through these difficulties. But what if you can't set up a workshop or even a lab?

Meltzer instead uses a "Potential First" approach in his lecture-only course (note to SEESP: he's at Iowa State, the university used in our course design exercise, under most of the constraints listed there). Students use a workbook and look at circuit segments. They don't even touch complete circuits until they're solid on $V=IR$ and the representations used. Preliminary results seem promising.

AG8: Tutorials in Introductory Physics at the U.S.A.F. Academy, Heidi Gruner (in association with the University of Washington).

The UWash Tutorials were integrated into the syllabus, rather than simply replacing a recitation section, and the amount of Tutorials used was less than a full load. Four experimental sections were set up: Tutorials, true control, an untreated honors section, and a "control" group where the students took the tutorial tests but didn't take the tutorials.

Looking at a particular problem of a loop moving near a current-carrying wire in such a way that the flux didn't change, she found that the group with some tutorial exposure outperformed all other

groups. The tutorial group got an average score of ~60%, the honors group about 50%, and the other two groups around 40%. When they looked at not just correct answers but also correct reasoning, the tutorial and honors groups did about the same, but the other groups tanked. The tutorial seemed to be successful at eliminating the "Induced current is proportional to magnetic field" misconception, and the tutorial group was more likely to attempt answers and explanations. Other groups tended to leave things blank.

Session BA: Awards

BA1: Melba Newell Phillips Award - Looking Back and Looking Forward, Howard Voss.

Largely personal reminiscences about the AAPT, but ended with a call for reformers to include the rest of the community. By 2007 we'll need 2 MILLION new teachers capable of teaching science, mostly elementary teachers. So it's important to consider the professional development of those teachers.

BA2: Klopsteg Memorial Lecture - Cosmology: From Quantum Fluctuations to the Expanding Universe, Michael Turner (co-author of The Early Universe by Kolb & Turner).

This was basically an overview of the progress made in Cosmology and Cosmogony in the past few years. If I hadn't read an article by Turner in Science News a few months ago about the same material, my jaw would probably have been on the floor for about half this talk. Whodathunk that the Cosmological Constant might really exist in a dynamic universe?

BA3: Millikan Award Lecture - Alan Van Heuvelen.

The complete slides from this talk should be available on the web. Here's a quick summary.

There's a sort of "impedance mismatch" in physics teaching right now. What we teach isn't a good representation of the useful skills in physics that people actually use after graduating, and how we teach still doesn't get much through to the students. One possible remedy for at least part of this situation is to create tasks that engage the higher levels of Bloom's Taxonomy: Analysis, Synthesis and Evaluation. This would help teach students a number of skills mentioned in various industry surveys and included in the A-K of the ABET standards. He ended with a challenge to people in the PER community (and outside it) to create such higher-level tasks, and announced that there would be prize money for the best ones (coming from a grant).

Session BH: Evaluation Methods

BH1: Model Evaluation with Multiple Choice, Joe Redish.

The context of this paper was analysis of data from research in student concepts of waves. One common naive model was the "Particle Point Model" or PPM, in which the wave really only exists as a point at maximum amplitude. However, the data didn't really lend itself to Factor Analysis, and besides, a lot of physicists either don't know Factor Analysis at all, or have some incorrect picture of it. So the idea was to look at a method of data analysis that would be familiar to physicists as well as useful for this sort of data.

The idea was to treat a student as existing in a mixed quantum state, with varying strengths of belief in several different models. Mathematically, this starts out just like Factor Analysis, albeit with different assumptions. But it uses the mathematical methods of quantum mechanics, which most physicists learn pretty well at some point.

$$|\text{Score}\rangle = A|\text{model 1}\rangle + B|\text{model 2}\rangle + \dots + |\text{unique variance}\rangle$$

Lei Bao and Michael Wittmann of UMaryland have developed various statistical tools to analyze data of this nature, including the Concentration Factor, c (the formula for which I cannot reproduce in ASCII, sorry). If the value of c is 1, that means everyone answered the item using the same model (and it should be obvious from inspection of the raw scores which model that was). If $c=0$, the distribution is effectively random, or at least equally distributed across the models.

BH2: Model Analysis, Lei Bao.

Part two of BH1, basically. Now that the concept has been introduced, it's time to get down to the nitty gritty. $|u\rangle$ is defined as the $|\text{Score}\rangle$ I have above. $|e(\text{sub } i)\rangle$ is the i -th model, and usually $i=3$ covers "all other models" since in most cases there will only be two strong or popular models for a single concept (at least in the wave research they're doing, some concepts may have several popular models). For a given student, there's a density matrix $D = |u\rangle\langle u|$.

When D is diagonal or very close to diagonal (very small off-diagonal elements), then the student is applying models consistently. If only one diagonal element is large, then the student mainly applies the model corresponding to that element.

When D is clearly not a diagonal matrix, then the student is applying models inconsistently. In other words, given two nearly identical problems, the student will answer one with one model and the other with another model.

Research seems to be indicating that students often start with a single incorrect model, then progress through a mixed state until they reach another consistent model...which will hopefully be correct, but isn't always.

This was only a 15 minute talk, there are more details in Lei Bao's thesis.

BH3: Epistemological Resources for Learning Introductory Physics, David Hammer.

Hammer zoomed through a bazillion transparencies, but since I was still in hyper-writing mode from following all the math in the first two talks, I was able to get down about a page of notes. No guarantee that they'll be consistent or very coherent, though...this was a classic example of an hour talk crammed into 15 minutes.

Student ways of thinking do include things that are in our favor. For instance, they recognize the importance of having some sort of model, even if the model they use is wrong.

Student ways of thinking are classically broken down into two types:

: Epistemological Theory - things the student can articulate, like strategies and the like.

: Epistemological Style/Trait - inarticulate, but fundamental aspects of personality.

Both of these together can be called (if I recall correctly) Epistemological "Primitives." They are very sensitive to context and can cover a wide range.

A "Toy Model" of knowledge

1) Nature of knowledge, i.e. "How Do You Know?" This can be broken up into things like "He told me," "I made it up," or "I discovered it." Authority, imagination, discovery.

2) Activities involving knowledge. "What will you do with it?" Accumulation, Building, Comparing, etc.

3) Forms of knowledge. "What's it like?" Facts, Rules, Stories, Systems, etc.

4+) He sped up here and it was impossible to keep up.

In teaching, one should attempt to find the students' focus and shift it to something more productive, like away from Authority and towards Discovery. Are there "anchors" which can help a student easily shift between these?

BH4: A big long title using the word Epistemology, Vince Smith.

This was another hour long talk compressed into 15 minutes, but after a few minutes I realized nothing was really being said as far as I could tell. No coherent point to the talk that I could find, seemed more like an attempt to summarize everything that had caught the speaker's interest in the past year.

BH5: Study in Student Epistemologies, Thomas Koch.

Followed a single pre-med student's progress through a physics course, a case study. Mumbled a lot, had foggy (as in, lots and lots of words in almost unreadable font size) slides.

BH6-9: At this point, I realized from the abstracts that the rest of this session would be more like BH4 and BH5 than like BH1 and BH2, so I left (besides, I had to skip 8-9 to make it to another event in time).

FRIDAY

Session CG: Curriculum implementation

CG1: Tasks Inspired by Physics Education Research (TIPER), Curt Hieggelke.

Basically collected and acronymized a whole slew of student activities based on PER. Ranking tasks, Physics Jeopardy Problems, What's Wrong problems, etc.

CG2: RealTime Physics/Interactive Lecture Demonstrations, Hadley Lawler was the speaker of record, but Joe Redish pinch-hit for him.

First of many talks this session about RTP and ILD, it was pointed out that it was necessary to test out any new curriculum idea at other schools. When implemented at the originating institution, you get better results because you can tweak it as needed and you know what it's supposed to be. However, clarity and goof-proofing are vital for anything that will be used out in the wild, so you need "playtesters" at other schools.

Initial results using tests developed by Thornton and Sokoloff (who also had a hand in RTP and ILT, raising issues of "testing to the teach" as it were) indicated great success in primary implementation (at the originating schools), and lesser success in secondary implementation (at other colleges, not at secondary schools). Either method alone also gives some results, but when they can both be used at the same time, results are much better.

CG3: "Is There A Right Way To Teach Physics?" Ian Johnston.

Was a secondary implementer of ILT. He chose ILT because, as lecture demonstrations, they can be more easily slotted into an existing curriculum.

Despite a rapid pace (an intensive 5 week summer course covering all of first quarter mechanics) and rigid curriculum requirements, he got improvements in the class due to the ILTs, and students liked the new treatment. However, both the ILT group and a control group had essentially identical scores on the final exam (which was the same for both group).

CG4: Issues in Implementation and Adaptation of Existing Curriculum, Karen Cummings.

Another secondary implementation of ILT and RTP, using a studio classroom format. One of her goals was to see why secondary implementation was less successful. She also made the point that two standard tests used to evaluate students in these classes, the Force and Motion Conceptual Exam and the Force Concept Inventory, test different things. The FMCE is purely conceptual, while the FCI has a problem-solving aspect.

CG5: SCALE-UP (Student-Centered Activities for Large Enrollment University Physics) Project, Jeff Saul.

The implementation of SCALE-UP was covered over several years as the facilities were updated. The final result is a tech-intensive special classroom without a single "front" to it, capable of serving 99 students. As more implementation occurred, results were better and better. Students in the special classes did much better on conceptual tests like the FMCE and parts of the FCI, but didn't do as well on plug-n-chug problems.

CG6: Active Learning Versus Lecture Mode: Methodology, Chancel Hoellworth.

The Active Learning in question involved the RTP studio classes. They had three instructors, each teaching a section of Active Learning and a section of traditional lecture. 40 students per section. They evaluated using the FCI and had the same final exam for all sections. Student demographics and previous performance essentially equivalent for each section.

The end result was that the studio classes outperformed the lecture sections, but even the lecture sections did phenomenally well for lecture on the FCI.

CG7: Active Learning Versus Lecture: Results, Randy Knight.

The sequel. The high FCI gains in both sections are partially explained by the fact that the FCI was put on the final exam, a definite no-no from a methodological standpoint (it's supposed to be a no-grade-pressure test). Also, the lectures may have had some interactivity leak into them.

In the studio group, FCI improvement was mainly in the area of Newton's Third Law and getting rid of the impetus idea. Similarly, their final exam strengths were in forces and Newton's Laws.

Both groups had good correlation between FCI scores and scores on the remainder of the final exam.

Following the students through the rest of the year, it was found that the studio students did a little better in electricity and magnetism, but no better in modern physics or engineering statics (odd, since they seemed to do better on forces). Little to no lasting gain from the active learning method used. However, it's worth noting that TAs had marginal training and may have helped wipe out some of the differences by guiding the students back into the traditional style.

CG8: Activity-Based Versus Lecture-Based Physics, Mark Markes.

Another RTP implementation. Very small number of students and an unwarranted amount of data analysis.

CG9: Activity-Based Versus Lecture-Based Physics, C. Trecia Markes.

Same thing at the algebra-based level, using activity worksheets and computer-based learning. Small N, large statistical analysis package.

CG10: "Do They Stay Fixed?" Jonte Bernhard

Between his large handout and the trouble he had getting powerpoint to work, I wasn't really able to follow most of this, but the answer to the title question was "sometimes."

CG11: Continued Assessment of a Preparatory Course, Ed Adelson.

Given a widely varied body of students taking the Physics 109 course at OSU, Dr. Adelson tried to analyze whether the course was any help at all in preparing them for taking a regular physics course. He found some improvement on things like belief in impetus and Newton's Third Law problems, plus some improvement in attitudes.

CG12: Writing: An Effective Learning Tool, Teresa Hein.

In a "Physics for Poets" course, Hein gave 5-10 writing assignments per semester, using the "elicit-confront-resolve" pattern in them. Somewhat like the journal entries we use in Physics By Inquiry, but more intensive. Gave feedback rather than grades, and it seems to work well.

Session DB: Introductory class student difficulties

DB1: David May's talk. Powerpoint slides should be on the web.

DB2: Self-Study to Improve Student Understanding of Vectors, Daniel Smith.

Part of Workbook for Introductory Mechanics Problem-Solving.

It is noted that textbook exercises are biased towards addition of vectors, so students are often lost when it comes to subtracting vectors. Students will blindly apply addition tools without understanding them and without actually paying attention to any contextual diagrams in the problem.

The tutorials used as a treatment emphasize drawing the vectors first, then writing an equation to explain the drawing, and work from Reif's problem-solving strategy. The tutorials have been reasonably effective in primary implementation.

DB3: "Where Do Students Go Wrong When Solving Newton's Second Law Problems?" Charles Henderson

This research looked at student solutions of Atwood machine problems (and variations on the theme). Even students with strong conceptual skills (FCI scores over 80%) tanked on this problem-solving exercise.

Common errors included assuming net force was zero, using incorrect masses or accelerations, and even adding new forces (like a "velocity force" or including Normal force in the equation even when it shouldn't be there).

Students who represented forces correctly tended to perform better.

DB4: Expert-Novice Problem Solving of Non-Traditional Problems, Melissa Dancy.

The conclusion of this talk was that experts tend to solve non-traditional problems and simple exercises in roughly the same way, although I would dispute that claim. Yes, they do use a number of the same basic techniques, like coming up with plans and checking their answers. But other research has shown that on true **problems** an expert will still end up going down blind alleys and flailing around a bit, while on exercises they just go straight through the established pattern. However, as my talk was next, I didn't feel like starting a fight over this during Q&A. }->

DB5: Dave Van Domelen's talk. A version of this is available on the web at

<http://www.physics.ohio-state.edu/~dvandom/Edu/>

DB6: Xueli Zou's talk. Should be available on the web.

DB7: Student Learning Processes with Simple Machines, Mehmet Tasar.

A case-study of one student's progress. Initially, changing the surface features of a problem confused the student. But once a deeper understanding had been reached, these surface features presented less of a problem.

DB8: Student Difficulties with Gravitation, Jack Dostal.

Student concepts of gravity have not been studied a lot, at least not gravity *as* gravity, as opposed to just being another force. To remedy this, Dostal and his colleagues developed a multiple choice test (11 items) and a free response test (10 items).

Turns out that Newton's Third Law gets all gummed up in gravity, as students believe a larger object exerts more gravitational force on a smaller object than vice versa.

Also, students do not believe gravitation is actually universal. Sometimes it's on, sometimes (like on the Moon) it's off.

DB9: "Chaos" for High School - Clarisa Bercovich with Uri Ganiel

It is attractive to teach chaos for mathematical, social, aesthetic and philosophical reasons. Additionally, learning chaos can help a student consolidate classical mechanics knowledge.

However, students have trouble grasping the difference between chaotic (sensitive to initial conditions, but with deterministic equations) and random actions. After study they tend to label all systems chaotic, yet hold onto the idea that deterministic equations guarantee predictable behavior.

DB10: Student Understanding of Hydrostatics and Thermal Physics, Paula Heron pinch-hitting for Mike Loverude.

First part considered the five block floating problem presented at the Lincoln meeting (talk FA8). Given five blocks of increasing mass but same volume, if the lightest floats and the heaviest sinks, what about the other three? Correct answer is that the second lightest maybe just floats, and the rest sink. Typical answer is a nice straight line of blocks floating midway in the water. Students often created correct free body diagrams, with buoyant forces and the like, but then ignored them in giving their final answers.

Second part looked at canisters of ideal gas under pressure. The initial setup had too many things set equal, which led to a suspiciously high success rate. The problem was adjusted, and success rates were cut in half.

In both cases, a misconception that position was related to force held sway. More weight meant floating lower under water...higher pistons meant more pressure. Thus, while it has long been known that in horizontal situations students believe force is proportional to velocity, it seems that students also believe force is proportional to height.

DB11: Learning Gains of Secondary School Teachers in an Inquiry-Based Summer Program, Graham Oberem.

In this case, Secondary School refers to grades 7-12. The summer program in question was a Physics By Inquiry crash course administered to in-service teachers. Gains were pretty good, and from what they've been able to test, long-term gains are also good.

DB12: Student Understanding of Measurement Uncertainty, Duane Deardorff.

Physics Education Research has largely de-emphasized teaching of measurement uncertainty and error analysis, mainly to make room for other stuff. However, such skills are important out in the workplace, and students tend to believe that errorless measurement is possible, which is bad. This talk was inspired in part by the results of talk FA1 in 1998, which showed measurement misconceptions among Japanese high school students.

SATURDAY

Didn't go to any morning sessions. The one I wanted to see was moved opposite session CG.

Session FD: History and philosophy of physics

FD1: The Second Career of Robert Karplus, Robert Fuller

Largely a biographical sketch of Karplus, one of the early PER people. He was one of the first to take Piaget seriously, and would probably have been called a constructivist if the term was in common use back then. He emphasized "Science For Everyone" early on.

FD2: Thermal Physics and Sciences That Involve Codes, Phil Fraundorf.

I didn't find this very interesting, and it was VERY foggy, but if you want to know more, check <http://www.umsl.edu/~fraundor/simplify>

FD3: Art and Physics, Michael Ponnambalam.

A rather impassioned, if somewhat incoherent, defense that there is in truth beauty and in beauty truth.

FD4: Einstein's "Annus Mirabilis," 1905, Sharon Rosell.

A discussion of the many major papers Einstein wrote in 1905, including special relativity, the photoelectric effect, Brownian motion, etc.

FD5: Nuclear Technology Requires Free Elections, Miroslav Synek.

He turned this into a debate session, and a lot of the debate was over whether this topic was even appropriate for an AAPT meeting (really should be at an APS meeting instead). Also, Synek didn't actually want free elections, he wanted free elections that elected leaders who wouldn't launch missiles. Seriously. I, and several others, spent a few minutes trying to convince Synek that the whole Pakistani testing mess was BECAUSE of free elections, because the people demanded it...and he just claimed that it wasn't sufficiently open. So, basically, the people should be listened to, except when they're stupid, yes? So much for the premise of free elections.

FD6: Rutherford and the Sign of the Nuclear Charge, Herb Retcofsky.

By tracing Rutherford's writings, it is claimed that the chemist became fully confident in calling the nucleus positively charged during July of 1912. But, as many pointed out, he probably had it sussed out long before that.

SUNDAY - PERC

I took some notes during the breakout sessions, but most of them were related to group exercises we were doing and not really notes per se. And at lunch I managed to give myself one of the milder heat-related problems (a 40 minute brisk walk in 100 degree heat is Not Recommended) and so I didn't take notes in the afternoon, sorry.