

Bob Hilborn - Amherst College (former AAPT chair)

- Physics BAs have declined while other BAs have increased 5-6 fold since 1950s (we are presently at 1957 levels for BA production).
- 350,000 take intro. physics courses per year (50% in CBIP).
- Only 3% ever take another physics course!!
(1% obtain BA in phys., 1/270 obtain PhD)
- Standard model: Mech., Thermo., E&M, Waves, all else....

What's wrong?

1. Way too much; nothing taken out; favors memorization.
2. Pre-20th cent. phys. does not inspire (Genome).
3. Course content isolated from what physicists do.
4. Students have changed since 1957.

General Philosophy for CBIP:

- **Limit number of topics – be thorough.**
- **Teach as growing subject; students should see frontiers.**
- **Get best faculty into these courses.**

SPIN-UP (Exxon Mobil) - Osheroff, Wiemann, Franz

- Site visits to 21 "thriving" UG phys. programs.
- Report in Physics Today, September 2003.

What makes them thrive?

1. Dept. leadership
2. Good mission
3. Recruit and retain students
4. Emphasis on entire UG program

- Most depts were experimenting with CBIP (pedagogy, not content).
- Departmental effort - **no heroes!**
- CBIP used **successfully** as recruiting tool for phys. majors.
- Dept. continually works to improve courses to serve audience.
- 61% report significant curricular change (71% in CBIP).

Why not widely adopted? Why resistance?

Widely held beliefs (not necessarily true):

- No documentation of success
- Large investment of time/resources
- No reward structure for faculty
- Resistance to change - tradition, tradition, tradition!!
- Reform is just "dumbing down"

Provocative thoughts:

- Goals are ill defined
- CBIP is not the only important step
- Energy, enthusiasm and concern are the most important
- **One size does not fit all**
- Departmental effort is crucial
- Continuous process

Why is this the time for reform? (Ken Krane)

1. Enhance understanding - public awareness of physics
2. Increase numbers of physics majors
3. Receptive faculty

"All you have to be is warmer and fuzzier than engineering!"

- Reform must be coherent - labs, recitation, lecture, etc..
- Students must be actively engaged - lecturing generally bad!
- Must have specific goals, together with formative assessment.

Tested over 15 years, documented from CC^s to Harvard.

- Promote adoption of proven national reforms.
- Best faculty into intro. physics courses who are aware of PER.
- Invite PER speakers to dept.; send faculty to national meetings.
- Collective ownership of intro. courses.
- Target new faculty - change habits early in career
- **Buy-in the entire faculty**

Illinois (Gary Gladding) - The OLD

- Introductory Physics at Illinois prior to Fall 1996

- We "Educate in Bulk"

• Calculus-based sequence	FALL	SPRING
- Physics 106 (Mechanics)	500	1000
- Physics 107 (E&M)	800	450
- Physics 108 (Waves)	400	750
• Algebra-based sequence		
- Physics 101 (Mechanics, thermo)	300	200
- Physics 102 (E&M, modern)	<u>200</u>	<u>300</u>
-	2200	2700

- Tradition, Tradition, Tradition

- Large (200-300) Lectures with Small (24) Sections for Discussions and Labs (6-7 hrs/week)
- Lecturers free to "reinvent the flat tire" , Discussion TAs pretty much on their own, Labs intellectually disconnected from rest of course.
- Exams: Quantitative Problems
- **RESULTS: NOBODY IS HAPPY !!**

The NEW (since '96)

-ALL COURSES TOTALLY REVISED !

• **The Big Idea:** Integrate all aspects of a course using active learning methods based on physics education research in a team teaching environment

• Faculty Participation

- 16-17 Faculty assigned for these courses (2500 students)
- Responsibilities: Lecturer, Discussion Coordinator, Lab Coordinator
- Faculty team meets weekly to keep course on track.
- Faculty team creates exams

• The Good Things

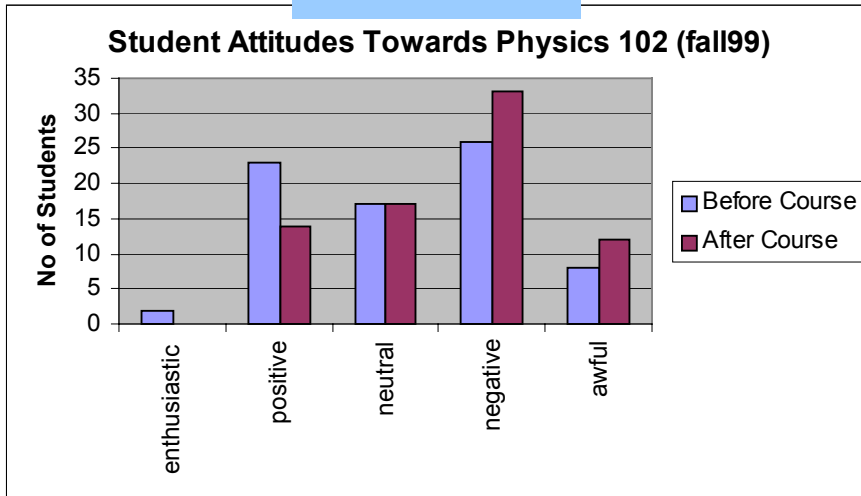
- Pain and gain are shared.. No burnout.. NO HEROES
- Existing Infrastructure lowers the bar for participation.. This assignment is seen as an ordinary assignment!

47 Faculty have taught in these revised courses

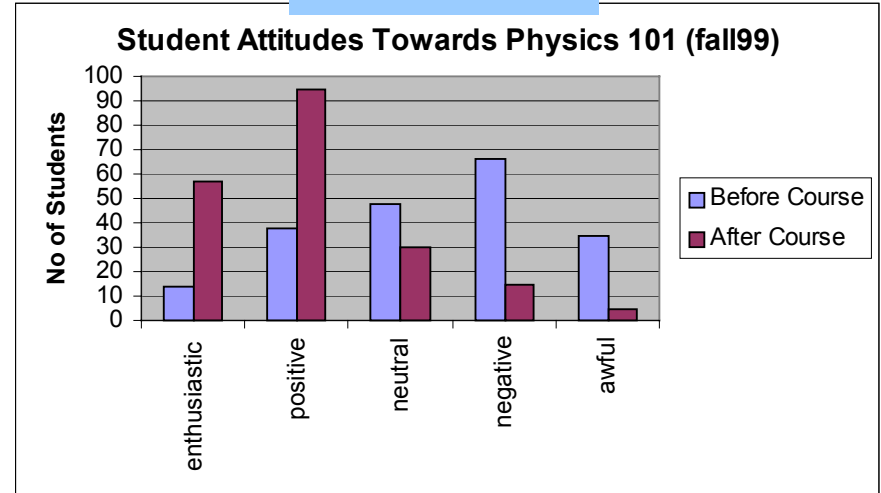
Student Satisfaction

- What do students think of physics after taking our courses?

THE OLD



THE NEW



- How do students rate their TAs?

- University-wide ranking of "excellent" \equiv top 30% of peers

THE OLD
Spring 95
Total Physics TAs = 77
"Excellent" = 15
19 \pm 5 %

THE NEW
Spring 01
Total Physics TAs = 75
"Excellent" = 58
77 \pm 6 %

What is My Point?

- We have made large systemic changes to the way we teach introductory physics at Illinois.
 - Good things have happened!
 - **The faculty are happy**
 - No heroes are needed or wanted.. Assignment is seen as regular assignment.
 - Most regular faculty can participate in and contribute to "the system".
 - **The students are happy**
 - They gain a more positive opinion of physics
 - They recognize uniformly good instruction
 - **The college is happy**
 - Of the last 25 College of Engineering Awards for excellence/innovation in teaching, 8 have gone to Physics faculty (we make up 15% of COE faculty)
 - What next?
 - What did we do to achieve these good results?

Why Is It Working?

- **Key 1: Design Process was a Collective Effort**
 - Committee of 8 met for a year to generate the design
- **Key 2: Infrastructure**
 - People (veteran faculty, computing help, lecture, lab & secretarial support)
 - Computing (all materials on NT server, faculty get NT machine for desk while teaching)
 - Welcome to 1XX, here's how we do things....
- **Key 3: Team-Teaching**
 - All faculty (3-4 per course) do faculty-type jobs
 - Pain and Gain are shared ... no more burnout... NO HEROES
- **Key 4: Administrative Support**
 - Released time essential for initial creation of materials
 - Total support for systemic change... JUST DO IT!
 - Continuing support (e.g., new Assoc Head position) to maintain the system as the "newness" wears off.

What Does it Take to Work Elsewhere?

- ORGANIZATIONAL CHANGE
 - An Unnatural Act ??
 - Probably more important than any of the substantive details presented earlier!
- What is the Main Obstacle to Exporting the "Illinois Model" to Other Research Universities?

The Faculty !



What Does it Take to Work Elsewhere?

- ORGANIZATIONAL CHANGE
 - An Unnatural Act ??
 - Probably more important than any of the substantive details presented earlier!
- MAJOR OBSTACLES (US !!)
 - Character issue: *The Arrogance of Physicists*
 - What makes effective instruction is largely an empirical question.
 - Listen to students
 - Learn from others
 - Cultural issue: *"My" Course*
 - Course is NOT just lectures
 - Progress comes from contributions of many

BOTTOM LINE: Overcoming these obstacles is a liberating experience