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.

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 CCs 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
      - 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) 200 300

  - 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**

Student Attitudes Towards Physics 102 (fall99)

- Before Course
- After Course

**THE NEW**

Student Attitudes Towards Physics 101 (fall99)

- Before Course
- After Course

• How do students rate their TAs?
  - University-wide ranking of “excellent” = top 30% of peers

**THE OLD**

Spring 95
Total Physics TAs = 77
# “Excellent” = 15
19 ± 5 %

**THE NEW**

Spring 01
Total Physics TAs = 75
# “Excellent” = 58
77 ± 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