Maryland Undergraduate Physics Program
Spring 2003

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Outline - Undergraduate Program

- Reminders
  - Peer review, Grades, …. 
- Admissions, Enrollment and Graduation numbers 
- Changes 
  - Budget and teaching issues 
  - Citation in Physics 
  - Computation and Physics Track Update 
- Possible changes in the Majors Program 
  - SPIN Report 
  - PHYS 374 issues 
  - encouraging undergrad research 
- Conclusions
Reminders

- Faculty conducting Peer reviews for:
  
  Becker, Fuhrer, Losert, Roberts
  
  Hammer, Eno, Lathrop, Yakovenko

  please finish this month and send me your report.

  Critical to improving teaching and for promotions

- Early Warning Grades: some faculty still not turning in early earning grades and the College notices

- Grades are due within 72 hours of the final - don't be late

- If you give a grade of I (Incomplete), you need to fill out an Incomplete contract (see Bernie or Tom)

- Students looking for summer research - write it into your grants!
Physics Majors

projecting: 28 Phys B.S. for Sp 03
32 total B.S. for year
~ 42 freshmen F 03
45-55 total F 03 entering
Physics Majors

- Last fall’s entering class was strong
  - 2 B-K, 6 President, 10 Deans Fellows (54% got merit award)
  - $\text{<SAT>} = 1390$, about 100 points above university average
  - $\text{<GPA>} = 4.05$, 18% women, 20-30% minority

- About 2/3 of graduating students went on to grad school last year

- Large number of double majors (about 1/4), and 3 triple majors
  - We need to be flexible to keep them

- Encourage students to do research (about 1/4 to 1/2 will)

- Problems
  - Attracting students and keeping them
  - Need more fellowships
  - Need more research support $\rightarrow$ INCLUDE IN GRANTS
  - Effectiveness of recruiting tools?
  - The common space (SPS lounge) is very poor
  - Some complaints about faculty attitude and teaching
  - Diversity low compared to university population
New Undergraduate Physics Student Lounge

Opened Fall 2003

Some of our majors are making heavy use of the room
Its quite visible to other students
New Undergraduate Physics Student Lounge

Opened Fall 2003

Richard Ott - former head of our SPS and one of our top undergrads

- Some of our majors are making heavy use of the room
- Its quite visible to other students
Undergraduate Physics Majors - Admissions

- Applied to enter Physics in Fall 03: 140
  - Fall 02: 120
  - Fall 01: 80

- Admitted Physics major for Fall 03: 85
  - Fall 02: 64

- Number B-K fellowship offers F' 03: 7
  - Fall 02: 6

Assume 50% yield and typical #:

- Entering Fall 03: ~ 42 freshmen + 10 transfers = ~ 52
- Fall 02: 34 freshmen + 12 transfers = 46
- Fall 99: 25 freshmen + 8 transfers = 33
Qualities of admitted Physics students look good:

**Fall 02 freshmen**

- $<\text{SAT}> = 1390$
- $<\text{GPA}> = 4.05$
- women 18%
- minority 20-30%
- 54% got merit-based award including 2 B-K fellowships

**Fall 03 admitted students**

- $<\text{SAT}> = 1400$
- $<\text{GPA}> = 4.13$
- women 27%
- minority 15-23%
- 63% got merit-based award offer
  - 7 B-K fellowships
  - 23 Presidents fellowships
  - 24 Deans fellowships
Budget and teaching issues

- Electronic Response Devices and Webassign
- No equipment upgrades in teaching labs
- No paid substitutes and more students
  - fewer special topics courses (700 and 800 level)
  - bigger sections
- 700 level issues
  (1) Two new 700 level courses
      Phys 721 and Phys 722 - AMO I and II
  (2) Course rotation is essential but controversial
- Fewer TA lines ---> less grading and more faculty running discussion sections
Budget and teaching issues

Phys 161-262-263 engineering sequence

- Using webassign for grading of most homework
- Renumbered to Phys 161-260-270 and 4 --> 3 credits

Phys 262a and 263a labs

- Renumbered to Phys 261 and 271
- Credit changed from 0 --> 1
- Lab manuals being published outside ($)

Grading scheme is same as before (lecture + lab)

Main impact is on faculty workload credited by University
  (instructors will finally get credit)
Increasing the number of physics majors

• Recruiting and Retention
  – Keep doing what we’re doing (instructors, research, advising…)
  – Visit local high schools: Why go to Maryland?
  – Outreach (Physics Open House, 2 ACTOHs, 4 Visit Maryland Day, Physics is Phun, Physics Olympics, MRSEC outreach, SPS, Summer Girls program, Maryland Day..)
  – Meteorology and Education Tracks approved
  – “Laptop Fellowships” (7 awarded: thank you for your donations!)

• Program Changes:
  • Added a Citation in Physics (non-majors only !)
  • Adding another track → Computation and Physics track
Citation in Physics (Physics Minor)- Approved starting F'03

• PHYS 171: Introductory Physics: Mechanics and Relativity (3)
• PHYS 174: Physics Laboratory Introduction (1)
• PHYS 272: Introductory Physics: Fields (3)
• PHYS 273: Introductory Physics: Waves (3)

and two of the following:
• PHYS 374: Intermediate Theoretical Methods (4)
• PHYS 375: Exper. Physics III: E&M, Optics and Modern Physics (3)
• PHYS 401: Quantum Physics I (4)
• PHYS 402: Quantum Physics II (4)
• PHYS 404: Introductory Statistical Thermodynamics (3)
• PHYS 411: Intermediate Electricity and Magnetism (4)
• PHYS 465: Modern Optics (3)
• PHYS 474: Computational Physics (3)

• Can substitute PHYS 161, 262, 263, for 171, 272, 273.
• Can use other 300-400 level Physics courses with approval
• Faculty advisor: Ted Jacobson
• No more than 7 credits in citation can count toward major requirements.
Key things about the new Citation in Physics

- Physics majors are excluded
- Astronomy majors are excluded – too much overlap
- The main purposes of the Citation are:
  - to attract new students into becoming Physics majors (convert the minor to a major)
  - to provide recognition to Engineering, Math, CS and life science students who are interested in Physics but don't have enough time to complete full B.S. program
  - to decrease the perceived "risk" of majoring in Physics by providing recognition for our students who can finish substantial parts, but not the entire program.
lower level Physics and Math same as in professional track +

AMSC 460 (3): Computational Methods
AMSC 462 (3): Computer Organization or CMSC 351 (3) Algorithms
PHYS 374 (4): Intermediate Theoretical Methods
PHYS 401 (4): Quantum Physics I or PHYS 420 (3): Modern Physics,
PHYS 474 (3): Computational Physics

- two courses from the following list of five courses:
  CMSC 106 (4): Introduction to C Programming
  CMSC 114 (4): Computer Science I
  CMSC 214 (4): Computer Science II
  CMSC 250 (4): Discrete Structures
  PHYS 165 (3): Programming in the Physical Sciences

- two courses from the following list of four courses
  PHYS 402 (4): Quantum Physics II
  PHYS 404 (3) Introduction to Statistical Thermodynamics
  PHYS 410 (4): Classical Mechanics
  PHYS 411 (4): Intermediate Electricity and Magnetism
Main Question:

Why did some physics departments in the 90's increase the number of bachelor’s degrees awarded .... or maintain a number much higher than the national average for their type of institution?

Team visited 21 departments that were doing well.
Things that are NOT Different about the Successful Departments

- The curriculum does not differ substantially from that at departments that lost majors.
- They do not make special efforts to recruit physics majors from high schools.
- They do not draw from a body of student applicants that happens to contain more potential science majors.
- They do not have special laboratory and research facilities that attract physics majors.
- They do not make extensive use of information technology that may be attractive to potential majors.
What is Different about the Successful Departments

- **Good Faculty Attitude**: Department is responsible for maintaining or improving the undergraduate program.
  - Department identified and initiated reform efforts …
    - …rather than complaining about lack of support, money, etc.

- **Challenging and supportive program** with:
  - well-developed curriculum
  - good advising and mentoring
  - an undergraduate research participation program
  - many opportunities for informal student faculty interactions,
  - strong sense of community among the students and faculty.

- **Strong, sustained leadership** with a clear mission for the undergraduate program.

- **Continuous evaluation and experimentation** with the program.
SPIN-UP Report

1. No “magic bullet”
2. Interaction of many activities seems to be key feature.
3. Took several years for departments to change and build a thriving program.
4. Critical resource is energetic people with vision, not money
5. Some modest financial resources are required
   ----> support student research, a physics club, make changes...
6. None of the departments “watered down” their undergraduate programs to attract and retain majors…
7. Some departments recruited heavily from engineers, math, CS.
   ----> Appeal: physics viewed as intellectually challenging.
8. Undergraduate program is everyone’s responsibility…none was sustained by a “hero” operating in isolation.
Specific Example: Reed College

• Emphasizes undergraduate research and independent work that supports close faculty-student research collaborations.

• All Reed students do a senior thesis project
  4 Reed physics majors have been recognized for their research work by the APS Apker Award (one winner, three finalists).
Specific Example - Harvard

- physics department graduates 50-60 majors each year
- various ways to get degree:
  - Basic program requires a total of 12 courses in physics and mathematics. The
  - Honors program requires 2 additional advanced math courses, 1 advanced lab course, and 3 additional physics courses.
  - joint-major programs:
    - Physics and chemistry
    - Physics-Mathematics
    - Physics-Astronomy
    - Physics-History of Science
    - Biophysics
    - Physics Teaching program

Note:
Harvard is unusual in that it has fairly minimal requirements for the physics B.S. degree
Specific Example - Rutgers

- Made changes and experienced large growth
- offers four tracks.
  - Professional Option
  - Applied Option & Dual-Degree option for students looking for applied work in physics or engineering.
  - General Option for students interested in law, medicine, or secondary-school teaching.
  - Astrophysics Option

+ considering adding an Engineering Physics degree.
Specific Example: Carleton College

Offers unusual introductory course:

**first 5 weeks:**

"Newtonian Mechanics" or “Gravitation & the Cosmos”
(depending on student background)

**next five weeks:**

"Relativity and Particles"

Basic idea: expose students to exciting, up-to-date topics early.

Traditional introductory topics are subsumed into intermediate-level sequence of atomic and nuclear physics, classical mechanics, computational mechanics, and E&M.
Specific Example: Bryn Mawr College

- Students in introductory physics courses are given tours of the research laboratories.
- Upper-level students involved in the research laboratories give presentations for these students at a mini-symposium.
- Many students cited the research opportunities as playing an important role in their decisions to become physics majors.
The Introductory Course

• All departments worked very hard to make the introductory courses as good as possible.... assign only their “best” and experienced faculty. When new faculty members rotate in, they often do so as “apprentices” with more experienced faculty.

• Many are using innovative pedagogy such as peer instruction [Mazur, 1997], just-in-time teaching [Novak, et al., 1999], and active demonstrations [Sokoloff and Thornton, 1997].

• But they are NOT doing anything radically different.
Recruiting

• Faculty actively recruit majors in the introductory physics (provide career information, contacts with upper-level physics majors, talking with students who show an aptitude for physics).

• Offer informal “get to know the department” meetings with talks about research, particularly student research, and career paths of recent alumni.

• Invite potential majors to departmental picnics or softball games.

• Chairs wrote letters to all admitted students who indicated some interest in physics or potential to be a physics majors.
## SPIN-UP CHECKLIST for Maryland Physics

<table>
<thead>
<tr>
<th>Growing?</th>
<th>moderately</th>
<th>senior level thesis required</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>interaction of many activities/community/informal interactions</td>
<td>some</td>
<td>get to know the department meetings</td>
<td>SPS, Phys 170</td>
</tr>
<tr>
<td>energetic people</td>
<td>some</td>
<td>letters to admitted students</td>
<td>YES</td>
</tr>
<tr>
<td>financial resources</td>
<td>good/fair</td>
<td>multiple tracks</td>
<td>some</td>
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<tr>
<td>vision for program</td>
<td>different views</td>
<td>honors (advanced) track</td>
<td>NO</td>
</tr>
<tr>
<td>solid curriculum</td>
<td>some issues</td>
<td>invite potential majors to department social events</td>
<td>NO</td>
</tr>
<tr>
<td>intro course staffing</td>
<td>GOOD</td>
<td>recruit from eng,…</td>
<td>some</td>
</tr>
<tr>
<td>innovative teaching for intro phys majors</td>
<td>no</td>
<td>required research component (option)</td>
<td>No (yes)</td>
</tr>
<tr>
<td>NOT doing anything radically different</td>
<td>YES</td>
<td>new and exciting phys in lower level</td>
<td>No</td>
</tr>
<tr>
<td>support student research</td>
<td>YES</td>
<td>Active SPS chapter</td>
<td>YES</td>
</tr>
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</table>
Other Problems in our Professional Physics track…..

mismatch in level of upper and lower level courses
little/no 200-level intro to modern physics, stat mech, relativity
role of Phys 374 is still unclear
uneven treatment of computer simulation (374,375)
fear of (overwhelmed by) certain lab courses (375 and 405)
few 400-level "special topics" courses offered/none required
relatively poor GRE scores
high-yield tracks not in place

change majors requirements, curriculum, environment?
Winter Term

Between the fall and the Spring semesters, there are 4 weeks in January - "Winter Term" - during which courses can be offered.

The University is encouraging departments to offer courses by making it financially appealing.

- Introduce a 1-credit "physics research course" targeted at seniors interested in doing a thesis.
- Offer a special topics course in exciting physics at an intro level: relativity, black holes, cosmology, strings…
- Offer special topic courses targeted at grads and undergrads doing research: quantum computing,…
- Offer 1-credit labs such as Physics 174.
Conclusions

- It's possible to grow a Physics Department in bad times...
  ...and even in good times.
- It is important to continue making adjustments in the program
  adding a few more tracks (computation, biophysics,..)
  straighten out problem areas (374, math, soph. mod. phys.)
- The faculty will need to give some thought to the program,
  how it can be enhanced,
  how it can be made more appealing,
  how it can be kept up to date
  how to improve the faculty-student community
  how to improve faculty instruction
  how to improve student learning
  how to engage students in their classes and in research
  how to continue growing with limited resources