# What Works for Thriving Undergraduate Physics Programs

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***American Association of Physics Teachers***

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Support from
American Association of Physics Teachers
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# Outline

I. Some Motivation and History

II. Why do some physics programs thrive and others don't – lessons from SPIN-UP 2002-3.

III. What has happened since.

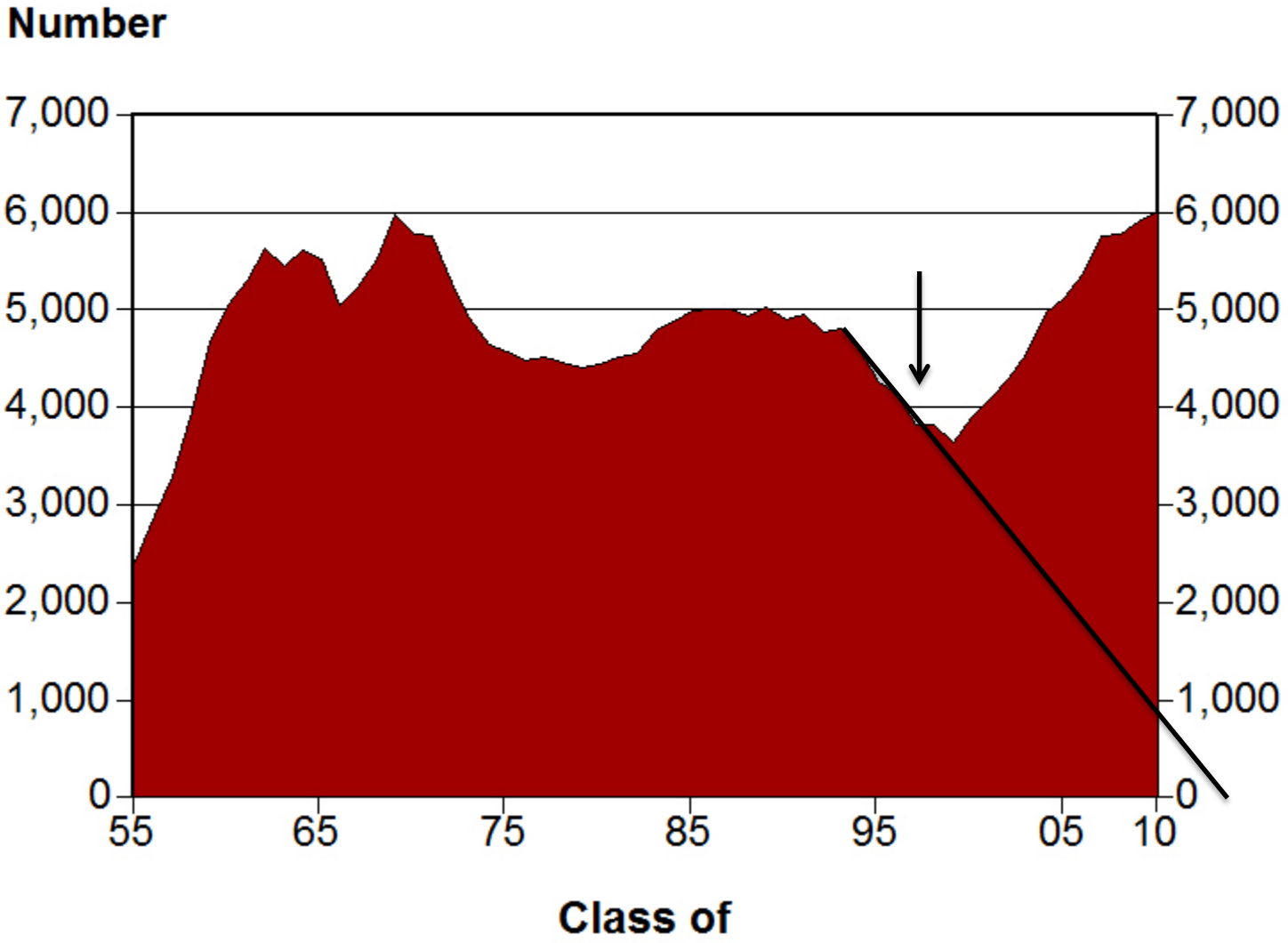
IV. Take home messages.

# Why focus on undergraduate STEM education?

- Fewer than 30% of undergraduates who start in STEM programs graduate.
- Only 20% of students from under-represented groups who start STEM programs graduate.

  (*Science*, 14 January 2011, p. 125)
- Future K-12 teachers – where do they learn science?
  - Business Higher Education Council
  - Association of American Universities
  - President's Council of Advisors on Science and Technology

# Physics Bachelor's Degrees Awarded in the US, 1955 through 2010.



# National Task Force on Undergraduate Physics (2000-2006)

## *SPIN-UP*

# Strategic Programs for Innovations in Undergraduate Physics

American Association of Physics Teachers,
American Physical Society
American Institute of Physics
The ExxonMobil Foundation

ExxonMobil

# National Task Force on Undergraduate Physics (2000-2006)

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# SPIN-UP

- Site Visits to 21 "thriving" undergraduate physics programs.
- Survey (with AIP) of all 761 bachelor's degree-granting physics programs in the US (74% response).
- Report and Analysis. 2002-2003

# What do we mean by "thriving"?

- Number of majors and graduates well above national averages
- Sense of community among majors
- Well-regarded by other science departments
- Strong program for non-science majors
- Department supports overall mission of the university
- Well-regarded by upper administration

# Site Visit Departments

visits carried out by 65 physics volunteers + Task Force members

- **Angelo State University**
- University of Arizona
- Bethel College
- Brigham Young University
- Bryn Mawr College
- Colorado School of Mines
- Cal State San Luis Obispo
- Carleton College
- Grove City College
- Harvard University
- University of Illinois
- **University of Wisconsin-LaCrosse**
- Lawrence University
- North Carolina State Univ.
- North Park University
- Oregon State University
- Reed College
- Rutgers University
- SUNY Geneseo
- University of Virginia
- Whitman College

# Essential Findings for Thriving Undergraduate Physics Programs

- The department is the crucial unit for change. The department must "own" the undergraduate program. "No Excuses!"
- The program is more than courses.
- Change takes time and energy (but not necessarily a lot of money).

# Essential Findings: What makes an undergraduate Physics program thrive?

- Strong and sustained departmental leadership.
- Well-defined sense of mission (correlated with mission of the institution).
- Large fraction of the faculty engaged.

# Essential Findings

- A challenging but supportive program
- Many opportunities for student-faculty interactions
- Continuous evaluation and refinement

# Crucial Element

- Recruit and retain students
  - Understand how students find out about your program
  - Introductory courses
  - Build "physics identity"
  - Multiple-tracks/options
  - Research and outreach experiences – early and often
  - Career information - alumni
  - Professional development and mentoring

# What is not on the list?

- Major interdisciplinary efforts (except through multiple-tracks)
- Radically different curricula
- Watered-down curricula
- Extraordinary use of IT – almost everybody uses some – no big deal
- Lavish new buildings and equipment

# What has happened since the SPIN-UP study?

- Data from departments that have had large increases in the number of undergraduate physics majors since 2000.
- Average 1997-1999
- Average 2003-2005
- N > 15 in 2005

# Top Increases 1997-99 -> 2003-05

## Research Universities (N>15 for 2005)

| | 2005 | Increase |
|---|---|---|
| CA-U of, Davis | 33 | big |
| Michigan State U | 26 | 164% |
| CA-U of, Santa Barbara | 34 | 163% |
| CA-U of, Riverside | 15 | 153% |
| Cornell U (Appl Sci) | 37 | 151% |
| AR-U of, Fayetteville | 19 | 148% |
| New York U (NYU) | 15 | 142% |
| South Florida-U of | 16 | 131% |
| NM Inst of Mining & Tech | 17 | 130% |
| Georgetown U | 25 | 121% |
| CA-U of, Santa Cruz | 25 | 119% |
| Maryland-U of, Coll Park | 31 | 118% |
| MA-U of, Amherst | 30 | 107% |
| Arizona-U of | 39 | 100% |
| Minnesota-U of, Minnpls | 27 | 95% |
| Florida-U of | 17 | 92% |
| Brown U | 19 | 92% |
| Washington-U of | 78 | 81% |
| IL-U of, Urbana/Champaign | 48 | 75% |

# Primarily Undergraduate Institutions (N > 15 for 2005)

| Institution | BS05 | Chge |
|---|---|---|
| James Madison U | 17 | 371% |
| Cal Poly St U-San L.O. | 30 | 243% |
| Williams Coll | 19 | 104% |
| WI-U of, River Falls | 15 | 94% |
| Dickinson Coll | 16 | 90% |
| Charleston-Coll of | 16 | 87% |
| Gustavus Adolphus Coll | 16 | 74% |
| Harvey Mudd Coll | 21 | 37% |
| Bethel Coll (MN) | 15 | 34% |

# NSF-funded SPIN-UP Regional Workshops: R1s June, 2010

- Harvard, MIT, Stanford, Illinois, Princeton, Michigan State…..(17 total)
- All have efforts focused on improving their undergraduate programs
- Almost all are following the "SPIN-UP Model"
- Almost all have evidence of improvements in numbers, student enthusiasm and engagement

# Other Workshops

- HBCU SPIN-UP May 2011
  - Council of HBCU Physics Dept. Chairs
- Council of Scientific Society Presidents, May 3, 2012
- Building a Thriving Undergraduate Physics Program, American Center for Physics, June 10-12, 2012

# More information:

- Hilborn and Howes, *Physics Today*, September, 2003
- Google "SPIN-UP Report" (#1 out of 47,800,000 hits) - included are reports about applying these principles to other disciplines
- **AAPT Guidelines for Self-Study and External Evaluation of Undergraduate Physics Programs**
- **President's Council of Advisors on Science and Technology – Feb. 2012:** ***Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics***

# SPIN-UP TYC

- Funded by NSF to understand physics programs at TYCs
- Report available at

http://www.aapt.org/Programs/projects/spinup-tyc.cfm

or Google “SPIN-UP TYC”

# Take Home Messages

- SPIN-UP provides 21 "existence proofs" that real STEM departments can build thriving programs. Many more since then.
- There are several models of successful programs. (Build on local strengths.) One size does not fit all.
- Meaningful change requires that you understand your entire undergraduate program and your students and keep working.