

SPIN-UP and the Recent Increase in the Number of Undergraduate Physics Majors

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Support from

American Association of Physics Teachers,

American Physical Society

American Institute of Physics

The ExxonMobil Foundation

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The Big Questions

- Why do some undergraduate physics programs “thrive” while others are less successful?
- How do undergraduate physics programs move from “good” to “great”?



Outline

- I. Why do some programs thrive – lessons from SPIN-UP 2002.
- II. Some examples and a counter-example.
- III. What has happened since.
- IV. Take home messages.

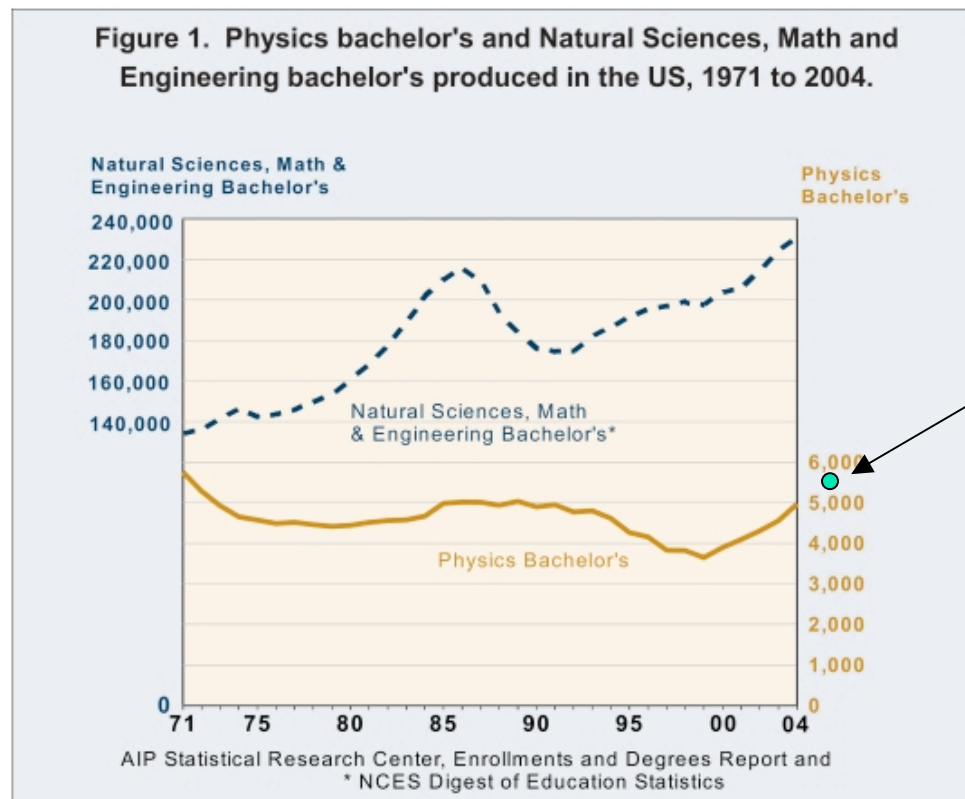


Why Should We Care?

The skeptic: “People have succeeded in physics with education from many different kinds of departments. Those good enough to do physics will succeed no matter what.”

- We need more people with strong STEM backgrounds. (Scientists, teachers, lawyers, legislators,...)
- Understanding what makes programs thrive helps improve education across the board.

Recent Physics Bachelor's Degree Production



Source: AIP Statistical Research Center: Enrollments and Degrees Report, and NCES Digest of Education Statistics



National Task Force on
Undergraduate Physics (2000-2006)

SPIN-UP

**Strategic Programs for
Innovations in
Undergraduate Physics**

National Task Force

on Undergraduate Physics (2000-2006)

J. D. Garcia (U. Arizona)

S. James Gates (U. Maryland)

Robert Hilborn (UT Dallas), Chair

Ruth Howes (Marquette), Co-Chair

Ken Krane (Oregon State)

Liz McCormack (Bryn Mawr)

Laurie McNeil (U. North Carolina-Chapel Hill)

Jose Mestre (Illinois)

Tom O’Kuma (Lee College)

Doug Osheroff (Stanford)

Joe Taylor (Princeton)

Carl Wieman (U. Colorado, U. British-Columbia)

Ex Officio:

AIP- J. Stith, J. Hehn

APS-J. Franz, T. Hodapp

AAPT-B. Khoury, W. Hein

PKAL – J. Narum



SPIN-UP

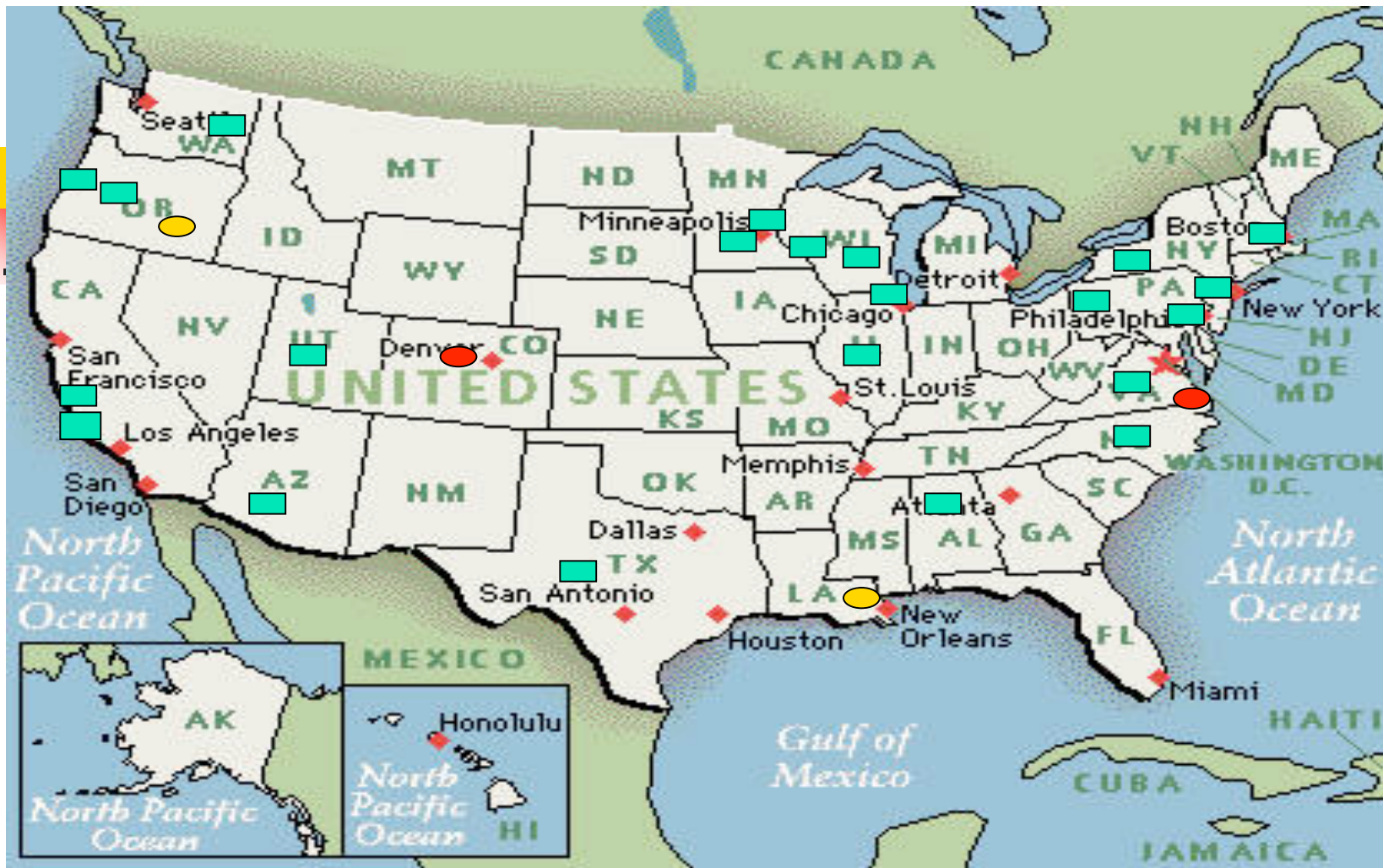
- Site Visits to 21 “thriving” undergraduate physics programs.
- Survey (with AIP) of all 761 bachelor’s degree-granting physics programs in the US (74% response).
- Report and Analysis. 2002-2003

What do we mean by “thriving”?

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



- Trial Site Visit 2000
- PhysTEC Site Visit 2000
- SPIN-UP Site Visit 2001-02

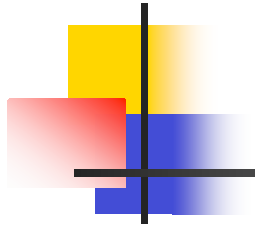


Essential Findings for Thriving Undergraduate Physics Programs

- The **department** is the crucial unit for change. The department must “own” the undergraduate program.
- The **program** is more than courses.
- Change takes **time and energy** (but not necessarily a lot of money) and is an **on-going process**.

What Makes an Undergraduate Physics Program Thrive?

Physics Today, September, 2003

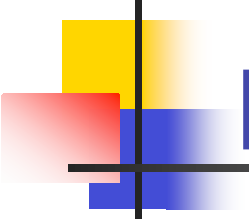


- Strong and sustained departmental leadership.
- Well-defined sense of mission (correlated with mission of the institution).
- Emphasis on the entire program of the department, large fraction of the faculty engaged.



Details

- Recruit and retain students
 - Challenging and supportive program
 - Career information - alumni
 - Introductory courses
 - Prof. development and mentoring
 - Multiple-tracks/options
 - Research experiences – early and often



What makes an undergraduate program thrive?

- A widespread attitude among the faculty that the **department has the primary responsibility** for improving the program – not a bunch of whiners
- A challenging but supportive program with many opportunities for **student-faculty interactions**
- Continuous **evaluation and experimentation**
- Strong and sustained **leadership** (worth mentioning again)



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



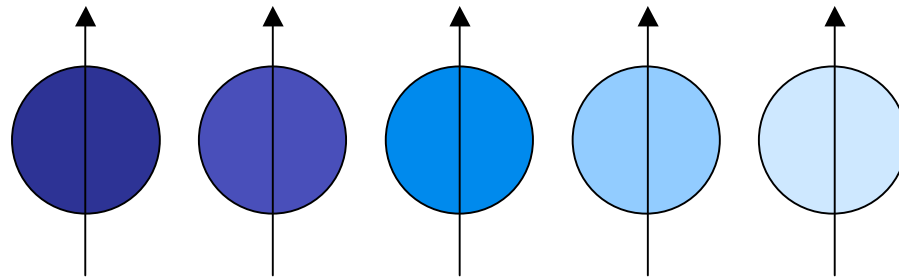
An Apparent Counter-Example

- What went wrong?

The SPIN-UP Report and Departmental Guidelines

Report: <http://www.aapt.org/Projects/ntfup.cfm>

**AAPT Guidelines for Self-Study and External
Evaluation of Undergraduate Physics Programs**





Consulting Site Visits

- Available upon request
- Department pays travel and local expenses
- Contact Bob Hilborn
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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%

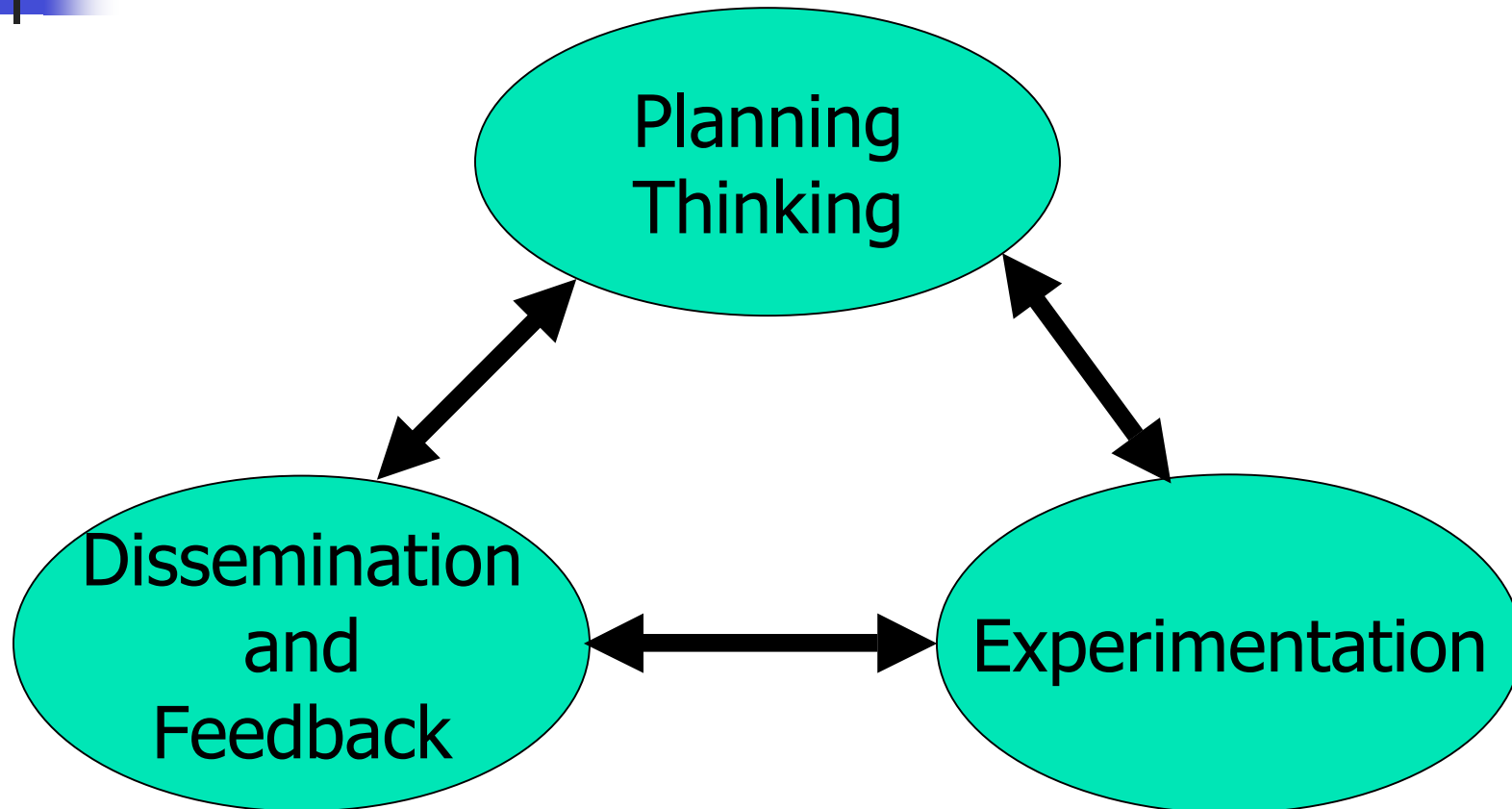


Why Isn't Every Program Thriving?

- Melba Phillips: “The problem with physics education problems is that they don't stay solved.”
- Albert Einstein: “We can't use the same kind of thinking to solve problems as we did when we created them.”
- John Russell: “All reform is ultimately local.”



Sustaining Enhancements



Individuals, **departments**, institutions, disciplines...

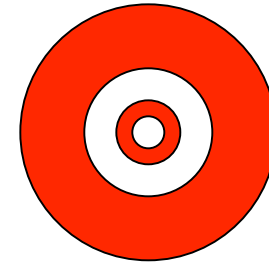


Theory

- Lev Vygotsky
 - Cultural mediation
 - Situated learning
- Jerome Bruner – Narrative Construction of Reality



Hitting the target



- Institution-wide programs are often too “dilute.”
- Individual investigator efforts are hard to sustain and to spread.
- Curriculum-only projects do not build the political infrastructure.
- The department is the political unit that can make things work.
 - Cf. NSF efforts in the 1960s



Other Connections

- Sheila Tobias, "*Revitalizing Undergraduate Science: Why Some Things Work and Most Don't*" (1992)
- Mathematical Association of America:
Models that Work: Case Studies in Effective Undergraduate Mathematics Programs (1995)
- Jim Collins, *From Good to Great* (HarperCollins, New York, 2001)



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.**