

Table of Contents

Preface	v
Executive Summary	vi
Chapter 1. Introduction	1
Caveats	1
Undergraduate Physics in the United States	2
The Report	3
Chapter 2. History of the National Task Force on Undergraduate Physics	4
1995–1998	4
1999–Present	6
Comparison with Efforts in Mathematics, Chemistry, and Engineering.	9
Chapter 3. Procedures for SPIN-UP Site Visits	11
Site Selection	11
Site Visit Information and Schedule	12
List of Site Visits	13
Chapter 4. Analysis	14
General Comments	14
An Analytic Outline	15
The Elements of a Thriving Undergraduate Physics Program	16
Counter-Examples	33
Chapter 5. The Survey	34
Background	34
Courses and Curricula	36
Recruitment Activities	39
Interactions between Faculty and Students	40
Alumni Tracking	43
Curricular Reform	44
Overall Evaluations of Undergraduate Physics Programs	46
Chapter 6. Connections, Lessons, and Other Issues	47
Undergraduate Mathematics Site Visits	47
Revitalizing Undergraduate Science Education	48
Thriving in the Business World	49
Underrepresented Groups and the Issue of Diversity	49
Two-year Colleges	51
Teacher Preparation	51
Future Directions	51
Final Words of Wisdom and Encouragement	52
References	53

Appendices

I. Physics Education Resources	56
A. Physlets	56
B. Scale-Up	56
C. Workshop Physics	57
D. Investigative Science Learning Environment (ISLE)	57
E. ALPS and ActivPhysics (Active Learning in Large and Small Classes)	58
F. Matter and Interactions, Electric and Magnetic Fields	58
G. Teaching Physics Through Cooperative Group Problem Solving	58
H. Peer Instruction	59
I. Just-in-Time Teaching (JiT)	59

J.	Tutorials in Introductory Physics	60
K.	Classroom Communication Systems: Transforming Large Passive Lecture Classes into Interactive Learning Environments	61
L.	Video Analysis in the Physics Laboratory	62
M.	Introductory Physics at a Large Research University	63
N.	RealTime Physics	63
O.	Interactive Lecture Demonstrations	63
P.	Studio Physics	64
Q.	Other Web Resources	64
II.	Undergraduate Physics Reading List	65
III.	Presentations and Articles on SPIN-UP	67
A.	Presentations	67
B.	Articles about the Task Force, and SPIN-UP and Related Activities.	70
IV.	Site Visit Volunteers	71
V.	Site Visit Documentation	72
A.	Definition of a Thriving Undergraduate Physics Program	72
B.	Letter to the Site Visit Chair	73
C.	Contract	74
D.	Departmental Questionnaire for Task Force Site Visits	74
E.	Site Visit Protocol	76
F.	After the Visit	77
G.	Sample Schedule	78
VI.	Formative Evaluator's Report	79
A.	Credibility of the Framework	80
B.	Elements of the Framework for Creating a Thriving Physics Department	80
C.	Additional Concerns for Creating Thriving Physics Departments	84
VII.	Survey Form	87
VIII.	Case Study Documents	94
A.	Angelo State University	95
B.	University of Arizona	97
C.	Bethel College	99
D.	Brigham Young University	101
E.	Bryn Mawr College	104
F.	California Polytechnic State University at San Luis Obispo	106
G.	Carleton College	108
H.	Colorado School of Mines	110
I.	Grove City College	112
J.	Harvard University	114
K.	University of Illinois	116
L.	North Carolina State University	119
M.	North Park University	122
N.	Oregon State University	124
O.	Reed College	126
P.	Rutgers University	128
Q.	State University of New York at Geneseo	130
R.	University of Virginia	132
S.	Whitman College	134
T.	The University of Wisconsin–La Crosse	136
U.	Lawrence University	139

Preface

This report describes the results of the project Strategic Programs for Innovations in Undergraduate Physics (SPIN-UP), organized by the National Task Force on Undergraduate Physics. The Task Force received support for SPIN-UP from the American Association of Physics Teachers, the American Physical Society, the American Institute of Physics, and a generous grant from the ExxonMobil Foundation. Particular thanks go to Edward F. Ahnert, President of the ExxonMobil Foundation, Truman T. Bell, program officer, and Jean Moon, consultant to the Foundation. Their assistance in shaping and focusing the goals of the project was invaluable. We gratefully acknowledge Roman Czujko and his colleagues at the American Institute of Physics Statistical Research Center for their work on the survey of all bachelor's degree-granting physics programs in the United States. Although led by the Task Force, SPIN-UP benefited from the volunteer efforts of more than 50 physicists for the site visits, the hospitality and work of the faculty of the 21 physics departments visited as part of the site visit program, and the generous time spent on the survey by 74% of the physics departments in the country. SPIN-UP is indeed a physics community effort.

Executive Summary

Strategic Programs for Innovations in Undergraduate Physics (SPIN-UP) set out to answer an intriguing question: Why, in the 1990s, did some physics departments increase the number of bachelor's degrees awarded in physics or maintain a number much higher than the national average for their type of institution? During that decade, the number of bachelor's degrees awarded in the physical sciences, engineering, and mathematics declined across the country. Yet in the midst of this decline some departments had thriving programs. What made these departments different? What lessons can be learned to help departments in the sciences, engineering, and mathematics that are—to put it generously—less than thriving? SPIN-UP, a project of the National Task Force on Undergraduate Physics, set out to answer these questions by sending site visit teams to 21 physics departments whose undergraduate programs were, by various measures, thriving. These visits took place mostly during the 2001–2002 academic year. In addition, with the aid of the American Institute of Physics Statistical Research Center, SPIN-UP developed a survey sent to all 759 departments in the United States that grant bachelor's degrees in physics. The survey yielded a 74% response rate distributed broadly across the spectrum of U.S. physics departments.

The site visit reports provided specific insight into what makes an undergraduate physics program thrive. In very compact form, these departments all have

- A widespread attitude among the faculty that the department has the primary responsibility for maintaining or improving the undergraduate program. That is, rather than complain about the lack of students, money, space, and administrative support, the department initiated reform efforts in areas that it identified as most in need of change.
- A challenging, but supportive and encouraging undergraduate program that includes a well-developed curriculum, advising and mentoring, an undergraduate research participation program, and many opportunities for informal student-faculty interactions, enhanced by a strong sense of community among the students and faculty.
- Strong and sustained leadership within the department and a clear sense of the mission of its undergraduate program.
- A strong disposition toward continuous evaluation of and experimentation with the undergraduate program.

In Chapter 4 of this report, each of these themes is further analyzed and illustrated with examples from the site visit departments. Chapter 5 provides a summary of the survey results.

Financial support for project SPIN-UP was provided by the ExxonMobil Foundation, the American Association of Physics Teachers, the American Physical Society, and the American Institute of Physics.