Appendix IV.
Site Visit Volunteers

Mary Alberg
Seattle University

Teresa Burns
Coastal Carolina University

Ruth W. Chabay
Carnegie Mellon University
(now at North Carolina State University)

Cliff Chancey
University of Northern Iowa

Wolfgang Christian
Davidson College

Robert Ehrlich
George Mason University

William Evenson
Brigham Young University

Andrew Gavrin
Indiana University-Purdue University

Gary Gladding
University of Illinois

Kenneth Heller
University of Minnesota

Dennis Henry
Gustavus Adolphus College

Theodore Hodapp
Hamline University

Donald Holcomb
Cornell University

William Ingham
James Madison University

Patrick Kenealy
Cal State University Long Beach

Randall D. Knight
Cal Poly State University, San Luis Obispo

John Knox
Idaho State University

Jean Krisch
University of Michigan

Priscilla Laws
Dickinson College

Ramon Lopez
University of Texas El Paso

Catherine Mader
Hope College

Mary Beth Monroe
Southwest Texas Junior College

Kathie Newman
University of Notre Dame

Thomas Olsen
Lewis and Clark College

Richard Peterson
Bethel College

Rick Robinett
Pennsylvania State University

Lyle Roelofs
Haverford College

Warren Rogers
Westmont College

Richard Saenz
Cal Poly State University

James R. Sites
Colorado State University

David Sokoloff
University of Oregon

Patricia Sparks
Harvey Mudd College

Paul Stanley
California Lutheran University

Conley Stutz
Bradley University

Doyle Temple
Hampton University

Michael Thoennessen
Michigan State University

Ed Thomas
Georgia Institute of Technology

Jan Tobochnick
Kalamazoo College

Dean Zollman
Kansas State University

Appendix V.
Site Visit Documentation

This appendix contains the documents that were used in setting up and running the site visits.

A. Definition of a Thriving Undergraduate Physics Program

1. The number of majors is stable at a level that the department and the administration consider satisfactory or shows significant and sustained growth toward that number.

2. Morale is high for both faculty and students. They are engaged with physics, and the atmosphere within the department is collegial. Faculty regularly evaluate and respond to the changing needs of their students both majors and students in service courses, and work to enhance their skills as teachers. They seek to improve the experiences they offer their undergraduate students by constantly updating the departments' curriculum and by involving undergraduate colleagues in research.

3. Graduates find good jobs or obtain admission to graduate programs both in physics and in other fields. The department actively supports the professional development of its students by activities such as making information available about diverse careers, arranging for internships, or working with industries in an industrial advisory committee.

4. The college or university in which the department is situated respects the department, and all students find its programs attractive. Here "all" includes students enrolled in service and general education courses as well as physics majors and minors.

5. The department faculty work as a team to provide excellent undergraduate education. The majority of the faculty consider undergraduate teaching very important and honor their colleagues who do it even if they personally are not actively involved. The department invests resources not only in major courses but also in service and general education courses.

6. The department regards both undergraduate students and staff members as important members of the departmental team. Their voices are heard in making departmental decisions.

7. The department attracts and retains minorities and women as physics majors.

8. The department recognizes its responsibility to promote excellence in physics education for all K–12 students. This responsibility may be expressed through a variety of activities, for example: direct education of pre-service teachers; supportive involvement in physics or physical science courses or curricula for pre-service teachers (whether or not these courses are not taught by the physics department); in-service programs for local teachers; or outreach activities for local teachers and students.

B. Letter to the Site Visit Chair

Dear (Department Chair):

The purpose of the site visits of the National Task Force on Undergraduate Physics is to learn what makes a thriving undergraduate physics program. We are particularly interested in innovations in physics departments that could be widely duplicated. The site visits are supported by Strategic Programs for Innovations in Undergraduate Physics (SPIN-UP) through funding from the ExxonMobil Foundation.

The Task Force seeks to answer two questions:

1. What are the activities that position physics departments for **success** in producing more majors, placing graduates in a variety of interesting careers, and playing a productive and significant role in the academic life of the institution through both service courses, general studies courses, outreach programs, and so on?
2. What are the essential conditions within a department needed to promote a constructive and creative response to environmental change, and what events or pressures combined to stimulate those responses?

Some secondary (but important) issues:

Some departments have a large fraction of their faculty involved in innovating their undergraduate programs. However, many departments have only a small fraction of the faculty involved actively in undergraduate programs beyond routine meeting of classes. In this case, it is critical that other members of the department support them in such tangible ways as promotion and tenure. What is the minimum number of active faculty needed for excellence in an undergraduate program, particularly for making substantive changes? What support from the rest of the department is absolutely essential? How long does it take to produce lasting change within a physics department? How do the department and the institution measure success, particularly the effect of innovations, in the undergraduate program? How are the resources and faculty time needed to create a thriving undergraduate program balanced against other demands on the department and the faculty?

The documentation submitted by the department before the visit should provide data on what the department thinks it has accomplished. The site visit is needed to look for elements such as morale of faculty and students and institutional support that do not appear in formal reports. The visit is not intended to evaluate directly the strengths and weaknesses of the department's program. We do, however, want to achieve a realistic picture of what was done, how it was done, and how it is working. The eventual goal is to be able to characterize those elements that are important (or in some cases crucial) for planning, developing, implementing, and sustaining successful undergraduate physics programs. We must keep in mind that what constitutes a "thriving" program is subject to local interpretation though, of course, there will be many features common to all physics programs.

The attached contract explicitly states the terms under which the site visit will be conducted. Please sign it, return it to me, and keep a copy for your files. Also attached are several questions whose answers should be provided to the Task Force before the site visit. The Site Visit Team will consist of three physicists including one member of the Task Force. We will try to select members of the team from institutions geographically close to yours. Should you desire it, a member of the Site Visit Team will present a colloquium to your department. More information about the Task Force and its membership can be found on the AAPT website: *http://www.aapt.org/Projects/ntfup.cfm.*

The Task Force appreciates your agreeing to participate in the SPIN-UP site visit program. Your contribution will help other physics departments design constructive responses to the changing environments in which they find themselves.

C. Contract

The Task Force makes the following agreement with the Physics Department at ___________:

The department will cover all local expenses (housing, meals and local transportation during the visit) for the three-member site visit team.

The department will make appropriate hotel reservations for the site visit team. SPIN-UP will cover all travel expenses for the site visit team.

The department will provide the site visit team with written responses to a set of questions about the department's undergraduate program at least two weeks prior to the site visit.

In consultation with the site visit team leader, the department chair will set up a schedule of appointments with small groups of faculty (both in the department and outside the department as appropriate), students (both majors and nonmajors and special groups such as engineers, pre-service teachers, etc.), clerical and technical staff, and administrators.

After the site visit, the site visit team will provide the department chair with a written report of the team's findings within three weeks of the site visit. The chair will have one week to correct factual errors in the draft and return it to the chair of the site visit team. The report in final form will be submitted to the department chair and NTFUP. The report is written for the department chair. The chair may share the report with other members of the department and with the institution's administration at the discretion of the chair. The Task Force will seek the permission of the chair before using any of the data in the report in a way that links the data directly to the department. The Task Force may ask for additional data and comments as it prepares a Case Studies document.

D. Departmental Questionnaire for Task Force Site Visits

The Task Force site visit will be much more productive both for the Task Force and for the department if the site visit team members have some information about the department in advance of the actual visit. Please provide the information described below. (If you have this information in a different format, for example, for a recent departmental review or self-study, please feel free to substitute that report for the format given below.) We emphasize that this visit is not a usual departmental review. We are interested in the steps you have taken to ensure that your department's undergraduate program is truly thriving. The site visit team wishes to collect data ahead of time and spend site visit time talking with faculty, staff, students and administrators.

1. Personnel information

Please list:

A. Faculty by rank and give years in service and a brief statement of research areas

B. The number of support staff, (for example, departmental assistants, lecture demo support staff, lab instructors, technical staff, machine shop staff, electronics shop staff, etc.) and indicate if these staff are full-time or part-time.

2. Information about students

Please list:

A. The number of majors you have by class (first-year, sophomores, juniors, seniors) and the number of majors you have graduated each year for the last 10 years. Any data you have on entering physics majors or enrollment by class for different years would be helpful, as would information on demographic characteristics of your students. (For example, do you have a large number of nontraditional or transfer students? How many minority or women students are physics majors? Do your students come from public schools? Rural schools? Private schools? Do you have any information on their SAT scores or their high school grade point averages? Have most of them taken AP physics?) You don't need to undertake major research for this questionnaire, but data on the characteristics will allow the SVT to acquire a clearer picture of your department.

B. The typical enrollments in each of the undergraduate courses offered by your department (precise figures are not necessary). It would be helpful to have a brief phrase describing each course and its primary audience. Alert us to any historical trends in the data.

C. Typical career paths for your physics majors. Roughly what fraction go directly into the workforce, to K–12 teaching, to graduate school, to professional school, etc. Again alert us to any historical trends in those data.

D. Research participation and TA opportunities for undergraduates in your department.

E. Other opportunities for physics majors outside the classroom (e.g. an active SPS chapter, a student lounge, tutoring, etc.)

3. Provide a brief narrative about your undergraduate physics program (including the program for majors and courses for nonmajors), particularly focusing on what you consider to be the most important components and novel features that you believe are particularly successful. We would also like to learn about how the department planned for and implemented innovative features and how they are being evaluated and sustained. The following questions should be addressed:

A. What changes have you made during the last five years to improve the experiences of undergraduate students in your department's program?

B. How did you make these changes? Specifically: Why did you embark on change?

C. How did you recruit faculty to work on the new programs?

D. How did you obtain resources to support change? What added resources were you able to obtain?

E. What evidence do you have that your department is thriving and that your activities produce success?

4. If you have other general information about your undergraduate program including recruiting brochures, course catalog information, course or faculty evaluation forms, and so on, we would appreciate receiving copies of that information.

5. What academic or psychological services (such as tutoring or help with test anxiety) does your department or your university provide to students? What services does your university provide to students that are particularly useful to your department? For example, some physics departments benefit greatly from the active recruiting programs of their colleges.

6. Does your department play a significant role in the preparation of K–12 teachers? Describe that role and the department's interactions with the school of education (or the appropriate group within your institution).

7. Please feel free to send along other information that you believe might give us a good picture of your department and its program.

E. Site Visit Protocol

Before the Visit:

The department chair and project directors agree on terms of visit. The chair returns signed contract to the project director who is coordinating the visit.

1. The project directors select a site visiting team (SVT) and coordinate dates with the department being visited. The SVT will consist of three people, one of whom will be a member of the Task Force. The project directors will inform the chair of the membership of the SVT, coordinate travel for the visitors, and assure that the department has made appropriate hotel and meal arrangements. The project directors will check with site visitors regarding special dietary and room arrangements. Two weeks before the visit, the project directors send each member of the SVT a packet of information about SPIN-UP.
2. The department prepares answers to a questionnaire given to the chair along with the contract and sends it to the project directors at least two weeks before the scheduled visit. The project directors distribute copies of the questionnaire to members of the SVT. The department will also supply copies of catalog materials and, at its discretion, copies of recent external reviews or self-study evaluations.
3. A week before the visit, the department chair sends the project directors a schedule of activities planned for the site visit that the project director then sends to the SVT.

4. Two or three days before the visit, the SVT should schedule a conference, call, or exchange email to identify issues and questions about the department.
5. If a colloquium by one of the members of the SVT is part of the visit, the project directors will ensure that the department receives a title in a timely manner.

It is essential that the site visiting team meet as a group before starting the visit. If possible, the team should plan to arrive in late afternoon and meet in the evening. Otherwise, a breakfast meeting should be scheduled. The department chair may be invited to attend all or part of this meeting. The purpose of this meeting is to discuss the written material and prepare a strategy for finding answers to questions that arise.

During the visit (which is expected to last about one and a half days), the SVT should meet with: the chair, the coordinator of undergraduate programs, faculty in circumstances where informal discussion is possible, at least two groups of undergraduate students (both majors and nonmajors), the dean or other appropriate administrator, key departmental staff, and others selected by the department. The number of formal presentations to the team should be kept to a minimum with all necessary factual information presented in the materials sent out before the visit.

At the end of the visit, the SVT should meet in executive session to discuss their report. If it seems appropriate, the SVT may meet with the chair to summarize their findings.

F. After the Visit

The chair of the site visit team appointed by the project directors is primarily responsible for drafting the team's report to the department chair and NTFUP. The initial draft should be circulated electronically to the SVT for comment and correction and then (within three weeks of the visit) sent to the department chair for correction of factual errors. The department chair will then have one week to respond with reports of errors or omissions. The report should be in final form and submitted electronically to the SPIN-UP project directors and the department chair not more than one month after the visit. The project directors will share the report with the members of NTFUP who are asked to keep it confidential.

G. Sample Schedule

National Task Force on Undergraduate Physics
Visit to Colorado School of Mines Physics Department
October 5–6, 2000

Thursday Oct. 5

8:30: Meeting with Dept. Head (Prof. McNeil, Room 325)

Greetings/Orientation

9:00: Meeting with Pres. Trefny — Institutional perspective

10:00: Tour of department and review of data (McNeil)

11:00: Meeting with Freshman/Sophomore Physics majors (Room 347)

12:00: Lunch (Table Mountain Inn with Physics faculty)

1:30–2:30: Meeting with Junior/Senior Physics Majors (Room 347)

2:30–3:30: Meeting with half of physics faculty (Room 335)

3:30–4:30: Meeting with other half (Room 335)

7:00: Dinner (240 Union with Physics faculty)

Friday Oct. 6

8:30: Task Force team meeting (Room 335 will be available, if needed)

9:00: Meet with D. Williamson (previous Head)

10:00: Exit interview with Dept. Head (Room 325)

Appendix VI.
Formative Evaluator's Report

Developing a Framework for Creating Thriving Physics Departments:
A Report to the National Task Force on Undergraduate Physics

by

Charles R. Payne

Introduction

Over the past 10 years, the number of physics majors in university physics departments has been steadily declining. The reasons for the decline are readily apparent. According to Krane, Department of Physics, Oregon State University, the decline in undergraduate physics enrollments in the 1990s has been well documented.

> The number of baccalaureate physics degrees awarded per year in the United States dropped by about 25%, from about 5000 per year in 1990 to about 3800 per year in 1999. Simultaneously, the total number of bachelor's degrees was *increasing*, from about 1,000,000 per year to 1,200,000. During this period, the fraction of physics degrees awarded thus fell from 0.5% of total bachelor's degrees to 0.3%. Although there is perhaps evidence of a small uptick in the data for the past year or two, it is not clear that this represented a trend and even less clear that it can be sustained to reverse the decline of the past decade.

To respond to the issue of the decreasing number of physics graduates, an 11-member National Task Force on Undergraduate Physics (NTFUP) was formed in 1999 under the joint sponsorship of the American Physical Society, the American Association of Physics Teachers, and the American Institute of Physics. NTFUP is a group of physicists who are befitting of the term a "community of learners." They are well organized in that there appears to be representation from all of the major physics organizations. Among its members are two Noble Prize winners, physics department chairpersons from leading institutions, and other well-known physicists. As one would surmise, NTFUP is a very politically astute group.

The NTFUP studied how the environment has changed for undergraduate physics programs. They also investigated the constructive and innovative responses that departments have taken toward the changing environment. NTFUP operated on the assumption that the primary cause of the decline in the number of physics majors is due to the changes within the environment. They also believe that if physics departments are to thrive, then the physics community must respond to the changes. In his essay, "What Produces a Thriving Undergraduate Physics Program," Krane discussed the issues related to the decline in enrollment of undergraduate physics programs.

Although physics graduates are declining nationwide, a few physics departments can be described as thriving. At the request of the department chairs of 21 thriving departments, visitation teams consisting of three physicists were formed to visit these departments. The visits lasted on the average of one and a half days. Each team wrote a summary report of their visit. A framework for producing a thriving department was developed inductively from observations of common themes found in the reports.

A. Credibility of the Framework

The framework of a thriving department was arrived at inductively by extracting data from the reports of the 21 visitation teams. The framework is described as general characteristics, similar trends, and common themes of thriving physics departments. Although some team members visited more than one department, a total of 54 different physicists were involved in the visitations. The large number of highly trained physicists who made similar observations of thriving schools validated the reported observations and strengthened the reliability and validity of the framework.

The schools and the environments within which these thriving departments existed were very diverse. With respect to student enrollment and the number of departmental faculty members, the colleges and universities ranged from some of the smallest to some of the largest in the country. While all of the schools were recognized as quality institutions, it is salient to mention that some of these institutions were recognized as being among the country's most selective schools. The participating schools included private, public, and religious institutions as well as large urban and rural campuses. Geographical diversity was also represented in that most sections (East, Mid-west, West, Northwest, and Southwest) were represented. The Southeast was the only geographical area that was not represented. These states included Alabama, Florida, Georgia, South Carolina, Tennessee, Mississippi, and Louisiana. It is also important to reiterate that the departments that participated in the visitations were identified as being successful in increasing the number of physics majors over the past few years.

Regardless of differences between the participating schools, essentially the same practices were being implemented in all of the thriving physics departments. From observations made by reading the reports, it has been concluded that there were certain practices common to all thriving physics departments. These practices are discussed below as key elements in the framework that other departments might be able to follow when attempting to change the departmental environment to be more inviting to students.

B. Elements of the Framework for Creating a Thriving Physics Department

A total of fourteen (14) elements were derived from the review of the reports. For the purposes of this report, each of elements will be listed and discussed in turn. The evidence that supports the element will also be provided along with reviewer comments where appropriate.

Element 1: Thriving physics departments have a reputation as being first rate in the types of academic programs that are offered, the pedagogical skills of the faculty, and the nurturing environment established by the faculty.

Evidence: The departments included in the visitations were chosen because they were going against the national trend of having a decline in the number of physics majors. All reports began with a description of the high academic quality of the undergraduate physics programs.

Comments: While it should be a given, it frequently has to be stated that "quality counts" when students choose academic programs. It is often the case when an academic department wants to increase the number of students involved in its program that the immediate fear of the faculty and the public is that the standards will be compromised. Nothing could be farther from the truth with regard to programs in these reports. The students who are attracted to the physics major are high caliber and very capable of determining whether or not they are receiving a high-quality education. They are also students who want to be challenged and they recognize when they are being challenged.

Of the 21 reports, there was only one instance where some members of the physics faculty intimated that quality was being sacrificed for the sake of increasing the number of majors. In this instance some of the faculty had negatively nicknamed one of the new courses “Light Physics.”

Element 2: Thriving physics departments offer students both research opportunities and personal involvement with professors.

Evidence: All 21 physics departments indicated that they had research opportunities available for undergraduate students. While research conducted by undergraduates with the guidance of professors was strongly encouraged by all of the departments, approximately half of the departments made it a requirement. There was also a trend for departments that had not focused on undergraduate research opportunities in the past to become more active in making research opportunities for undergraduates more available.

Comments: Research opportunities were being made available in a variety of ways. For example, some of the smaller departments were encouraging their students to gain greater exposure by applying for Research Experiences for Undergraduates (REUs) at larger institutions during the summer. Other departments were beginning to fund their own research projects. All departments including those with the smallest number of faculty members offered some type of research opportunities and experiences for their undergraduate students. Quite often a senior research project was a capstone experience for undergraduate physics majors.

Element 3: Thriving physics departments have faculties whose reputations for having excellent pedagogical skills rank highly for attracting students into the major.

Evidence: It was frequently reported by visiting teams that students regularly commented on the pedagogical skills of the physics faculty. Students’ comments were generally unsolicited and compared the physics faculty with faculty members in other departments. Some departments recognized a need for a change in pedagogy through a review of physics education research (PER). Departments also reported that they began to experience growth in the number of majors when the faculty began incorporating research findings from PER into classroom instruction. One of the schools developed an elaborate system to reward excellence in instruction for both faculty and graduate teaching assistants.

Comments: It has been a long-standing belief within the educational community that learning is determined by how people are taught, and that the quality of learning for any student is directly related to the quality of instruction. Excellent instruction, therefore, must be the premise for all changes. In addition, good teaching should be recognized and rewarded.

Element 4: Thriving physics departments have professors who serve, either formally or informally, as advisors.

Evidence: It was stated directly in 10 of the 21 departmental reports that physics professors served as academic advisors. Additionally, another 10 departments implied that the physics professors served informally as academic advisors. One department employed a person with a science degree to serve as an advisor, while only two departments made no mention of an advising component for physics majors.

Element 5: Thriving physics departments have goals that are clearly stated, are well known, and understood by the faculty and staff. The departmental goals are also consistent with the goals of each respective university.

Evidence: It was either directly or indirectly stated in each of the reports that the physics departments had goals that were aligned with the universities' goals. These departmental goals were clearly stated and understood by most faculty members. Visiting teams frequently met with administrators who expressed gratitude for the efforts of the physics department faculty in corroborating the goals of the university.

Element 6: Thriving physics departments actively recruit physics majors.

Evidence: Eighteen of the 21 departments reported some type of direct recruitment of physics majors. Seven of those departments reported having direct contact with and active recruitment in high schools. Three of the most successful physics programs, however, seemed to have a limited involvement with recruiting but were successful in attracting physics majors based on academic reputation alone. However, these same programs reported fostering a strong sense of community for physics majors.

Element 7: Thriving physics departments have departmentalized the practices that have been implemented to attract students. All departmental faculty members reported embracing the efforts that were put forth by a few of its members as valuable to the entire department.

Evidence: This was especially evident from the reports of three of the most highly successful programs. The problem with the lack of departmentalization was made very clear from one example of a department that described an aggressive and successful recruitment program; however, recruitment was done only by one individual. This was particularly problematic last year when this person was on leave and only half of the usual number of students chose physics as a major.

Element 8: Thriving physics departments foster environments where personal involvement of the faculty with individual students is the rule.

Evidence: Faculty involvement with students and their availability to students were elements that were observed in 100% of the departments. According to the reports, students readily responded to these faculties and expressed appreciation for their attitudes. Visiting teams, when describing faculty and student interactions, frequently used the expressions "sense of community" and "a community of learners." As reported by four of the visiting teams, the apparent positive effect that this type of interaction had on students prompted a comment such as the following: "Why can't other departments foster such an atmosphere?"

Comments: Involvement of the faculty was carried out in a number of ways.

An informal atmosphere where faculty are friendly with each other and accepting of students as members of the physics family.

All majors have easy access to faculty and departmental administration.

Majors are made to feel like they are part of the department and the physics endeavor.

Element 9: Thriving physics departments have flexibility in the physics curriculum.

Evidence: Flexibility within the physics curriculum was found to be the rule rather than the exception. Although there are a few departments that continue to hold on to the traditional physics curriculum, the trend is toward more flexible programs. For example, a number of departments have begun to offer a Bachelor of Science degree with fewer courses than the typical Bachelor of Arts.

Comment: There was great flexibility offered in the physics curriculum, but the most common pattern was a physics major combined with one of the other sciences; however, there were some unique combinations. It also appeared as though many departments had begun to reduce the physics requirements in order to accommodate a more flexible physics major. Of course this raised the issue of the standards of courses and programs being compromised. If a program meets the professional needs of a student by offering fewer courses, then it does not inherently lower the quality of the physics program.

Element 10: Thriving physics departments have strong institutional support both financially and academically.

Evidence: According to the departments, institutional support is provided for the physics departments in a number of ways. Some examples include the following: (a) funding undergraduate research projects; (b) supporting department chairs who made crucial decisions about implementing change; (c) granting permission to hire additional faculty; (d) supporting a more flexible physics curriculum; and (e) giving general praise and appreciation for faculty of the physics departments.

Comment: When an institution depends on its faculty to make major changes without financial assistance, it runs the risk of burning out the faculty. The possibility of faculty being over worked was raised in several of the reports, particularly in smaller departments.

Element 11: Thriving physics departments have a chapter of the Society of Physics Students (SPS) and/or other similar organizations.

Evidence: Seventeen departments indicated that they had SPS chapters. Although the activity level of the chapters varied, many of the departments gave high marks to the SPS chapters for creating a nurturing environment. The chapters were also responsible for many activities such as seminars, field trips, recruiting and other social functions. Six of the departments did not have SPS chapters; however, activities similar to SPS were carried out informally.

Element 12: Thriving physics departments are committed to undergraduate physics.

Evidence: All 21 departments indicated that they have made a commitment to undergraduate physics. For some departments, making this commitment was a major step toward creating an environment that would attract more majors. Several of the departments indicated that faculty made a conscious decision not to develop graduate programs but to focus on undergraduate physics. A common theme throughout the reports with regards to undergraduate physics was as follows:

> We learned that the entire faculty is involved in discussions of the undergraduate program at the department's faculty meetings, though revisions of particular courses or the development of new courses is often done by individual faculty members or a small group of faculty.

Element 13: Thriving physics departments have faculty members who are accepting and nurturing of students.

Evidence: The idea of a nurturing environment was a major thread that seemed to help establish bonds between students and faculty. Although departments used differing terminology, each addressed creating a nurturing environment. A representative categorization of one department is as follows:

a. Undergraduate majors get keys to the building and have access to a library, a computer area, and an informal "penthouse" area with a refrigerator, microwave, etc.

b. The physics building layout has faculty offices and labs in close proximity to classrooms and instructional labs. This fortuitous geographical layout encourages students to take advantage of the "open door" policy of most of the department's faculty members.

c. The department hires many of its undergraduates as lab and recitation T.A.s, research assistants, and computer assistants.

d. The students remarked that faculty members were willing to talk to them about anything, including questions dealing with materials in courses that the faculty member was not teaching.

Comments: A nurturing climate is the energy that makes the other elements of the framework successful. The success in implementing the framework is greater than just the sum of the elements. If the framework is to be successful, then there must be a genuine conviction and belief that the elements in the framework will make a difference in increasing the number of students who choose physics as a major. As one departmental faculty member stated, "warm fuzzes are not enough."

Element 14: Thriving physics departments have strong leadership.

Evidence: Although the word leadership may not have been used specifically within each department, department chairs and other administrators made strong inferences about leadership. Strong leadership was a key factor in assisting departments in changing the environment to attract a significant number of physics majors. In the majority of departments, most people were able to identify a specific person as a leader. This gave the impression of strong leadership through the change process.

C. Additional Concerns for Creating Thriving Physics Departments

After the review of the reports, it should be noted that there were several critical issues that were not addressed. Further, it seems appropriate for these issues to be of concern to NTFUP. Specifically, three (3) issues have been identified: (1) the preparation of high school physics teachers; (2) the educational preparation of women and minorities; and (3) the departmentalization of the elements for producing thriving physics departments.

First, there was little or no mention of interest in the preparation of high school physics teachers included in the reports. Of the 21 physics departments visited, 11 reported having some type of teacher education program; however, the comments about these programs made it clear that the preparation of high school physics teachers was not a focus for most physics departments. Two of the representative comments are as follows:

> [The] physics major is a very rigorous degree program and it is very difficult for students to major in physics if they are interested in teaching at the secondary level (although an occasional physics major does go into teaching).
>
> The department also has a Physics Teaching program that attracts one student per year. In addition, a few physics graduates join the Teach for America Program each year.

After reviewing the comments about the preparation of physics teachers, it seemed questionable about whether or not the maintenance and portrayal of the academic rigors of the major was at the expense of preparing people to use physics. It is also possible that the attitude about preparing high school physics teachers manifested the fear of lowering the standards of the major. If the number of physics majors is to increase at the university level, it seems unreasonable to expect that high school physics teachers can/will be able to prepare large numbers of potential majors if physicists are unwilling to teach the necessary content. Perhaps the physics community has recognized its negligence in preparing high school physics teachers because the NTFUP is piloting a nationwide PhysTEC Program, a very noteworthy effort for preparing high school physics teachers.

Although it might be issues of commitment, encouragement, and desire to do so, it should be pointed out that some departments already have the structure for producing high school physics teachers in place. The Masters of Arts in Physics Education (MAPE) that is offered by one of the departments already serves as a model program for assisting physics teachers who are already in the field.

The MAPE degree is designed to provide middle school physical science and high school physics teachers with a strong background in physics. The degree is designed for teachers who do not have an undergraduate degree in physics.

The physics education research and teacher preparation efforts of two other departments are also notable. But overall, only a few departments are showing concern about the preparation of physics teachers.

A second issue is that there was only an occasional mention of minorities and women in the departments, obviously not a strong point of emphasis. Again there are a few schools making a special effort to address this issue. Often when the issue of minorities is mentioned, it is assumed that the main concern is an issue of civil rights. To the contrary, this concern is for the future of physics and the acceptance that the perspectives of any given academic profession cannot rest solely with only one subgroup of the population—white males.

A related concern is the consideration of the white male subgroup of our society that the majority of physics majors come from, and whether this subgroup is increasing or decreasing in respect to its interest in physics. Due to the capabilities of the students in the present targeted pool, it is probable that they are excellent students not only in physics, but in other areas as well. Consequently, they will be attracted to other areas of study as well as recruited into other fields. If in fact potential physics majors primarily come from the subgroup of white males, then it is probable and conservatively estimated that 65% of the American population is not considered to be in the pool of potential physics majors. Further, if the U.S. demographic data continue as predicted, then the relative size of the pool of majors will continue to decline.

In one sense, finding a solution for the concern of increasing the presence of minorities and women in physics is related to the issue of preparing more and better high school physics teachers. More quality physics teachers in high schools will lead more potential physics majors to universities. However, finding a workable solution to the issue will be decidedly different from the issue of just preparing teachers. There are many sociocultural factors and barriers that must be overcome. The same elements of the framework will work for women and minorities, but there must be an understanding of cultural differences. More importantly, however, genuine attitudes of acceptance will remove barriers to learning. Credit must be given to NTFUP for its quick response in arranging a meeting scheduled for the fall of 2002 to begin addressing issues of diversity.

The third concern is a lack of departmentalization of the framework elements by many physics departments. The framework must become embedded within departmental policies, and the responsibilities for implementation must be shared by all faculty members. Although the term departmentalization was not specifically used in the reports, there was concern for the sustainability of practices once key people retired. This supports the concern that the framework needs to be departmentalized.

Summary

Concerned about the decline in the number of physics majors, members of the National Task Force on Undergraduate Physics (NTFUP) conducted a study to determine the causes of the decline and to determine strategies for reversing this phenomenon. Since not all physics departments have a declining enrollment in physics majors, NTFUP identified 21 thriving departments for study. To conduct the study, teams consisting of three physicists each visited the 21 physics departments for about one and a half days of observation. Each team summarized its observations and drafted a report. All reports were then examined to ascertain if there were any common themes that could possibly serve as a framework of elements for other departments to emulate. A framework consisting of fourteen (14) elements was identified as common to all thriving departments. Based on these elements, it appears as though there are practices that other physics departments can follow to increase the enrollment of physics majors.

There were also three concerns that might influence potential physics majors which were not mentioned in the reports but should be of concern to NTFUP. These issues are the lack of interest and focus in preparing high school physics teachers from many of the departments; the lack of minority and women representation in the departments; and the lack of departmentalization of the elements for producing thriving physics departments.

NTFUP is to be commended for its ability to take action by supporting PhysTEC, a nationally piloted program to increase the number of physics teachers and improve the preparation of high school physics teachers. Plans have already been made to begin addressing issues of diversity with a meeting for the fall of 2002.

Appendix VII.
Survey Form

The survey was administered as a web-based form. The following is a text version of the form.

National Task Force on Undergraduate Physics

Project SPIN-UP: Strategic Programs for Innovations in Undergraduate Physics
Sponsored by the ExxonMobil Foundation

SURVEY OF UNDERGRADUATE PHYSICS PROGRAMS

1. Your name: ______________________________

   Your title: ______________________________

   Your institution: ______________________________

   Email: ______________________________

Physics courses and curricula

2. How many total credits (not only physics) are required to earn a bachelor's degree at your institution? __ __ __ credits

Is your academic calendar divided into (check one)

___semesters? ___quarters? ___other?

What does "one credit" typically represent at your institution?

___ One hour per week in class

___ One course for an entire academic term

___ One course for an entire academic year

___ Other (please describe)__________________________________

3. Please respond below with information about your "most rigorous" physics program. This is usually the undergraduate curriculum that requires the largest number of physics credits and is often designed for students preparing for graduate study in physics. For this survey, we will refer to this program as your "standard" physics curriculum.

Degree title (check only one that gives the closest match with your "standard" program):

___ Bachelor of Science in physics

___ Bachelor of Arts in physics

___ Bachelor's in engineering physics

___ Bachelor's in applied physics

___ Other_________________________(please describe)

3a. How many credits are required in the following areas for this "standard" physics degree?:

_____ Physics credits

_____ Mathematics credits

_____ Chemistry credits

3b. Does this degree track **require** (check as many as apply):

___a research experience? ___a thesis?

3c. Total number of graduates (in this specific "standard" degree program) in past 3 years:
_______ (graduation years 1999, 2000, 2001)

4. Indicate below **the number of credits** in each area required for your "standard" degree program described in Question 3. The total should equal the number of physics credits you entered as a value in Question 3a.

____ Introductory classical physics (including lab, if appropriate)

____ Introductory modern physics

____ Intermediate classical mechanics

____ Intermediate electromagnetism

____ Mathematical physics

____ Optics

____ Thermal and/or statistical physics

____ Quantum mechanics

____ Advanced laboratory courses (including electronics)

____ Other physics courses

5. **In addition to** the "standard" degree program described in Questions 3 and 4, which of the following alternative degree tracks do you offer? Check the tracks at left, and also indicate the required number of physics credits and the total number of graduates in that track in the past 3 years (graduation years 1999, 2000, and 2001).

Below: First column: Number of physics credits required

Second column: total number of graduates in the past 3 years

___ Bachelor of arts (only if "standard" degree is *not* B.A.)	_____	_____
___ Engineering physics	_____	_____
___ Applied physics	_____	_____
___ Physics degree for teachers	_____	_____
___ Specialized degree or concentration (e.g., geophysics, biophysics, computational physics etc.)	_____	_____
___ Combined degree (e.g., physics + math, physics + business, etc.)	_____	_____

___ Astronomy degree (if offered through a separate department check here___) _____ _____

___ Other________________________ _____ _____

__________________________ _____ _____

___ None of the above

5a. Are you planning to add any alternative degree tracks in the near future? Please describe.____

____

____

6. Does your department or program offer a minor?

__ No __ Yes, in physics __ Yes, in astronomy

6a. How many **physics** credits are required for the **physics** minor? ___ credits

6b. How many students minored in physics over the past 3 years? ___

6c. How many students minored in astronomy over the past 3 years? ___

7. Averaged over the last 3 years, approximately **how many** of your graduating seniors participated in the following activities each year:

___ Undergraduate research on campus

___ Undergraduate research off campus (such as REU or industrial internship)

___ Presented research results at local, regional, or national meeting

Recruiting physics majors

8. Which, if any, of the recruiting activities below does your department pursue? Please check all that apply:

<u>Recruiting of high school students:</u>

___ Hold annual (or more often) departmental open house for students & parents

___ Host individual prospective students and their families in the department

___ Hold summer workshops for high school students

___ Faculty or students regularly visit local schools

___ Target recruitment of students likely to major in physics

___ Target recruitment of students who are underrepresented minorities

<u>Recruiting of enrolled college students:</u>

___ Identify and recruit talented students in service courses

___ Offer “introduction to the profession” courses for first-year students

___ Group potential physics majors in special section of the introductory course

___ Actively recruit transfer students from two-year colleges

___ Other (please describe) ______________________________

8b. Please describe the recruitment activity or activities that you consider most successful in attracting majors to your department:______________________________

____

____

Interactions between physics faculty and physics majors

9. Who has **primary** responsibility for advising physics majors?

___ Several or all physics faculty members

___ One physics faculty member (other than the department chair)

___ The department chair

___ A non-faculty physics department staff member

___ University advisors outside the physics department

___ Other (please describe) ______________________

10. On average, how often do most physics majors interact with their advisor(s)?

__ Less than once per year

__ Once per year

__ Once per semester or quarter

__ Several times per semester or quarter

11. Which of the following does your department do for students? (*Check all that apply*)

__ Assign a faculty mentor to each student

__ Assign a peer mentor to each student

__ Provide dedicated undergraduate study room or lounge

__ Have an active physics club or SPS chapter

__ Provide building keys to undergraduate physics majors

__ Conduct exit interviews with graduating seniors

__ Other activities that enhance undergraduate program (*please describe*)

____

11b. Which (if any) of these activities does your department consider most effective in shaping student attitudes regarding your department? Please explain.

____

____

12. Which of the following have you used in the past year to provide career information to your undergraduates? (*check all that apply*)

___ Alumni visits to the department

___ Field trips to local industries

___ The university career services office

___ Departmental colloquia by physicists in industry

___ Career materials from the professional societies

___ Other (please explain) ________________________________

___ None of the above

12b. Which of these activities (if any) does your department find to be most useful in guiding your students' career choices?____

____

____

Alumni of the Department

13. What percentage of your alumni from the past three years have gone into the following areas?

Graduate study in physics	___ %
Graduate study in other area	___ %
Employment in technical field	___%
Employment in nontechnical field	___%
High school teaching	___%
Continued in a 3/2 engineering program	___%
Other	___%
Don't know	___%

14. What type of information does your department currently maintain on its alumni? (*Check all that apply.*)

___ Updates from past students by email or phone

___ Mailing or email addresses for students at the time they graduate

___ Information on employment or graduate school plans at time of graduation

___ Mailing list for departmental newsletter

___ Surveys of alumni

___ Other (please describe) ____

___ None of the above

Curricular reform

15. Have you made significant changes in your curriculum over the last several years?

___ Yes (*if yes, please continue to question 16*)

___ No (*if no changes were made, please skip to question 19*)

16. For each area in which changes were made, please specify whether the changes were made in content or in the way in which the courses are taught (pedagogy).

	Content	Pedagogy	Both	N/A
General education courses:	___	___	___	___
Algebra-based introductory course:	___	___	___	___
Calculus-based introductory course:	___	___	___	___
Introductory course for majors:	___	___	___	___
Upper-division courses:	___	___	___	___

17a. What motivated or prompted the curriculum changes? (e.g., threats from dean, energetic individual faculty member, external review committee, complaints from students, etc.) Please explain.

17b. What were these changes intended to accomplish? (e.g., increase introductory enrollments, increase number of majors, improve preparation of students for graduate school or careers, etc.) Please explain.

17c. What measures or indicators of success do you have for these changes? (If none, please state "none.")

18. How were the costs of these changes financed? (*Check all that apply.*)
   ___ Internal reallocation of resources within the department
   ___ University or endowment funds from outside the department
   ___ Grant(s) from private foundation(s)
   ___ Grant(s) from NSF or other federal agency
   ___ Funds or equipment from business or industry
   ___ Other (describe)____

19. What are your undergraduate program's greatest strengths?

____
____
____

20. What are your undergraduate program's greatest needs or challenges?

____
____
____
____