Final Report
Academic Program Review
Physics and Astronomy

Review Process

The Department of Physics and Astronomy prepared a self-study following program review guidelines. An external review team visited the campus, reviewed the self-study documents, interviewed unit personnel and University administrators and submitted an external review report. The Program Review Committee (PRC) read the self-study and the external review, and met with the director of the department and the Dean of Arts & Sciences. This document reflects the PRC findings and recommendations.

Self-Study

Mission

The Physics Department was created as a separate department in 1947. The first graduate (M.S.) degrees were awarded in 1969. The Department became the Department of Physics and Astronomy in 1979. The unit was last reviewed in 1991. In conjunction with the Department of Physics and Astronomy at the University of Toledo, the Ph.D. degree is now being offered in a cooperative arrangement, where the degree is granted by Toledo, but research and some instructional activities can take place here with the BGSU faculty.

The self-study reports the mission of the Department of Physics and Astronomy is to contribute to knowledge and understanding of the natural world through both teaching and research. The Department serves undergraduate students by providing general education courses and offering an undergraduate B.S. degree for students who have career aspirations in physics, astronomy, physics education, and engineering. The Department offers an M.S. and participates in a cooperative Ph.D. program at Toledo for students and scholars who wish to pursue research in physics and astronomy. The Department offers programs aimed at primary and secondary school students and the general public by means of the BGSU Planetarium and Observatory.

Finally, the self-study notes that the Department is an integral component of the interdisciplinary Center for Materials Science.

Facilities and Resources
The department is located in The Physical Sciences Laboratory Building, which opened in 1984. This facility includes the Planetarium and Observatory, both of which have revolutionized the capabilities of the astronomy instructional and research efforts. Several modern experimental laboratories were added to bolster the physics research effort. During 1987-1990, the renovation of Overman Hall was completed, bringing the Physics instructional facilities and offices up to date.

Currently, the department has seven undergraduate and graduate instructional laboratories, five research laboratories, two student computation facilities, a machine shop including a student shop, a planetarium and a rooftop observatory.

The faculty and students of the Department rely on a variety of information resources. The needs of the research program are not being met by the library holdings at BGSU, alone. The department also relies on the science and technology library holdings of the University of Toledo, and interlibrary loan. Over the past few years many journals have become available in electronic form on-line. The maintenance of a fast computer network connecting the Department to the outside world contributes to the success of the computational researchers on the staff.

**Faculty and Staff**

There are currently nine tenured and probationary faculty members in the unit: three Full Professors, three Associate Professors and three Assistant Professors. There are currently nine graduate students enrolled in the M.S. program.

The support staff comprises three full-time and one part-time classified person. The full-time staff includes a secretary for the department, a laboratory machinist, and a laboratory technician.

**Curriculum/Pedagogy**

The curriculum has concentrations in the three areas of faculty research focus: Computational physics, astronomy, and experimental materials physics.

The average number of majors over the past five years has been 15. Each undergraduate major is required to spend a semester working on a research project. The average time for completion of the B.S. degree at BGSU over the period 1994-1998 has been nearly five years. The self-study attributed this to two main factors: (1) students rarely declare themselves Physics majors in their first year; and (2) many students need to sharpen their mathematics skills before they are prepared to pursue a physics degree.

The department discourages its own undergraduate students from continuing on to the M.S. at BGSU. The department has graduated 27 students with the M.S. over the period 1994-1999. All are gainfully employed or in further graduate programs.
Assessment

For the past two years, the department has used the Force Concepts Inventory Test (FCI) in Physics 201 to assess student understanding of Newtonian force concepts. Further implementation of assessment measures is in the works.

Research Productivity

Over the past five years, the self-study reports that the Department faculty has obtained $1,109,793 in external funding or an average of $123,000 per faculty member per five years.

The publications of six current members of the department over the past five years (1995-2000) include 49 papers and 3 laboratory manuals. This total does not include one faculty’s publications prior to coming to BGSU in 1998. This total also does not reflect the research productivity of one productive member who left in 1999 and one member who arrived in spring of 2000. Two members of the department published nothing during the period.

Integration with the Wider University Community

The Department of Physics and Astronomy sees itself as occupying a key role in helping to achieve the University’s mission as the premier learning community in Ohio. As a fundamental science faculty, the Department sees itself as [1] contributing to both graduate and undergraduate instruction and learning; [2] promoting scientific research by faculty, students and other scholars; and [3] working to forge alliances with the external community through its research programs and through the outreach programs of the BGSU Planetarium and Observatory. In these ways, the Department of Physics and Astronomy sees itself as contributing to the discovery of knowledge, imparting this knowledge to students and professionals alike, encouraging an appreciation of science among the general public, and furthering of beneficial interactions with local industry.

Although the program does not produce many majors, it offers required courses in such diverse programs as pre-medicine and other allied medical professions, mathematics, technology, and communications disorders. The self-study also emphasized the importance for all citizens of the 21st Century to have at least a conceptual understanding of physics, physical processes, and the laws that govern them.

Comparative Advantages

According to the self-study, the Physics and Astronomy program at BGSU compares favorably with regional competitors. The relatively small size of the program gives students a better opportunity to perform individual research and receive personal attention. In addition, the focus on computational physics provides
students at both the undergraduate and graduate levels with an advantage in the marketplace.

**Financial and Resource Adequacy**

Physics is an equipment intensive unit. The budget for the department has not been significantly increased since 1987. Part of that budget is allocated for laboratory equipment and computer facilities. After 1997, the funding procedures for equipment and computers were changed. The OBOR Instructional Equipment allocation was placed under the control of the Vice Provost for Information and Communications and the Vice Provost for Research. All computing equipment is now supplied by ITS at no department expense. However, the bulk of the instructional equipment needs of the department are for items other than computers - oscilloscopes, digital voltmeters, and the other types of apparatus that are used in the instructional laboratories. The self-study points out that the upper division laboratories are in need of state-of-the-art equipment at an estimated cost of $200,000.

Maintenance expenses for the BGSU Planetarium and Observatory are handled through the Department operating budget. The self-study notes that both the Planetarium projector and telescope are reaching the age when they will need major refurbishment. Given that costs have increased since 1987, but the operating budget has not, the maintenance and upgrading prospects for these facilities are severely limited.

**Strengths and Weaknesses**

**Strengths**

1. The self-study reports that external funding generated by Physics and Astronomy is near the top of the list for non-Doctoral programs. This represents a dramatic rise from nearly zero in 1988.

2. As a result of the service courses that it offers, the department ranks itself within the top ten subsidy generating units of the University.

3. The Planetarium provides educational programs that serve an average of over 4,000 school children, from elementary through secondary level. In addition, an average of over 4,000 members of the general community attends the public presentations each year.

**Weaknesses**

1. The self-study concluded that the department needs to work to increase the number of undergraduate majors.

2. The average time for completion of the degree at BGSU is close to five years.
3. The average gain in understanding of Newtonian Force concepts, as measured by the FCI, is below the national norm. Steps are being taken to address this.

4. The budget is small, particularly in light of the costs of maintaining the planetarium and the equipment demands of instruction in modern physics.

**Strategic Plan**

- Increase the number of physics majors and minors.
- Reintroduce the school visitation program, cut in 1991, in order to recruit students at the pre-college level. This will entail a $5,000/year increase in the operating budget.
- Develop a Masters program in teaching for in-service secondary school teachers, in conjunction with the University of Toledo.
- Revamp the mode of presentation in the introductory service courses and bring the FCI scores up.
- Develop an inquiry-based, small-lab, group-instruction method for teaching introduction to physics (requires additional faculty).
- Provide state-of-the-art non-computing equipment and apparatus for the laboratory courses on an incremental basis, with an initial layout of $50,000 to the operating budget.
- Split the current duties of the Laboratory Machinist into two positions: Laboratory Machinist and Astronomy Technician/Artist. One new full time technical staff person required.
- Split the current duties of the Laboratory Technician (who sets up the labs and maintains the computer systems) into two positions: Laboratory Technician and Systems Technician. A second full time technical staff person is needed.
- Two new classified staff positions are needed; an upgrade of an existing half-time position is also needed.
- The availability of a new support slot every two years would allow the Department to complete the upgrade program after six years.

**Seven-Year Timetable**

**Year 1**

Develop an M.S. in physics pedagogy for in-service teachers. Hire one probationary faculty person [number 1] with a specialization in one of the core research areas of the department. Add an Astronomy/Artist classified staff person. Augment the department operating budget by $50,000 for instructional equipment and $5,000 for student recruitment.

**Year 2**

Implement an M.S. in physics pedagogy for in-service teachers. Hire a probationary faculty member [number 2] with a specialization in one of the core research areas of the department.
Year 3

Add a systems technician classified staff person. Assess the effectiveness of reducing the size of the recitation sections in the Physics 201/202 and 211/212 courses from 40 to 20.

Year 4

Hire a probationary faculty member [number 3] with a research specialization in physics pedagogy to help implement the MAT program and to teach the undergraduate inquiry-based small-lab sections.

Year 5

Move the part-time secretary up to full-time.

Year 6

Hire a probationary faculty member [number 4] with a research specialization in physics pedagogy to help implement the MAT program and to teach the undergraduate inquiry-based small-lab sections, or a faculty member in one of the three core research areas of the department.
Year 7

Assess the effectiveness of new teaching techniques: [1] the reduction of recitation sizes in 5-credit-hour introductory courses; and [2] the replacement of one credit hour of plenary lecture-demonstration time with a 20-seat simulation/self-paced exploratory session using the ideas of Physics by Inquiry.

External Review Team’s Report

In general, the review team was favorably impressed with the current status of the department and their plans for the future. The department was viewed as having made progress since the last review in 1991 despite the lack of support in terms of operating budget and staff positions to replace retirees.

Strengths

• The level of grant support of some of the faculty is excellent.
• The research efforts are concentrated in three areas: computational physics, astronomy, and materials science.
• The department is committed to improving the teaching of undergraduate physics.
• The Planetarium is a special teaching and outreach resource.
• The morale of both the undergraduate and graduate students is unusually high.
• Since the last review in 1991, the department, without increased resources, has introduced computer simulations and modeling into the classroom.
• In addition, some have taken advantage of the recommended sabbatical program; however, its effectiveness has been diluted by the large number of retirements without full replacements.

Weaknesses

• The external reviewers concluded that the department is seriously understaffed.

Neutral

• The external reviewers judged that the collaborative Ph.D. program with the University of Toledo is too new to form any judgments one way or another about its success or prospects.

External Team Recommendations

The external team made the following recommendations:

• The size of the faculty should be increased to its previous level of twelve full-time professional positions.
• An additional full-time technical staff position should be added and the department should reassign staff responsibilities accordingly.
• The department should investigate the feasibility of using student assistants for
selected support duties.

- A line item should be added to the department budget for teaching (laboratory) equipment. The target should be to make this a significant part of the department’s annual budget.
- The department is encouraged to continue the expansion of its popular courses for non-science students as a means to further science education of undergraduates. Such courses should be considered part of the core mission of the department.
- In order to facilitate the graduation of physics majors in four years, the department should establish a formal liaison with the Advising Office to insure coordination between the curriculum and advising.
- Two of the new hires should be in the area of computational physics and computer simulation. These individuals should also have demonstrated excellent teaching skills and a strong interest in pedagogy using computers in the classroom and labs. But the primary consideration should be their contribution to the research effort. The need for a modest increase in the number of faculty to a total of at least 12 FTEs is critical.
- The University is encouraged to establish an Office of Research Computing Support that will provide UNIX support for all of the science departments.
- The graduate degree with a focus on education should be an M.S. with an emphasis in pedagogy rather than an MAT.

**Program Review Committee Findings**

The PRC finds that the Department of Physics and Astronomy is making a solid contribution to the undergraduate mission at BGSU. The Department serves a large number of undergraduate students through its service courses, and it reaches a very large number of school children and the general public through the Planetarium. Furthermore, the research efforts of some of the faculty are commendable.

However, there is room for improvement in a number of areas. The PRC shares the concerns expressed in the self-study regarding the small number of majors and the long time to degree completion. We believe that it would be well worth the faculty’s effort to investigate questions such as: What attracts students to the major? What does the major prepare students to do? Are there ways to change the program to facilitate completion in four years? Could the emphasis in the major be changed (e.g. “applied physics”) in a way that would draw more students? Particularly given the competition with the University of Toledo, the Department needs to develop a distinctive niche, and develop an area in undergraduate physics in which it can excel. We emphasize the importance of developing areas that are not already strong at U.T. Perhaps the Department should develop a program that is different from the traditional line of preparation for graduate school. It may be the case that such a distinctive undergraduate program, once developed, could be linked to and invigorate the Master’s program.

The PRC is impressed with the Department’s recent efforts in assessment. The discovery that “gain scores” on the Force Concept Inventory are low is an important finding for the Department, one that clearly warrants vigorous
departmental response. In a parallel fashion, assessment efforts directed at student achievement in the major would help address issues in the previous paragraph.

The PRC finds that the research efforts of the department may be too diffuse. The Department has the nucleus of a solid research program in Astronomy. The PRC questioned whether the resources exist to sustain a viable research effort in both computational physics and materials science as well. Efforts to tighten the focus (concentrate on fewer areas of specialty) of the research mission of the Department would be advantageous.

The PRC encourages the Department’s interest in developing a program in teacher education. However, the PRC believes the plan to develop a joint (with UT) MS in physics with an emphasis on teaching physics at the secondary school level is too narrow. If the Department decides this could become a significant program, we find that partnering with other science departments at BGSU to build a broad-based program in science education would be more productive.

The self-study notes that the faculty realizes “this is an appropriate time to make significant long range plans and to set goals for the department.” Given the current budgetary constraints, the PRC felt that the department might be aiming in too many directions at once. The report indicates a desire to [1] increase the number of undergraduate majors; [2] increase the research productivity of the department; [3] develop an MAT or MS program for secondary school teachers of physics; [4] develop a joint Ph.D. program with the University of Toledo; [5] continue the excellent community outreach program in Astronomy; [6] maintain a high quality undergraduate general education program. The PRC sees a need for explicit prioritization of these departmental priorities. The outgoing Chair suggested the following prioritization, which should be discussed by the faculty as a whole: 1st: 6 & 1; 2nd: 2 & 4; 3rd: 5; and 4th: 3.

The PRC notes the lack of gender diversity of the faculty.

Program Review Committee Recommendations

1. The PRC recommends that the Department decide upon the priorities within its mission. The mission as written is too broad and unfocused to give substantive direction. This is a complex process, touching upon other recommendations that follow. The Department should consult with the Dean of Arts & Sciences as it develops these priorities, to make sure they can be supported by the College. A report summarizing the priorities of the Department should be delivered to the Dean by the end of Spring semester, 2001.

2. The PRC recommends that the Department undertake a revision of the undergraduate major. Ideas for changing the focus of the program so that it is not in direct competition with the strong undergraduate program in physics at UT are presented in the Findings. The faculty should provide a report to the Dean on their plans for developing a distinctive program for the majors by the end of Spring semester, 2001.
3. The PRC recommends that the department use the very successful Astronomy outreach program as a recruiting tool for potential students and majors. We further recommend that the department investigate the feasibility of obtaining the capital necessary to renovate and maintain the planetarium, and that the SPAR and Development offices be engaged to ascertain whether there is a possibility of external support for this project.

4. The PRC recommends that the Department vigorously pursue its efforts in assessment. This includes making changes in curriculum and pedagogy (being guided, perhaps, by studio approaches to teaching physics) aimed at improving student outcomes identified through the administration of the Force Concept Inventory. It also entails continuation of assessment of student achievement using old and new assessment means. Furthermore, given the interesting and valuable information obtained through assessment of the introductory courses, the assessment effort should be expanded to include the major and the graduate program. The PRC was not persuaded that any new lines were needed in order to implement these changes. Assessment reports should be made yearly to the Dean of the College of Arts & Sciences and the Vice Provost for Academic Programs.

5. During the fall semester, 2000, the Chair in consultation with the Dean should devise a differential teaching load system for the Department. This system should be designed to create equitable workloads, take into account that workload typically changes throughout a career, protect the career development needs of the faculty with reference to criteria for promotion and tenure, encourage only those service activities that are in the best interests of the department and University, and make efficient use of the department’s personnel resources. The new system should be implemented beginning in the fall semester, 2001.

6. The PRC felt that the research efforts of the department, while showing a marked improvement in the last 10 years, need clearer focus. Three areas of research “focus” may be too many for a department of this size. The Department should report to the Vice Provost for Research on its plans to develop its research program by the end of Spring semester, 2001.

7. The PRC endorses the department’s plan to implement an MS in pedagogy only if the department agrees that this area should receive a high priority. If it does, we recommend that this option be explored with the goal in mind of developing a broad-based curriculum in science education that would involve Chemistry, Mathematics, other departments engaged in teaching science to secondary school students, and the College of Education and Human Development.

8. Finally, the PRC recommends that, over the next three years, the department continue to work on redefining the major, continuing assessment activities and responding to information obtained thereby, and focusing their research efforts. If, at that time, they have made significant steps towards the restructuring of their program, requests for additional lines should be considered.
The Department of Physics and Astronomy should report annually to the Dean of the College of Arts & Sciences, with a copy to the Provost, on the implementation of these recommendations.