Physics Department Assessment Plan

3 April 2003

Guiding Principles and Organization of the Plan

1 The Physics Department Assessment Plan is intended to provide department faculty and staff with data that are *genuinely* useful as inputs to a continuing effort to improve our programs. To maximize the likelihood of achieving that end, all data that is obtained specifically for the purposes of our assessment program will be used exclusively for formative purposes of design and redesign, *not* for purposes of summary evaluation. (This is not, however, intended to exclude from the assessment process the use of data that is collected for other purposes including summary evaluation.)

2 Our Assessment Plan is informed above all by our commitment to meet our professional obligations to our students. Accordingly, its procedures are designed to *maximize* the usefulness of the data obtained while *minimizing* the additional burden on faculty. Doing so will help prevent the assessment process from collapsing under its own weight.

3 Our department Mission Statement identifies our primary mission and three auxiliary missions each having different client populations. For each of our client populations we enunciate a set of "Desired Outcomes" that are to be distinguished from "goals" in the same sense that the criteria for an "A" grade must be distinguished from realistic—even if *optimistic*—goals for class achievement. Nevertheless, like goals, the desired outcomes provide purpose and direction to the assessment process. Our implicit goal is always and only to improve the *extent* to which we achieve our Desired Outcomes.

4 For each of our client populations we propose a number of assessment activities. Each assessment activity is explicitly motivated by a question that we are genuinely interested in answering. We explain specifically why the question is of interest to us, how we intend to go about gathering data that will help to answer the question, and what we expect to do in response to our analysis of the data we obtain.

5 We have written *into* the Assessment Plan periodic assessments *of* the Assessment Plan to insure that the assessment activities we undertake are properly motivated by questions that continue to be relevant. We anticipate that some assessment activities will be long-term features of the plan and that others will be replaced as the questions, which drive them change.

6 Finally, we declare our view that students, faculty, staff, and administration are partners in the educational process, that each has responsibilities that are essential to the success of that process, and that program assessment will be likely to reveal deficiencies that *cannot* be remedied without good faith effort on the part of one or more of these partners. We are committed to doing *our* part to address those deficiencies that are under our control and we expect the administration—both at the local and systemwide levels—to follow through on its expressed commitment to the assessment process by doing *its* part to address those deficiencies that are under *its* control.

Mission Statement

The primary mission of the Cal Poly Pomona physics department is to provide a rigorous undergraduate education in physics in order to prepare its majors for a wide range of technical and teaching careers. In fulfilling our mission we take advantage of the enormous flexibility of physics as a liberal academic discipline and the unique strengths of the physics curriculum in promoting powerful, general, and transferable skills in analysis and problem solving.

In addition the physics department has three other missions:

- to serve the prerequisite and corequisite instructional needs of our client departments via our offerings in calculus and algebra-based introductory physics.
- to offer high quality physical science courses in service of the general education needs of Cal Poly Pomona students.
- to help prepare teachers to effectively perform physical science related instructional activities at the elementary and secondary levels.

Desired Outcomes

Client population 1: Physics majors (courses beyond the Physics 130 series)

We want the graduates of our majors program to

1 understand the fundamental principles of physics as well as their ranges of applicability and their interconnections and be able to apply those principles readily, flexibly, broadly, and efficiently in the analysis of problems in physics and related disciplines,

2 understand the complementary roles of theoretical, experimental, and computational physics and have personal experience in each area,

3 be familiar with the use of research equipment, be able to design experiments to answer specific questions, and be able to analyze experimental data with proper attention to the limitations imposed by measurement uncertainty,

4 employ advanced computational methods when necessary and appropriate,

5 communicate clearly both in writing and in speech,

6 know how to learn independently,

7 take pride in their accomplishments and feel membership in the global community of physicists, and

8 leave Cal Poly Pomona well prepared for success in their ultimate professions as well as in their personal lives.

Client population 2: Freshman physics majors and students from our client departments (algebra and calculus based introductory physics courses)

We want students in the120 and 130 series to

1 come *to* those courses properly prepared to undertake the study they involve,

2 understand the "art" of physics—i.e., that *doing* physics means building "models" of reality that are neither needlessly complex nor too simple to give reasonable

results; that *building* such models requires above all a thorough *conceptual* understanding of a relatively small number of very general principles; and that, while physics is quantitative, it is *not* primarily "about" equations,

3 be able to convert problem statements into simple models, be able to apply physical principles to the models thereby obtaining quantitative relationships between "givens" and "unknowns", be able to carry out the required calculations to obtain solutions, and know *to* and *how* to check solutions for reasonableness,

4 understand the role of experiment in scientific disciplines; understand basic principles of good experimental design and procedure; understand that all experimental data is subject to measurement uncertainty; be able to carry out simple experimental procedures with their minds engaged; and be able to analyze experimental data and make appropriate judgments about the implications of experimental results,

5 employ simple computational methods when necessary and appropriate,

6 be able to communicate their understanding of physics clearly in written form, and

7 be properly prepared for success in subsequent course work in their majors as defined by their major department (including the physics department in the case of physics majors and our client departments in the case of non physics majors.)

Client population 3: Nonscience majors (general education courses)

We want nonscience majors to

1 understand the nature of science a) as an ongoing product of human creativity rather than as a received compilation of facts, b) as an activity whose theories must be testable and *are* rigorously tested against the verdict of nature in controlled experiments, c) as a provider of always tentative and demonstrably improving theories about nature, *not* as a source of "Truth",

2 appreciate the enormous impact that advances in the scientific understanding of our world have had and continue to have on society, philosophy, and political affairs,

3 understand the basic principles of physics underlying physical processes and the operation of devices that are the product of technology, and

4 critically evaluate the scientific components of information received from news sources.

Client population 4: Preservice and in service teachers (teacher preparation and enrichment courses)

In *addition* to the desired outcomes for nonscience majors, we want students pursuing careers in primary and secondary education to

1 have adequate subject competence in the physical science content areas and at the levels that they will be expected to teach,

2 be able and eager to involve students as partners in explorations of simple physical phenomena using elementary scientific approaches whether or not they know what is likely to be found or are able to explain the findings, and

3 enjoy science so that they can pass that enjoyment on to their own students.

Assessment Activities

Client population 1: Physics majors (courses beyond the Physics 130 series)

1 Question and Concern: *Do the abilities of our graduating seniors compare favorably with those of physics students graduating from other institutions?* This is an obvious, fundamental, ongoing concern.

Method for obtaining data: Administer the MFAT (Major Field of Achievement Test) to senior physics majors.

Use of data obtained: Analysis of the results will help us determine areas of relative weakness and strength. That information, in conjunction with consideration of our particular mission will be used to focus our efforts in curricular improvement.

2 Question and Concern: *Should we develop new options in physics?* We are concerned that students' varying career goals may not be well served by our current "one size fits all" physics major. We are also concerned that we may fail to attract students who would be well served by new options. At the same time we are concerned that any new options should not make unreasonable demands on existing resources especially related to the fact that upper division courses in physics generally serve a small number of students.

Method for obtaining data: Survey non-physics majors in the physics 130 series to determine a) if they ever considered becoming a physics major, b) if so, what considerations may have made them opt against doing so. Survey graduating seniors to determine a) their career goals and b) their own perceptions of possible weaknesses in their preparation for those careers. Survey other physics departments to determine a) what alternative options they offer and b) their perceptions of the utility and success of those alternative options. Survey alumni to get their view of a) how well their physics degree has served them and b) what alternative options might have served them better.

Use of data obtained: Analysis of the results will help us determine whether there is a need for new options, what specific new options would best serve the needs of our students, and if those options could be developed and offered subject to the constraints of current or foreseeable departmental resources.

3 Question and Concern: *Would it be possible to reduce unit requirements for the physics major while maintaining an appropriate level of quality?* While we are committed to maintaining and improving the quality of our program, we are also concerned that unnecessary obstacles to graduation be eliminated. Doing so would have the additional benefit of reducing costs to the department, the college and the CSU.

Method for obtaining data: Survey other physics departments to determine current norms in undergraduate physics curricula. Survey alumni to determine their perceptions of the strengths and weaknesses in the education they received in the physics department.

Use of data obtained: Analysis of the results will help us determine whether it is possible and advisable to make adjustments in the physics curriculum that would lower the number of units required for graduation. However, we must also be open to the possibility that it will suggest precisely the opposite.

4 Question and Concern: *Do our students attain an appropriate level of facility in the use of computational methods and tools?* We are concerned that our students should leave Cal Poly Pomona with a level of computational skill that is in keeping with the expectations of other physics departments, grad schools, and employers.

Method for obtaining data: Survey students in the physics 130 series and graduating senior physics majors to determine their level of familiarity with computational tools such as programming languages, spreadsheets, graphing programs, computer algebra systems, and scientific data analysis packages. Survey alumni to get their view of the adequacy of their preparation for the use of computational tools in their professional work. Survey other departments to determine what steps they have taken to incorporate the use of and explicit *instruction* in the use of computational tools into courses in their undergraduate physics curriculum.

Use of data obtained: Analysis of the results will help us determine whether more explicit instruction in computational methods and tools should be incorporated into the curriculum.

Client population 2: Freshman physics majors and students from our client departments (algebra and calculus based introductory physics courses)

1 Question and Concern: *Do our students come to us with a level of preparation that is adequate to permit success in an introductory college level physics class?* We are concerned that precious instruction time in physics may be lost as a result of our need to address deficiencies in mathematics, critical thinking, vocabulary, etc. that ought not to exist in students who are at least minimally prepared to do college level work.

Method for obtaining data: 1) Administer a written diagnostic to incoming students in Physics 121 and 131 with questions designed to assess skills and vocabulary (in trigonometry, calculus, logic, etc.) that are relevant to success in physics. 2) Survey other CSU physics departments for related data and statements of minimal expected competencies.

Use of data obtained: The results will help us determine whether a genuine problem exists and, if so, how best to go about addressing the problem. It will also be used to develop a statement of expected minimal competencies to help faculty apply uniform standards and to help students make self-diagnoses.

2 Question and Concern: *Is the amount of work required by one unit of academic credit for physics students or by one weighted teaching unit for physics faculty in reasonable keeping with standard norms as observed in other disciplines on campus?* We suspect and are concerned that physics students and physics faculty may be subject to unreasonable workloads as a byproduct of receiving inadequate credit in terms of the units that are intended to quantify the effort involved both in

learning and teaching. Beyond basic concerns of fairness, unreasonable workloads can lead to failure on the part of students and early burnout on the part of faculty.

Method for obtaining data: 1) Administer a written survey to students to determine a) the average time they find is required to pass their lower division physics lab and lecture courses at various grade (as in "A" or "C") levels, b) the average time they find is required to pass lower division courses in other areas at the same grade levels. 2) Administer a written survey to faculty in physics to determine the nature of and time required for the activities involved in conscientiously performing their assigned teaching duties and obtain systemwide data on average teaching related workload activities.

Use of data obtained: Analysis of the results will help us determine whether or not a genuine problem exists. If it does, we would expect to require the administration's assistance in helping us find ways to mitigate the problem

3 Question and Concern: *Do our lower division courses satisfy the needs of our client departments?* We are committed to providing students with a solid foundation in physics to support later study in their chosen majors. We depend on faculty in our client departments to provide us with feedback on how well we are performing that duty just as they depend on us to keep them informed about constraints that may adversely affect our ability to perform that duty.

Method for obtaining data: Provide faculty in client departments with a detailed description of the course content in the physics 120 and/or 130 series. Consult with representatives from those departments to a) determine their priorities and areas of current concern with respect to the preparation their students and b) provide them with our view of what can reasonably be accomplished current constraints related to current unit assignments, the needs of other departments, and the preparation level of entering students. Discuss whether meeting the perceived needs of the client departments might require fewer or more assigned units of credit.

Use of data obtained: Analysis of the results will help us to determine how we might better meet the needs of our client departments subject to current course time constraints and may even help us to find ways to reduce unit requirements without sacrificing quality. It may also provide evidence that current time constraints prevent us from fully satisfying those needs.

Client population 3: Nonscience majors (general education courses)

Assessment activities in this area will be developed with the help of experience gained from the assessment activities in areas 1 and 2.

Client population 4: Preservice and in service teachers (teacher preparation and enrichment courses)

Assessment activities in this area will be developed with the help of experience gained from the assessment activities in areas 1 and 2.