CENTRAL WASHINGTON UNIVERSITY

January 9, 2010

To Whom It May Concern,

I am pleased to submit the 2009 Self-Study for the CWU Department of Physics. This self-study provides a critical review of the department's activities for the 2004-2005 through 2008-2009 academic years. The physics department made a conscious decision to conduct a thorough and in-depth self-reflection, with the recognition that documents such as this play a critical role in providing information to various entities on campus, informing decision making that ranges from campus planning of facilities to budget allocation and investment.

I would like to take this opportunity to highlight some of the physics department's major accomplishments during this review period (discussed fully in Section VII.A, Table 17). These include

- developing articulation/affiliation agreements with engineering programs within the state of Washington designed to attract a new stream of students into high-need disciplines (e.g. Appendix A, Table A.12, and Appendix N);
- continued pattern of assessing its physics curriculum and significantly improving its efficiency (e.g. Appendix A, Table A.1 – A.6);
- continuing to advance its reputation for providing high-quality undergraduate instruction (e.g. participation in the STEP, DHC, and Science Honors programs; the introduction of PHYS 106);
- physics faculty are engaged in a variety of scholarly pursuits that incorporate undergraduates into their research (e.g. Sections III.C and IV.A, Appendix Y) with all T/TT faculty currently serving as PIs or co-PIs on external grants; and
- physics faculty and staff are engaged in and lead numerous professional activities throughout campus and the community (e.g. leading workshops, professional societies, and outreach programs, some examples can be found in Appendices T, X, and AA).

These activities highlight how the physics department is central to the mission of Central Washington University. Some of the major concerns the physics department faces along with its unmet needs (with most challenges and unmet needs discussed in Sections VII.B and VII.D, Table 18, and Appendices V and Z) include:

- the decrease from 5.5 FTEF to less than 4.5 FTEF, along with losses to its goods and services budget (e.g. Appendix A, Tables A.1 through A.7, Appendices U and Z);
- the lack of research facilities and a lack resources for maintenance of instructional and research laboratory equipment and technology (e.g. Tables 14 through 20, Appendices M and Z); and
- the uncertainty in how the plan for resource allocation endorsed by the prior administration will be implemented (e.g. Appendices H, R, and Z).

The physics department looks forward to meeting with the administrative team conducting the review and President Gaudino to discuss the contents of the document and how the administration will assist the department in meeting the challenges it currently faces. We see this document as presenting a case for a SIGNIFICANT investment in the physics department and are looking forward to hearing how this will occur.

Sincerely,

Michael Jackson
Professor and Chair
Department of Physics

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Central Washington University

College of the Sciences

Department of Physics

Date:

_____	_____
Department Chair	**College Dean**

List of Sections

I. Introduction to the CWU Department of Physics

A. Department mission statement.
B. Brief description of department and program contexts including date of last review.
C. Departmental governance system and organizational chart for the physics department.
D. Department/Program(s)
    1. Department/program goals.
    2. Discussion regarding the relationship of each department/program(s) goal to the relevant college and University strategic goals along with how each relevant strategic goal for the University and college are being met within the department.
    3. Data used to measure (assess) goal attainment.
    4. The criterion of achievement (standard of mastery) for each goal.
    5. The major activities that enabled goal attainment.
E. Results for each department/program goal.
    1. Results in specific quantitative or qualitative terms for each department/program(s).
    2. Comparison of results to standards of mastery previously listed.
    3. Concise interpretation of results.
F. Description of:
    1. specific changes to the physics department as they affect program(s) (e.g., curriculum, teaching methods),
    2. specific changes related to the assessment process, and
    3. documentation of continuing program(s) need.

II. Description of degree programs and curricula

A. Undergraduate degree program listing offered in the physics department.
B. List of courses, location, and student number for the following:
    1. General Education contributions,
    2. Professional Educators contributions, and
    3. Service Course delivery.
C. Required measures of efficiency for each department for the last five years:
    1. Number of Instructional staff in department.
D. Description of the currency of curricula in discipline and how the curriculum compares to recognized standards promulgated by professionals in the discipline?
E. Effectiveness of instruction. Includes a description of how the department addresses the scholarship of teaching with specific supporting documentation including each of the following:

1. Departmental teaching effectiveness – includes a five-year history of the "teaching effectiveness" department means as reported on SEOIs, indexed to the university mean on a quarter-by-quarter basis.
2. Evidence other than Student Evaluation of Instruction (SEOI) used in the physics department to evaluate the effectiveness of instruction?
3. Effectiveness of instructional methods to produce student learning based upon programmatic goals including innovative and traditional methods.

F. Distance education technology used for instruction.

G. Assessment of programs and student learning

1. Description of student learner outcomes for each undergraduate degree program with how the outcomes are linked to department, college and university mission and goals.
2. Results for each student learning outcome.
3. Description of specific changes to the physics program as they affect student learning and the assessment process.

III. Faculty

A. Faculty profiles.
B. Faculty Vitae (see Appendix O).
C. Faculty awards for distinction: instruction, scholarship, and service.

IV. Students – For five years

A. Student accomplishments.
C. Description of departmental policies, services, initiatives, and documented results for successful student advising.
D. Description of other student services offered through the department including any professional societies or faculty-led clubs or organizations and their activities.

V. Facilities & Equipment by location

A. Description of facilities available to the physics department and their adequacy. This includes a description of anticipated needs.
B. Description of equipment available to department and its adequacy. This includes a description of anticipated needs.
C. Description of technology available to department and its adequacy. This includes a description of anticipated needs.

VI. Library and Technological Resources by location

A. Description of general and specific requirements for library resources that assist in meeting educational and research objectives. This includes ways in which the present library resources satisfy and do not satisfy these needs along with a description of anticipated needs.
B. Description of the information technologies faculty regularly and actively utilize in the classroom. This includes a description of anticipated needs.
C. Description of the technology available to the physics department and its adequacy. This includes a description of anticipated needs.

VII. Analysis of the Review Period

A. What has gone well in the department and each degree program(s)?
    1. Accomplishments of the past five years.
    2. Description of how these accomplishments been supported though external and internal resources.
B. What challenges exist for the department and for each degree program?
    1. Major challenges of the past five years.
    2. Likely causes of each challenge supported with documented evidence.
C. What past recommendations from the previous program review have been implemented?
    1. Description of how past recommendations have been implemented and how have the department and degree programs been impacted.
    2. Description of which recommendations were not implemented and why.
D. Make a comparison between the last program review and where the department is now.
    1. Description of how the advances have been supported.
    2. Description of outstanding, unmet needs/challenges from the last program review and what the physics department proposes in order to meet these challenges.

VIII. Future directions

A. Description of the physics department's aspirations for the next five years.
B. Description of the ways the physics department plans to increase quality, quantity, productivity, and efficiency as a whole and for each program.
C. Description of the specific resources the physics department needs to pursue these future directions?
D. Other information that is not included in this self-study.

IX. Suggestions for the program review process or contents of the self-study.

List of Tables in the Main Document

List of Appendices

List of Tables in the Appendices

I. Introduction to the CWU Physics Department

A. Departmental mission statement:

Physics is the study of the universe and its elements – from the interaction of subatomic particles and investigations in nanoscale science, to the motion of everyday objects, to the evolution of galaxies. Physics involves discovering the fundamental rules that describe matter and energy on every scale, hence it is the basic science that underlies all the natural sciences.

The mission of the CWU physics department is to provide high quality instruction at the undergraduate level, emphasizing the fundamental and practical nature of physics throughout its curriculum. Students at all undergraduate levels, from general education through undergraduate research courses, pursue the intellectual excitement of discovery and the widely applicable experiences of problem solving, quantitative reasoning, and scientific inquiry skills. Throughout our courses, stress is placed on careful development of key concepts and skills in a logical sequence, often using either guided or self-paced inquiry. This emphasis on concept and skill development is intended to produce the habits of independent study and self improvement essential to success after graduation.

B. General description of department that provides an overview and context for the rest of the self-study:

The CWU physics department is located in the College of the Sciences and provides course offerings in the natural sciences core curriculum of the university. The department has programmatic offerings consisting of two majors (B.S. and B.A.) and two minors (Physics and Astronomy). This includes the option of participating in the dual-degree physics/engineering program through the department's majors.

During this review period, the number of faculty members in the CWU physics department has varied significantly. Nominally, the Department has had an average of 165 Work Load Units (WLU) allocated toward the instruction of physics courses. The Student Credit Hour (SCH) production and related Departmental Data can be found in **Tables A.1** through **A.6** (in the Appendix). Nominally, these numbers correspond to:

- One full-time tenured physics faculty serving as Department Chair (with a 9 WLU teaching release)
- One full-time tenured physics faculty
- One full-time tenure-track physics faculty
- One half-time tenured physics faculty
- One full-time non-tenure-track physics faculty
- One part-time non-tenure-track physics faculty

Due to budget cuts, the instructional WLUs will be significantly different for the 2009-2010 Academic year; the Department is expected to have 139 WLUs allocated toward the instruction of physics courses (note: physics faculty also teach in the STEP and DHC programs and those courses are not reflected here).

The CWU physics department has averaged 4.4 graduates per year during the review period. This is comparable to the average number of physics degrees for Bachelor-only degree granting institutions (approximately 4.6 physics graduates per year nationally; number is from the American Institute of Physics annual survey found at http://www.aip.org/statistics/trends/archives/physrost.htm). About 80% of CWU physics students earn a B.S. and 20% earn a B.A. Table A.7 provides a comparison with Physics Departments from institutions considered to be our peers (as listed by the Office of Institutional Research at http://www.cwu.edu/~ir/peerInstitutions.php).

A strength of the CWU physics department is the versatility of its faculty members. All faculty members teach a variety of upper and lower division courses using appropriate pedagogy. Physics faculty also incorporate their research activities into the curriculum. This includes having undergraduates participate in their research activities and assisting students develop their own research projects. A unique aspect of the physics program is the undergraduate research experience that requires an external dissemination of results for all degree programs (in line with the "Best Practices" curricular models supported by the Society of Physics Students, the American Physical Society's Committee on Education, and the Council on Undergraduate Research). Research projects range from those that are purely for the benefit of the student to those that significantly advance physics and physics-related fields as evidenced by peer-reviewed publications.

During this review period, physics faculty have been heavily engaged in a variety of curricular programs outside the department that includes CWU's Science Honors program, the Science Talent Expansion Program (STEP), Project TEACH at CWU Kent Center, and the Douglas Honors College. Finally, physics faculty and students are engaged in service to the University, the profession, and the community through a variety of public outreach activities. The activities range from giving school science presentations to being local experts in physics related issues.

The Physics Department's last review was January 2005.

C. Describe departmental governance system and provide organizational chart for department.

The CWU physics department makes every decision (as appropriate) through the collaborative effort of all department employees. The department chair, elected to a four-year term, serves in a leadership role to guide the department. The faculty of the department operates as a whole unit when making decisions that affect policies, programs, and curriculum. All faculty are involved in making recommendations and decisions that affect the entire department and its programs. When the department chair is the focal point for department decisions, the chair seeks the advice, consensus, and approval of the faculty and staff on such issues. Typically, department meetings are held a minimum of four times per year (beginning fall quarter, end fall quarter, end winter quarter, and end spring quarter).

Current Physics Department Staffing

- Dr. Michael Braunstein, tenured
- Dr. Michael Jackson, tenured (hired Fall 2007, Chair: Fall 2007 – present)
- Dr. Bruce Palmquist, tenured (1/2 time position with Science Ed. Program, Chair: Fall 2004 – Spring 2007)
- Dr. Andy Piacsek, tenure-track (hired Fall 2007; prior to this, Dr. Piacsek taught part-time in the department and was Director of the Science Honors Program)
- Professor Sharon Rosell, Full-Time Non-Tenure Track
- Ms. Erin Sargent, Secretary Senior (half-time, 9 month position, hired March 2008)
- Mr. Greg Lyman, Instructional and Classroom Support Technician III (full-time, hired Summer 2008)

Other Physics Faculty and Staff during the Review Period

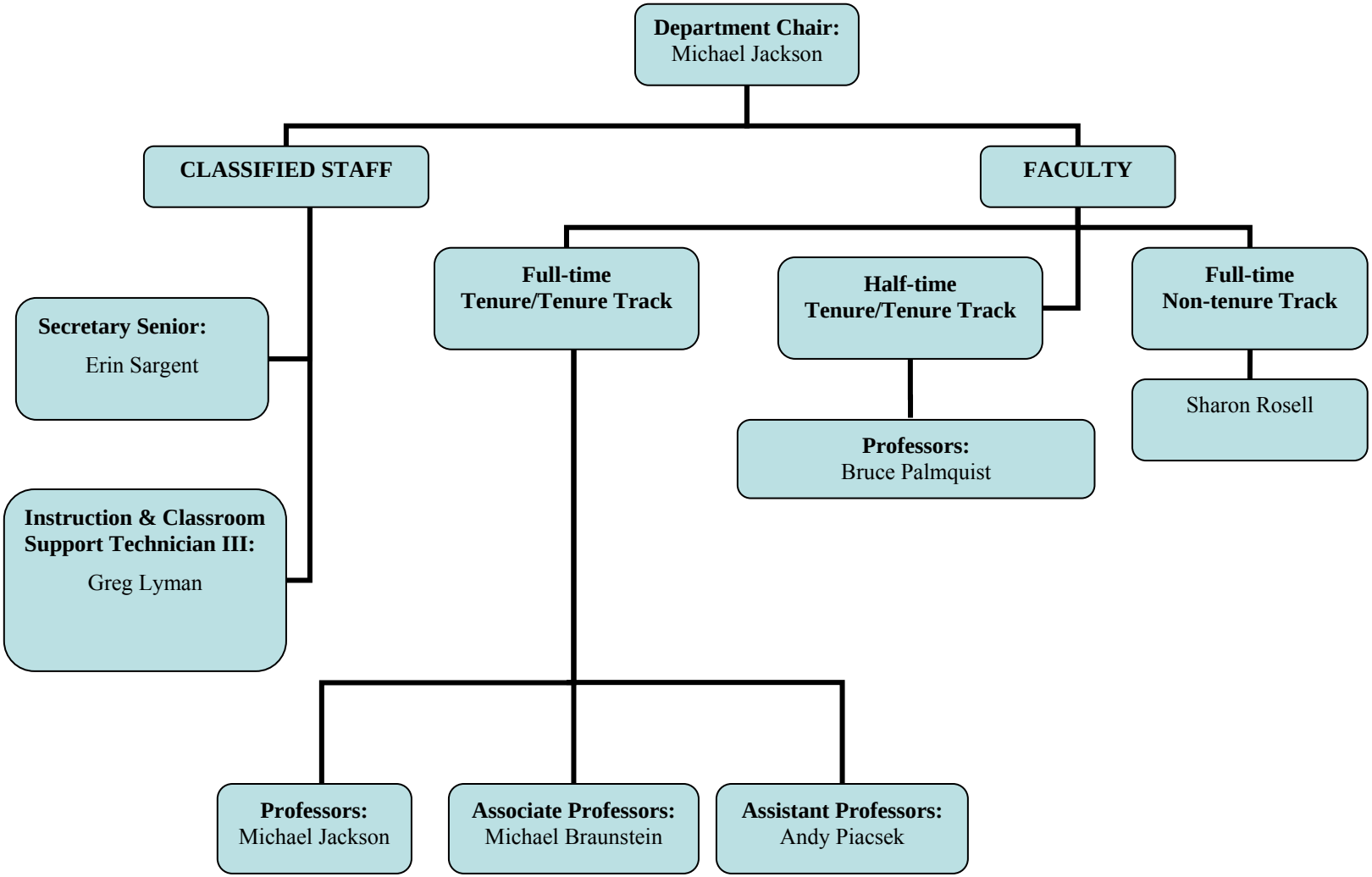
- Dr. David Laman, Tenure-track
- Dr. Ed Lulofs, Part-Time Non-Tenure Track
- Dr. Matt Pruis, Part-Time Non-Tenure Track
- Professor John St. George, Part-Time Non-Tenure Track
- Ms. Margo Alden, Secretary Senior (1/2 time, 9 month position)
- Mr. Don Williamson, Instructional and Classroom Support Technician III (full-time)

Department Committees

- Department Committee of the Whole: All faculty discuss and vote on department issues.
- Assessment Committee: All faculty discuss and vote on departmental assessment issues.

Personnel Committee

- Varies depending on the review being conducted. For example, during the 2008-2009 academic year, the department's personnel committees were
    - Dr. Andy Piacsek's Personnel Committee (tenure/reappointment): Dr. Bruce Palmquist (chair), Dr. Michael Braunstein, Dr. Jim Schwing (Computer Science).
    - Dr. Bruce Palmquist's Personnel Committee (Post-tenure): Dr. Mark Oursland (chair), Dr. Stuart Boersma, Dr. Rebecca Bowers
    - Dr. Michael Braunstein's Personnel Committee (Post-tenure): Dr. Mark Oursland (chair), Dr. Rebecca Bowers, Dr. Bruce Palmquist



Organization chart for the 2008-2009 CWU Department of Physics.

D. Department/Program(s)

1. List department/program goals (be sure to include goals for each degree program).

The goals of the Department of Physics are:

a. Promote student learning.

b. Faculty and students engage in scholarly activities.

c. Serve as a center for physics and educational services to the University, Professional Societies, and local communities.

These goals are relevant to both the B.A. and B.S. degree programs.

2. Describe the relationship of each department/program(s) goal to relevant college and University strategic goals. Explain how each relevant strategic goal(s) for the University and college are being met within the department.

Relevant College Goals

Goal I: Provide for an outstanding academic and student experience in the College of the Sciences.

All of the department's faculty are dedicated and engaging teachers that keep their course materials and professional activities up-to-date with respect to the current literature and techniques within the general physics community and their respective areas of expertise. In addition to providing CWU students with outstanding classroom teaching opportunities, physics department faculty also provide opportunities for students to become involved in research often resulting in collaborative presentations and publications. Physics Department faculty members place teaching and mentoring students as their primary role.

The curricula of physics classes challenge CWU students with a set of rigorous requirements that are at the core of not only fundamental scientific study, but all intellectual and quantitative reasoning.

Goal V: Build partnerships that support academic program quality and student experiences in the College of the Sciences, including those with private, professional, academic, government, and community-based organizations.

The department promotes and builds partnerships within the college and across the university by having many of our faculty involved with several interdisciplinary programs, including the Science Honors program, the Science Talent Expansion Program (STEP), Project TEACH at CWU Kent Center, and the Douglas Honors College.

Goal VI: Strengthen the college's contributions to the field of education.
Department faculty serve as experts in the field of Science Education. Some examples include:

- present innovative educational practices at regional/national/international meetings,
- serving on the Center for Teacher/Scholar Advisory Committee along with committees for the Center for Teaching and Learning,
- serving as external reviewers for the science-related grants and textbooks,
- serving as officers of physics-related educational professional societies,
- leading a number of externally funded workshops for educators (such as the Yakima and Wenatchee Math/Science partnerships).

Relevant University Goals

Goal I: Maintain and strengthen an outstanding academic and student life on the Ellensburg campus.
All of the department's faculty are dedicated and engaging teachers that keep their course materials and professional activities current with respect to the current literature and techniques within the general physics community and their respective areas of expertise. In addition to providing CWU students with outstanding classroom teaching opportunities, physics department faculty also provide opportunities for students to become involved in research often resulting in collaborative presentations and publications. Physics Department faculty members place teaching and mentoring students as their primary role.

The curricula of physics classes challenge CWU students with a set of rigorous requirements that are at the core of not only fundamental scientific study, but all intellectual and quantitative reasoning.

Goal IV: Build mutually beneficial partnerships with the public sector, industry, professional groups, institutions, and the communities surrounding our campuses.
The department promotes and builds partnerships with professional physicists and engineers in the private sector and other universities. This is accomplished in a variety of ways; through seminars, interactions at professional meetings, and in serving as elected leaders in a variety of professional societies (Acoustical Society of America, Council on Undergraduate Research, Society of Physics Students, Washington Section of the American Association of Physics Teachers, and the Pacific Northwest Association for College Physics).

Goal V: Achieve regional and national prominence for the university.
All of our T/TT faculty are active in their particular field of research and regularly interact with colleagues regionally and nationally in the form of presentations at meetings, publications, grants, and reviews. Our NTT faculty also regularly interact with colleagues regionally and nationally in the form of presentations at meetings and serving as officers for professional societies. These and other activities bring prestige, distinction, and recognition to the university.

3. Identify what data was used to measure (assess) goal attainment.

Goal 1: Promote student learning.

Data:

a. Sections 1, 2, and 5 of the portfolio (section 6 of older portfolios); results are tabulated in Table A.8: Evaluation of Student Portfolios.

b. Table 8: Mean values for the MRB Indices); Table 9: MFT and GPA Comparisons via the MRB Indices; Table A.9: Physics Student Academic Performance.

c. Assessment data for students enrolled in the Introductory Physics courses (e.g. PHYS 111, PHYS 181, and PHYS 183).

Section 1: apply the following concepts to analyze and interpret the physical behavior of systems of intermediate complexity: classical mechanics, modern physics, thermodynamics, optics, classical field theory, and quantum mechanics.

Section 2: apply the following mathematical tools to analyze and interpret the physical behavior of systems of intermediate complexity: integral and differential calculus, vector mathematics, vector calculus, differential equations, approximation techniques, linear algebra and eigenvalues.

Section 5 (newer portfolios): apply the following in analyzing physical systems: Experimental Techniques and Computational Techniques.

Section 6 (older portfolios): apply the following technologies to analyze the behavior of physical systems: computers, electronic, mechanical, and optical.

Goal 2: Faculty and students engage in scholarly activities.

Data:

a. Sections 6 and 7 of the portfolio (sections 7 and 8 of older portfolios); results are tabulated in Table A.8: Evaluation of Student Portfolios.
b. Table 13: Tenured and Tenure-track Faculty Profile.

Section 6: recognize, understand and value the relationship between the CWU physics curriculum and current research in physics as published in a peer-reviewed journal.

Section 7: recognize, understand, value and be able to apply the process of science.

Goal 3: Serve as a center for physics and educational services to the University, Professional Societies and local communities.

Data:

a. Section 4 of the portfolio; results are tabulated in Table A.8: Evaluation of Student Portfolios.
b. Table 13: Tenured and Tenure-track Faculty Profile.

Section 4: use physics or physics-related knowledge to contribute to their community.

4. Describe the criterion of achievement (standard of mastery) for each goal.

Goal 1: Promote student learning.

Standard of Mastery:

a. For each standard: All students meet standard.
b. Tables 8, 9, and A.9 were not developed for statistical purposes.
c. Performance of students enrolled in the introductory physics courses (e.g. PHYS 111, PHYS 181, and PHYS 183) meet or exceed normalized gains on validated assessment instruments for traditionally taught courses.

Goal 2: Faculty and students engage in scholarly activities.

Standard of Mastery:

a. For each standard: All students meet standard.
b. All T/TT faculty are engaged in scholarly activities (as determined through a variety of measures).

Goal 3: Serve as a center for physics and educational services to the University, Professional Societies and local communities.

Standard of Mastery:

a. All students meet standard.
b. All T/TT faculty are engaged in service activities (as determined through a variety of measures).

5. Describe the major activities that enabled goal attainment.

Goal 1: Promote student learning.

Activity:

a. Artifacts given in the appropriate sections of the portfolio.
b. N/A.
c. Force Concept Inventory (Fall 2007 – PHYS 111.002; Fall 2008 – PHYS 181.001; Fall 2009 – PHYS 111.001, PHYS 181.001); Conceptual Survey of Electricity and Magnetism (Spring 2009 – PHYS 183.001).

References

- David Hestenes, Malcolm Wells, and Gregg Swackhamer, "Force Concept Inventory," *The Physics Teacher*, **30**, 141-158, March (1992).
- R. R. Hake, "Interactive-engagement vs. traditional methods: A six-thousand student survey of mechanics test data for introductory physics courses," *American Journal of Physics*, **66**, 64 (1998).
- D. Maloney, T. O'Kuma, C. Hieggelke, and A. Van Heuvelen, "Surveying students' conceptual knowledge of electricity and magnetism," *American Journal of Physics*, **69**, S12 (2001).

Goal 2: Faculty and students engage in scholarly activities.

Activity:

a. Artifacts given in the appropriate sections of the portfolio.
b. Faculty engagement in scholarly activities may include peer-reviewed publications, publications in proceedings, professional presentations, seminars, grants (PI, co-PI, and submitted), and the mentoring of students in a research setting (such as in PHYS 495 – Undergraduate Research, in the STEP, Science Honors, DHC, or McNair Scholars programs, etc.).

Goal 3: Serve as a center for physics and educational services to the University, Professional Societies and local communities.

Activity:

a. Artifacts given in the appropriate sections of the portfolio.
b. Faculty engagement in service activities may include CWU and state committees; leadership positions and service in professional organizations and within the University; service to the community (such as participation in Expanding Your Horizons, Nature of Night, etc.).

E. List results for each department/program goal.

1. Provide results in specific quantitative or qualitative terms for each department/program(s).

Goal 1: Promote student learning.

Data:

a. Based on fourteen evaluated portfolios

Section 1: 13 Meets, 1 Exceeds

Section 2: 13 Meets, 1 Exceeds

Section 5 (recent portfolio version):

Experimental: 1 Fails*, 6 Meets,

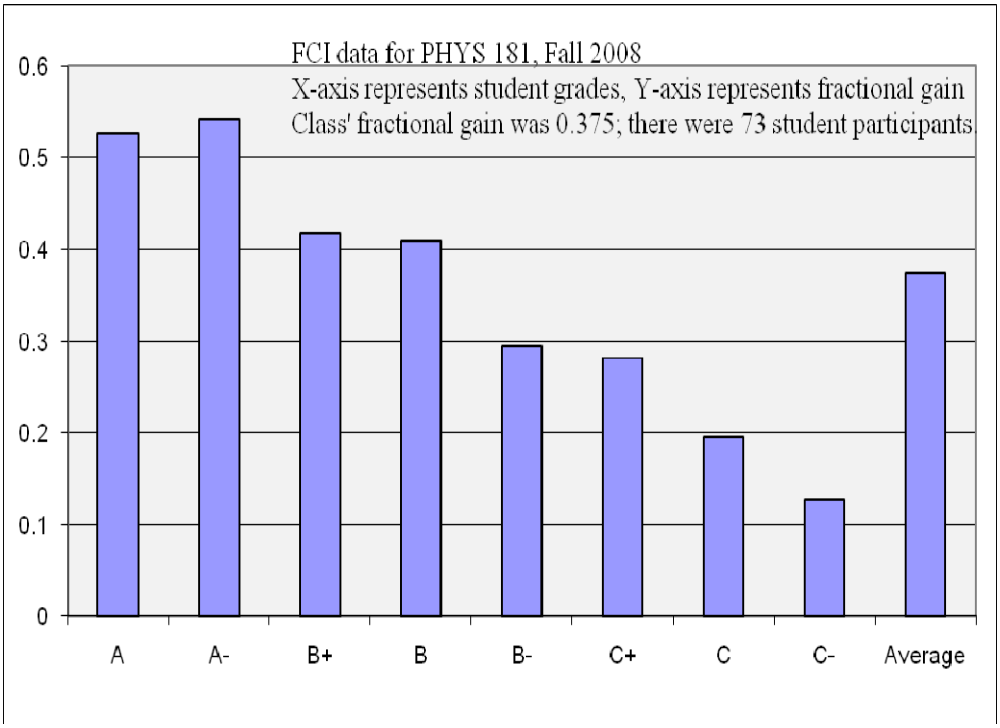
Computational: 7 Meets

Section 6 (older portfolio version): 7 Meets

*Student did not provide an artifact for this section. However, it was determined that the artifacts provided in the other sections were sufficient to ensure the Learning Objective was met.

b. N/A.

c. Only a preliminary analysis has been performed (using Fall 2008, PHYS 181.001). The course was taught in a "Traditional" format and preliminary results show a normalized gain of 0.375. For traditionally taught courses, normalized gains are about 0.25; for classes that are taught in a more interactive manner, values vary from about 0.36 to 0.68 for the normalized gain.



Goal 2: Faculty and students engage in scholarly activities.

Data:

a. Based on fourteen evaluated portfolios

Section 6 (newer version; section 7 older version): 1 Exceeds, 10 Meets, 3 Fail*

Section 7 (newer version; section 8 older version): 6 Meets, 8 Fail

*Students did not provide an artifact for this section. However, all participated in a research experience.

b. Over the review period, all T/TT faculty have been involved in scholarly activities.

Goal 3: Serve as a center for physics and educational services to the University, Professional Societies and local communities.

Data:

a. Based on fourteen evaluated portfolios

   Section 4: 4 Exceeds, 8 Meets, 1 Fails*

   *Student did not provide an artifact for this section. However, they did participate in a research experience.

b. Over the review period, all T/TT faculty have been involved in scholarly activities.

2. *Compare results to standards of mastery listed above.*

Goal 1: Promote student learning.

Standard of Mastery:

a. Standard of Mastery has been met.
b. N/A.
c. Inconclusive at this time since there is insufficient data from which conclusions can be drawn.

Goal 2: Faculty and students engage in scholarly activities.

Standard of Mastery:

a. Standard of Mastery has not been met.
b. Standard of Mastery has been met.

Goal 3: Serve as a center for physics and educational services to the University, Professional Societies and local communities.

Standard of Mastery:

a. Standard of Mastery has been met.
b. Standard of Mastery has been met.

3. *Provide a concise interpretation of results.*

   a. Preliminary evaluation via artifacts in the student portfolio indicates the vast majority of students meet the Physics Department's Content Knowledge learning objective.
   b. Via the development of the MRB index, there appears to be a moderate correlation between GPA and MFT score. Based on this, assessment of student performance in the physics curriculum as determined by GPA appears consistent with an independent measure of physics content knowledge as determined by the MFT. In all but a few cases, the "outliers" can be attributed to student idiosyncrasies (time management, class attendance, "over-achiever" vs. "under-achiever", etc.).

   Note: The MRB indices were developed to expose trends that could facilitate discussion about the physics curriculum and should not be used for detailed statistical analysis. The examination of this data is limited to determining whether the committee could understand, in the case of individual students, why there might be a lack of correspondence between their GPA and MFT score. As presented above, in all but a few cases, any significant discrepancies between GPA and MFT scores were attributed to student idiosyncrasies.

   c. Students are provided with sufficient opportunity to become involved in civic engagement.
   d. All T/TT faculty are involved in scholarly and service activities.
   e. Students need to be required to provide artifacts for their portfolios. The development of PHYS 489 has helped with this.
   f. Although this information has not been requested in this section, NTT physics faculty have also been involved in a diverse variety of scholarly and service activities such as serving as co-PI on externally funded grants, giving scholarly presentations, and serving as research mentors to undergraduates.

F. *Based on the results for each department/program(s) listed above describe:*

1. *Specific changes to your department as they affect program(s) (e.g., curriculum, teaching methods).*

   Based on the assessment performed over the review period, the physics department has implemented the following curricular changes:

   a. development of an articulation agreement with Washington State University's College of Engineering for a dual-degree physics/engineering program,

b. development of an affiliation agreement with the University of Washington's College of Engineering for a dual-degree physics/engineering program,
c. slight revision of student portfolios,
d. introduction of PHYS 489 – Senior Assessment (1 credit),
e. re-introduction of PHYS 499 - Physics Seminar (1 credit),
f. revision of curricular course offerings and requirements for the BS and BA degrees,
g. incorporating validated assessment instruments as part of the introductory course sequences, and
h. development of rubrics used to evaluate undergraduate research, student performance/involvement in outreach activities, and oral/poster presentations.

2. *Specific changes related to the assessment process.*

Please see above.

3. *Provide documentation of continuing program(s) need including reference to the statewide & regional needs assessment*

a. To improve the Department's ability to collect quality student portfolios (in particular quality artifacts), the Department is considering "Department Chair Approval" for students to graduate.
b. For the next review, the Standard of Mastery for each of the portfolio sections will move to: All students meet standard with half deemed as exceeding standard.

Future Assessment meetings will deal with:
c. Evaluation of Senior Surveys.
d. Continued evaluation of student performance on the Major Field Test.
e. Evaluation of the "Oral Presentations" and "Poster Presentations" rubrics.
f. Evaluation of data collected with the "Physics Undergraduate Research Assessment" Rubric.
g. Evaluation of assessment data obtained from the introductory course sequences.

Table 1

Updated CWU Department of Physics Assessment Plan

Department: Physics Program **Bachelor of Science (105 credits) and Bachelor of Arts (83 credits)**

Department/ Program Goals	Related College Goals	Related University Goals	Method(s) of Assessment (What is the assessment?)	Who/What Assessed (population, item)	When Assessed (term, dates)	Criterion of Achievement (Expectation of how good things should be?)
1. Promote student learning.	Goal I: Maintain and strengthen an outstanding academic and student life on the Ellensburg Campus.	Goal I: Maintain and strengthen an outstanding academic and student life on the Ellensburg Campus. Goal V: Achieve regional and national prominence for the university.	Record curriculum improvements resulting from 1. student performance on the Major Field Test, as compared with the Physics Major GPA and 2. student assessment of major program. Review syllabi and student learning objectives at department's annual assessment day at the end of the spring quarter.	Structure of major programs Course syllabi (which include learning objectives)	Review by program committees at least biennially. PHYS 489 includes MFT and student assessment of major program. Annual department assessment day.	Information is documented by the Department. Artifacts are assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard" (explained at the end of this document). Review of syllabi and learning objectives will be assessed by the Department's Assessment Committee using content recommendations from National Physics Societies.
2. Faculty and students engage in scholarly activities.	Goal I: Maintain and strengthen an outstanding academic and student life on the Ellensburg Campus.	Goal I: Maintain and strengthen an outstanding academic and student life at all sites.	Tabulate faculty supervised student participation in local symposia, such as SOURCE, or non-peer reviewed national or regional venues.	Physics department faculty and student records.	Academic year annual summary	Information is taken from student portfolios and faculty annual activity reports. Artifacts are assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard".

		Goal V: Achieve regional and national prominence for the university.	Tabulate faculty and/or faculty mentored student peer-reviewed manuscripts, conference proceedings and presentations. This includes participation at the national and regional/state level.			
3. Serve as a center for physics and educational services to the University, Professional Societies and local communities.	Goal V: Build partnerships with private, professional, academic, government, and community-based organizations. Goal VI: Strengthen the college's contributions to the field of education.	Goal IV: Build mutually beneficial partnerships with the public sector, industry, professional groups, institutions, and the communities surrounding our campuses. Goal V: Achieve regional and national prominence for the university.	Tabulate faculty and student service activities to the University, Professional Societies and the local community. For outreach programs, include audience description (who was the target audience, number in attendance, duration, etc.).	Physics department faculty and student records.	Academic year annual summary	Information is taken from student portfolios. Artifacts are assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard".

II. Description of degree programs and curricula

A. *List each degree program (undergraduate and graduate) offered in department by location, regardless of state or self support. Include minor and undergraduate certificate program(s).*

Table 2

Programs Offered in the Department of Physics

Degree Program (Specialization)	**Delivery Location(s)**	**# Students in Major**					**# Degrees Awarded**				
		2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Physics Major: BA	**Ellensburg**						**2**	**1**	**0**	**0**	**1**
Physics Major: B.S.	**Ellensburg**						**2**	**3**	**5**	**1**	**6**
Physics Major: B.S. (Engineering)	**Ellensburg**						**0**	**0**	**1**	**0**	
Pre-Engineering	**Ellensburg**						**0**	**0**	**0**	**0**	**0**
Minor Programs	**Delivery Location(s)**	**# Students in Minor**					**#Minors Completed**				
		2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Physics Minor	**Ellensburg**						**5**	**2**	**3**	**1**	**1**
Astronomy Minor	**Ellensburg**						**2**	**1**	**2**	**1**	**1**
Certificate Programs	**Delivery Location(s)**	**# Students in Program**					**# Cert. Completed**				
		2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Not Applicable											

- The "Physics Major: B.S. (Engineering)" was placed on reserve beginning the 2008-2009 academic year.
- The "Pre-Engineering" program is not a degree-granting program. The Department uses it to recruit students into the dual-degree program.

B. Provide a that lists courses, location, and student number for: 1. General Education contributions; 2. Professional Educators contributions; and 3. Service Course delivery

Table 3

The Physics Department's Contributions to the General Education program, Professional Educators program and Service Courses

Contributing area	**Delivery Location**	**# Students**				
General Education Courses	Location(s)	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
PHYS 101/101 LAB//101	Ellensburg	39/39	38/39	40/38	68/68	39/39
PHYS 102/101 LAB//101	Ellensburg	44/44	41/39	43/42	0/0	42/42
PHYS 103/103 LAB	Ellensburg	31/31	36/36	37/36	39/38	43/43
PHYS 106	Ellensburg					0
PHYS 108	Ellensburg					0
PHYS 111/111 LAB	Ellensburg	113/113	119/117	124/121	99/100	97/94
PHYS 181/181 LAB	Ellensburg	115/115	117/115	118/115	113/109	122/115
Professional Education Courses	Location(s)	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
PHYS 106	Ellensburg					0
Service Courses	Location(s)	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
PHYS 111/111 LAB	Ellensburg	113/113	119/117	124/121	99/100	97/94
PHYS 112/112 LAB	Ellensburg	81/81	70/68	70/67	80/75	78/75
PHYS 113/113 LAB	Ellensburg	76/76	73/69	61/61	72/72	73/71
PHYS 181/181 LAB	Ellensburg	115/115	117/115	118/115	113/109	122/115
PHYS 182/182 LAB	Ellensburg	56/56	72/70	62/60	59/28	47/38
PHYS 183/183 LAB	Ellensburg	32/32	38/38	47/46	40/40	39/38

- Courses were not in existence when the boxes are crossed out.
- The PHYS 101 and 102 courses were modified to become lecture/lab courses. As a result, the labs are no longer independent courses; they have been integrated into the lab. Similarly for PHYS 106 and PHYS 108.
- PHYS 106 was originally scheduled for Spring 2009; due to budget cuts, the course was rescheduled for Fall 2009.
- PHYS 108 was originally scheduled for the 2009-2010 academic year; due to budget cuts, the course will be rescheduled for a later date.
- **Table A.11** in the Appendix outlines which of the above service courses are required by degree programs on the CWU campus.

C. Required measures of efficiency for each department for the last five years

1. Number of Instructional staff in department

Table 4

Number of Institutional Staff (head-count) in the Department of Physics

	# Staff (head-count) each year				
Degree Program Instructional Staff	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Faculty FTE Tenure Track*	2.28	1.94	2.08	2.19	2.83
Faculty FTE Non-Tenure Track**	1.93	2.13	2.06	1.78	1.42
Grad Assist. FTE***	0	0	0	0	0

* Number of faculty based on FTE teaching load of 36 credit hours.
** Number of faculty based on FTE teaching load of 45 credit hours.
*** Number of graduate assistants that have assignments based on 20 hours per week work load.

Note: This table has been generated using the definitions listed above (provided by the Associate Vice President for Undergraduate Studies on November 4, 2009). The data was taken from **Table A.1**. **Tables A.1** through **A.6** in the appendix can be used to obtain a complete picture of physics department staffing during the review period.

D. Describe currency of curricula in discipline. How does the curriculum compare to recognized standards promulgated by professionals in the discipline (e.g., state, national, and professional association standards)?

Comparison of Curriculum for the Physics Major

In the 2000-2004 Self-Study, the Physics Department compared the requirements for the physics major at CWU to the programs at thirty other institutions that offer the BS in physics, have no graduate program, and graduate a number of physics majors each year similar to the number graduated by CWU (< 10). The core curricula (general physics, modern physics, analytical mechanics, electrodynamics, quantum mechanics, thermodynamics, calculus, differential equations, linear algebra) across all institutions were similar.

In 2007, the Department hired an external chair from one of the Departments considered as "thriving" by the National Task Force on Undergraduate Physics. The *Strategic Programs for Innovations In Undergraduate Physics* (SPIN-UP) project report can be found at http://www.aapt.org/Projects/ntfup.cfm). The curriculum in this "thriving" department is comparable to the current curriculum of the CWU Department of Physics (through the addition of PHYS 489 [Senior Assessment] and the offering of PHYS 363 [Optics] and PHYS 499 [Seminar] on a yearly basis).

Analysis of Major Points from *Strategic Programs for Innovations In Undergraduate Physics*

The *Strategic Programs for Innovations In Undergraduate Physics* (SPIN-UP) project report makes a number of recommendations for departments that want to maintain a thriving undergraduate physics program. We review each of these recommendations relative to the undergraduate physics program at CWU.

- Leadership for the Undergraduate Program - Collective responsibility for the undergraduate program is required. In thriving departments "faculty members agreed that the undergraduate program was everyone's responsibility". This is certainly the case at CWU, where there is only an undergraduate program.
- Mission and Vision - Departments need to articulate a mission and have a realistic vision of growth based on the department size and available resources. The recently hired Department Chair presented a plan for growth and investment in the Department. The Dean and the Provost at that time both endorsed the plan before leaving their positions (see Appendix H).
- Substantial Majority of Engaged Faculty - All faculty should be engaged in the undergraduate physics program and involved in sustaining innovations that keep the program thriving. While all CWU physics faculty are actively engaged in undergraduate physics, innovations are difficult to sustain in an environment that requires a heavy teaching load with a research program at the level of generating peer-reviewed publications.
- Administrative Support - Strong administrative support is a mark of a thriving undergraduate physics program. Departments that don't have strong support of the administration need to take steps to improve the situation. While the CWU physics department has a good working relationship with the administration, the Department has not been the recipient of a sustained investment in its program (a stark contrast to the recently hired Department Chair's experience at his

former institution). If the administration has concerns about investing in the CWU Physics Department, these concerns have never been presented.

- Supportive, Encouraging and Challenging Environment and Recruitment - The thriving department has an active recruitment program that sells the program as a challenging but rewarding course of study. While the CWU physics department has some semblance of a recruitment program it is not entirely effective. The Department sends two letters out each year (fall and winter quarters; see Appendix G) to prospective students (whose names are supplied by Admissions; how they are selected is not entirely known however). Table A.15 illustrates the effectiveness of these letters. Clearly these letters have not served as an effective recruitment mechanism. The Department has revised its recruitment letter and has begun promoting the program through high school teachers associated with the Cornerstone program. The Department has participated in open houses and campus recruitment efforts, while maintaining an updated website (Appendix P). The Physics Department has been fortunate enough to participate in the STEP program. As a result, the Department has been able to piggy-back on their recruitment program with little additional cost.
  Note: It would be beneficial to be informed of how students are recruited to different programs by the University. The Department is always willing to help but to date, we know of no specific plan that outlines how more students interested in pursuing majors in the sciences are being recruited, particularly those who are "calculus-ready" (defined in Appendix W). This information is particularly important in this budgetary landscape, where the University has decided that the only solution possible is to "grow" ourselves out of this budgetary problem. The physics department proposes a new recruitment plan that is outlined in Section VII.D.
- Advising - Thriving departments provide active advising. The CWU physics department does a good job in this respect by requiring students to develop a four-year plan when they declare a major, providing sample schedules for its programs and meeting with students on a quarterly basis.
- Career Mentoring - Thriving departments provide career path advising for their students. The CWU physics department provides sufficient career advice to its students. This is accomplished through individual advising sessions, through informal one-on-one interactions, interactions via student organizations within the Physics Department, and by discussions and presentations made in PHYS 499 (Physics Seminar).
- Introductory Physics Courses - It is suggested that introductory physics courses are a key component in undergraduate programs since it is in these courses that first contact is made with potential physics majors. It is clear that from the *Strategic Programs* study that the best departments "work very hard at making the introductory courses as good as possible." In addition, they typically assign only their "best and experienced faculty" to these courses and only rotate new faculty members into these courses after an apprenticeship period with more experienced faculty. Such a system for running the introductory physics classes at CWU would be virtually impossible due to the extremely small size of the physics department.
- Flexible Majors Program - The *Strategic Programs* study found that thriving departments "have developed a set of requirements for the major with considerable flexibility to meet the needs of students with a broad spectrum of career interests." Again, such a flexible major requiring different courses for

different career tracks would be very difficult due to the small size of the department. The department does have a track for training physics majors to be secondary school physics teachers, however this track does not train students to be industrial physicists. Some departments offer an applied physics track that is geared toward students that wish to obtain a masters degree in physics related engineering or medical discipline. Such a track would be an attractive addition to the CWU physics program, given sufficient faculty and resources to run the program. Another challenge the department faces however is how the "emphasis" or "concentration" designation for a degree is defined by the university (there is a lack of flexibility in these definitions).

- Dual-Degree Physics/Engineering Program - It has been found that dual-degree programs attract a new stream of students who would not otherwise consider a physics program. This program broadens the content knowledge base and technical skills of future engineers while generating degrees for both participating institutions. The physics department at CWU has a dual-degree program and, as Tables A.12 and A.14 show, enrollments in this program are increasing. One reason for this is greater visibility in the program through articulation agreements that help streamline the transfer process. To operate this program effectively however assistance from the university is needed. Aside from resources, the Department needs to have the articulation/affiliation agreements with the engineering institutions (see Appendix N) signed by CWU!
  As of September 21, 2009: The physics department has not received any feedback from the CWU Administration regarding the articulation agreements under consideration. The program with WSU was submitted to the COTS Office on March 11, 2009. The Department Chair was informed by the Dean the document was approved and forwarded to the AVPUS approximately one week later. Regarding the agreement with UW, a question was asked to the Registrar's Office on April 15, 2009. On May 12, 2009, the Registrar's Office mentioned some inconsistencies in general education courses (which we have not learned any more about). We also did not receive an answer to our original question since it was to be answered by the AVPUS. To date, the Department has yet to be contacted regarding these agreements. Rather than continue waiting for a response, the Physics Department has removed the portion of the agreement UW had a question about, submitting it to the COTS Office on September 21, 2009.
  On October 22, 2009: The chair of the physics department was informed by the COTS Dean (through a monthly meeting) that the CWU administration (in particular Provost Quirk and AVPUS Pellett) did not support the affiliation agreement with UW. While the administration was excited and supportive of the agreement with WSU, they were cold to the UW agreement. The primary reason cited was a lack of cooperation offered by UW through the agreement (unlike the WSU agreement). This is certainly a valid concern and was a primary concern of the physics department. However, the physics department maintains support of this affiliation agreement with UW for several reasons, which are:
    - This affiliation agreement provides a formal mechanism for the physics department to approach and talk with UW's College of Engineering (COE) and its respective departments. While the document does not guarantee any meaningful assistance, it does provide the mechanism for these discussions; if not discussions with the COE office, then with

individual faculty in an engineering department. This may eventually lead to an enhanced agreement. However, an enhanced agreement will never occur unless we adopt this initial document. This was the Department Chair's experience at his former university.

- There is strong student interest in UW and it is the students who would eventually gain the most from such an agreement. It also allows the department a way to be involved in the transfer process, ensuring the completion of portfolios, the proper substitution of course work, etc..
- From a larger perspective, the agreement illustrates how higher education institutions are working together, utilizing their various strengths and resources. The physics department believes this would be beneficial when promoting the university to alumni, legislators, and the general public.
- Another administrative concern was that the agreement would be misleading to students. This physics department completely disagrees with this concern; in fact the difference in the two agreements highlights the selling point for the program with WSU and the uncertainty in the program with UW (it also highlights the selling point of CWU over UW to prospective freshmen).
- Finally, the agreement costs nothing to CWU and the physics department only sees positive results coming from signing this agreement.

Therefore while the Department agrees with most of the administration's concerns regarding this document, it disagrees with their decision not to support the affiliation agreement. Dean Johnson has offered the physics department chair the opportunity to present this case to the Provost's Council, which will be done after the review of the Department's self-study.

Note: Although Dean Johnson mentioned the administration's support of the dual-degree articulation agreement with WSU, the CWU physics department has yet to receive any formal information on it being adopted by Central Washington University. This lack of communication is incredibly disappointing.

- Undergraduate Research - The *Strategic Programs* study found that all of the thriving departments "had thriving undergraduate research programs." The study also states "Most undergraduate research programs focus on work in the summer after the junior year and during the senior year, often culminating in a significant research thesis or report." Faculty in the physics department require their research students to make a presentation at the annual CWU undergraduate research symposium (SOURCE); several students have also had paid summer research experiences.
- Physics Clubs and Common Rooms - The *Strategic Programs* study indicates that all thriving departments have an active physics club or Society of Physics Students (SPS) chapter. Our SPS club won "Outstanding SPS Chapter" awards each year of the review period. The study also indicates that most thriving departments provide a common space for physics students (majors and service students) to interact and collaborate. The CWU physics department provides an open collaborative learning lab and resource room for its students, named for one of the founding Department faculty, Dr. Willard (Bill) Sperry.

- Informal Student/Faculty Interactions - The physics department holds a number of formal activities ranging from advising, research mentoring, and student club advising. Informal activities also include these items along with helping students with their course work outside of class and having students serve as tutors, supplemental instructors, and teaching assistants (the physics collaborative learning lab helps facilitate these interactions). More could be done though. For example, the department would like to hold informal physics seminars with students (to discuss recent advances in physics, etc.). However, due to the demands of the position, coupled with the recent budget cuts in the department, there has been a lack of time faculty have had to pursue a variety of academic pursuits.
- Alumni Relations - According to the *Strategic Programs* study, thriving physics departments keep in touch with their alumni. For the most part, the CWU physics department doesn't keep in touch with its alumni as well as it should. Graduate information is difficult to maintain due to a lack of time/resources. One way the Department has decided to address this problem has been to introduce an annual newsletter (see Appendix S). Alumni are also invited back to give seminar presentations.
- Physics Education Research - The *Strategic Programs* study indicates that thriving physics departments have some faculty members who are aware of the findings of physics education research. In this case the CWU physics department is in good shape, as we have all attended workshops on physics education and use materials generated by physics education research. One of the faculty members has a joint appointment in the university's Department of Science Education and is active in science education reform. New faculty participate in the "New Physics and Astronomy Faculty Workshop" sponsored by APS, AAPT, and AAS (via support through the National Science Foundation).

E. Effectiveness of instruction - Describe how the department addresses the scholarship of teaching with specific supporting documentation including each of the following:

1. Departmental teaching effectiveness – report a five-year history of the "teaching effectiveness" department means as reported on SEOIs, indexed to the university mean on a quarter-by-quarter basis.

Table 5

SEOI scores for "teaching effectiveness" in courses in the Department of Physics

		Form A/Form D	Form A/Form D	Form A/Form D
		Fall	**Winter**	**Spring**
2004-2005	Physics	3.7 ± 1.1 / 4.1 ± 0.9	3.9 ± 1.1 / N/A	3.9 ± 1.3 / N/A
	COTS	4.3 ± 1.0 / 4.3 ± 1.0	4.3 ± 1.0 / 4.3 ± 1.0	4.3 ± 1.0 / 4.3 ± 1.0
	CWU	4.3 ± 1.0 / 4.3 ± 1.0	4.3 ± 1.0 / 4.4 ± 0.9	4.4 ± 1.0 / 4.4 ± 0.9
2005-2006	Physics	4.1 ± 1.2 / N/A	3.9 ± 1.2 / 4.3 ± 0.8	4.2 ± 0.9 / 4.4 ± 0.8
	COTS	4.3 ± 1.0 / 4.3 ± 1.0	4.3 ± 1.0 / 4.3 ± 1.0	4.4 ± 0.9 / 4.4 ± 0.9
	CWU	4.3 ± 1.0 / 4.4 ± 0.9	4.3 ± 1.0 / 4.4 ± 0.8	4.4 ± 1.0 / 4.5 ± 0.8
2006-2007	Physics	3.5 ± 1.4 / 4.3 ± 0.9	4.2 ± 1.0 / N/A	4.2 ± 1.1 / 4.4 ± 0.9
	COTS	4.3 ± 1.0 / 4.3 ± 1.0	4.3 ± 0.9 / 4.3 ± 0.9	4.3 ± 1.0 / 4.3 ± 1.0
	CWU	4.3 ± 1.0 / 4.5 ± 0.8	4.3 ± 1.0 / 4.4 ± 0.9	4.3 ± 1.0 / 4.5 ± 0.8
2007-2008	Physics	3.7 ± 1.4 / 4.2 ± 1.0	4.1 ± 1.0 / 3.8 ± 1.2	4.2 ± 0.9 / 4.0 ± 1.0
	COTS	4.3 ± 1.0 / 4.3 ± 1.0	4.3 ± 1.0 / 4.3 ± 1.0	4.3 ± 0.9 / 4.3 ± 0.9
	CWU	4.3 ± 1.0 / 4.4 ± 0.9	4.3 ± 1.0 / 4.3 ± 0.9	4.4 ± 0.9 / 4.4 ± 0.9
2008-2009	Physics	4.4 ± 0.9 / 3.7 ± 1.0	4.1 ± 1.0 / 4.4 ± 0.9	4.5 ± 0.8 / 4.5 ± 0.9
	COTS	4.3 ± 1.0 / 4.3 ± 1.0	4.2 ± 1.0 / 4.2 ± 1.0	4.3 ± 1.0 / 4.3 ± 1.0
	CWU	4.3 ± 1.0 / 4.2 ± 1.0	4.3 ± 1.0 / 4.4 ± 0.9	4.4 ± 1.0 / 4.5 ± 0.8

Notes

- Form A is used in lecture classes while form D is used in lab classes. SEOI forms are listed in Appendix E.
- On a number of occasions, the SEOI forms had to be returned to the Department of Testing and Assessment due to a variety of errors (from incorrectly scanning the forms to mixing course sections together). Therefore the uncertainty in the SEOI scores may be slightly higher than the Standard Deviation indicates.
- Several examples illustrating the errors in the SEOI reporting are given in Appendix V.

2. *What evidence other than Student Evaluation of Instruction (SEOI) is gathered and used in the department to evaluate the effectiveness of instruction?*

The Department evaluates effectiveness of instruction in a variety of ways:

- Peer Evaluation (see form in Appendix E)
- Recognition of Faculty Accomplishments by Peers (e.g. Awards)
- Student Performance in Graduate School
- Feedback from Other Departments and Graduate Programs (see Appendix T for an example)

3. *Effectiveness of instructional methods to produce student learning based upon programmatic goals including innovative and traditional methods – examples include:*
   a. Collaborative research between student and faculty
   b. Inquiry-based, open ended learning
   c. Use of field experiences
   d. Classic lectures
   e. Lecture and inquiry based guided discussions
   f. Service learning or civic engagement
   g. Other innovative methods (e.g., online integration)

Physics faculty use a variety of teaching techniques for its lower and upper division courses including Just-In-Time Teaching, Interactive Engagement, Instructional Technology/Information Technology, Student Centered Learning, Inquiry-based Activities, and Traditional Lecture/Lab. The techniques are selected on the basis of student needs and preparation along with some consideration of best pedagogical practices. There are some pedagogical activities that physics faculty would like to apply but cannot due to time and resource availability (equipment, space, course size, etc.). Physics faculty also develop pedagogical practices and disseminate them through a variety of avenues.

It is difficult to measure instructional effectiveness. Physics faculty reflect on their SEOI scores to ascertain one measure of the effectiveness of the instructional methods used in that course. Department faculty recognize that effective teaching originated in using the best method for the intended instructional goal. In general, each physics course uses a variety of instructional strategies. We do this for three reasons.

a. Students have different learning styles. Some students learn best by hearing information. Some students learn best by seeing information. Some students learn best by discussing information with classmates. That is why physics department courses are a combination of lecture, class discussion, small group discussion, and problem solving.

b. Different sets of knowledge and skills require different teaching techniques. For example, a student doesn't learn how to use an oscilloscope via lecture. Thus, physics faculty select the best teaching technique for the desired outcome. Below is a table that summarizes the BA and BS major outcomes along with the pedagogical tools that best help students meet that outcome.

c. Faculty members have different teaching strengths. It does not make sense for someone who does an excellent job leading class discussions and developing hands-on and minds-on assignments to primarily lecture to students. Physics faculty are allowed to teach to their strengths while working to integrate other teaching techniques for the reasons stated in a. and b. above.

Table 6
Required Pedagogical Techniques for each Physics Major Outcome

Physics Major Outcome	Required Pedagogical Techniques
1. Students can apply concepts from the following areas to analyze and interpret the physical behavior of systems of intermediate complexity: modern physics, optics, thermodynamics and other physics or physics-related sequence (such as classical field theory or quantum mechanics).	Solving problems, small group discussion, and lecture.
2. Students can apply the following mathematical tools to analyze and interpret the physical behavior of systems of intermediate complexity: integral and differential calculus, vector mathematics, vector calculus, differential equations, approximation techniques, linear algebra and eigenvalues.	Solving problems, small group discussion, and lecture.
3. Students can communicate scientific ideas through both oral and written means to a scientific audience and/or the public.	Publications and theses, lab reports, and presentations.
4. Students can use physics or physics-related knowledge to contribute to their community.	Presentations and leading small group discussions.
5. Students can analyze physical systems using experimental techniques and computational techniques.	Undergraduate research, lab work (experimental and computational), and lab reports.
6. Students recognize, understand, and value the relationship between the CWU physics curriculum and current research in physics as published in a peer-reviewed journal.	Undergraduate research, lab work, lab reports, and self study.

7. Students recognize, understand, value and be able to apply the process of science.	Undergraduate research, small group discussion, lab work, and self study or directed study with faculty.
8. Students effectively utilize library and electronic information resources.	Undergraduate research, lab work, lab reports, and self study.

F. Degree to which distance education technology is used for instruction.

1. ITV

2. Online

Not applicable at this time.

G. Assessment of programs and student learning

1. List student learner outcomes for each graduate and or undergraduate degree program and note how the outcomes are linked to department, college and university mission and goals.

a. Describe the specific method used in assessing each student learning outcome. Also specify the population assessed, when the assessment took place, and the standard of mastery (criterion) against which you will compare your assessment results. If appropriate, list survey or questionnaire response rate from total population (e.g., alumni, employers served).

What SLOs were assessed?

During this review period, the Physics Department Assessment Committee has evaluated four (of the Department's six) Student Learning Outcomes (SLOs).

SLO 1 Content Knowledge: Graduates demonstrate a comprehensive knowledge base of the major areas of physics and related disciplines.
SLO 3 Intellectual Skills: Graduates demonstrate critical thinking skills.
SLO 4 Communication Skills: Graduates demonstrate an ability to communicate effectively.
SLO 5 Civic Engagement: Graduates demonstrate civic engagement.

What were the methods used to assess the SLOs?

One method for evaluating SLOs was through the Student Portfolio. For over ten years, the physics program has required students to submit a portfolio. Recently the Department added PHYS 489 (Senior Assessment) that gives the Department a mechanism for requiring quality submissions. The cover sheets for the BS portfolio and the BA portfolio can be found in Appendix E. The criteria used to assess artifacts in a student's portfolio are as follows:

Exceeds standard means the artifact: 1) clearly addresses the outcome, 2) is exceptionally well presented, 3) has no errors or the errors have been corrected or reflected upon in a written reflection, and 4) provides overwhelming evidence that the student has met the outcome.

Meets standard means the artifact: 1) clearly addresses the outcome, 2) is well presented, 3) has no distracting errors, and 4) provides sufficient evidence that the student has met the outcome.

Fails standard means the artifact: 1) does not address the outcome OR 1) is not well presented and 2) has numerous errors.

The methods and additional criteria used to assess each SLO are given below.

SLO 1

All students majoring in Physics (BS or BA) are required to take the MFT. This standardized test is an important assessment tool with which the performance of CWU physics students can be compared with physics students across the country. The results were assessed in two ways.

Method A: Within the portfolios for the BA and BS degrees, SLO 1 is assessed in part by Section 1: "Students can apply concepts from the following areas to analyze and interpret the physical behavior of systems of intermediate complexity: classical mechanics, modern physics, thermodynamics, classical field theory, and quantum mechanics."

Method B: All students majoring in Physics (BS or BA) are required to take the MFT. This standardized test is an important assessment tool with which the performance of CWU physics students can be compared with physics students across the country. It is expected that performance on the MFT should correlate with GPA for courses in the major. To quantify this relationship, the following indices are defined using the ratio of GPA to MFT score:

$$\text{MRB Index}_{\text{Intro}} = \frac{25 \times \text{Physics GPA (Intro)}}{\text{MFT Subscore (Intro)}}$$

$$\text{MRB Index}_{\text{Advanced}} = \frac{25 \times \text{Physics GPA (Advanced)}}{\text{MFT Subscore (Advanced)}}$$

$$\text{MRB Index}_{\text{Coupled - Version A}} = \frac{25 \times \left[\text{Physics GPA (Intro)} + \text{Physics GPA (Advanced)}\right]}{\left[\text{MFT Subscore (Intro)} + \text{MFT Subscore (Advanced)}\right]}$$

$$\text{MRB Index}_{\text{Coupled - Version B}} = \frac{50 \times \text{Physics GPA (overall)}}{\text{MFT Total Score}}$$

The CWU courses included in the GPA calculation for the $\text{MFT}_{\text{Intro}}$ section are PHYS 181, 182, 183, 317, 318, 342, 351, 363, 381, 382, and 383. The CWU courses included in the GPA calculation for the $\text{MFT}_{\text{Advanced}}$ section are PHYS 301, 331, 333, 334, 352, 361, 463, 474, and 475.

The MRB indices are scaled such that a student with a 4.0 GPA and a perfect MFT score would have an MRB index of 1.0. An index value larger than 1.0 indicates a higher GPA relative to the MFT score, while a value less than 1.0 indicates a higher MFT performance relative to their GPA. Because a perfect MFT score is more difficult to obtain than a 4.0 GPA, typical values of this index are likely to be greater than 1.0.

The average and standard deviation were calculated for each respective MRB index. The number of students within one, two and three standard deviations from the mean was tabulated and used for comparisons.

With baseline values established (as described above), the MRB index can be used to analyze "outliers" in the distribution (students whose index was beyond one standard deviation from the respective mean). The department assessment committee looks at the full record of "outlier" students to identify trends in student performance that may be predictors of an index significantly larger or smaller than the mean.

SLO 3

Faculty research advisors (typically through PHYS 495) evaluated students using the "Physics Undergraduate Research Assessment" form (see Appendix E). Faculty comments and student performance will eventually be evaluated by the PHYS 489 course instructor when there are sufficient numbers to draw a conclusion. Within the portfolios for the BA and BS degrees, SLO 3 is assessed in part by Section 7: "Students recognize, understand, value and be able to apply the process of science."

SLO 4

With the assistance of students in PHYS 499 (Seminar), the Department developed and adopted two rubrics for "Oral Presentations" and "Poster Presentations" (see Appendix E). These rubrics will be used to evaluate student presentations. Faculty advisors and audience participates will be asked to use these rubrics when evaluating presentations. Students in the PHYS 499 course will also use these rubrics to evaluate professional and student

presentations. Within the portfolios for the BA and BS degrees, SLO 4 is assessed in part by Section 3: "Students can communicate scientific ideas through both oral and written means to a scientific audience and/or the public."

SLO 5

Method A: Faculty supervising outreach activities evaluated students using the "Physics Undergraduate Outreach Assessment" form (see Appendix E). Faculty comments and student performance will eventually be evaluated by the PHYS 489 course instructor when there are sufficient numbers to draw a conclusion. Within the portfolios for the BA and BS degrees, SLO 5 is assessed in part by Section 4: "Students can use physics or physics-related knowledge to contribute to their community."

Method B: "Outstanding SPS Chapter" recognition of CWU SPS club activities by Zone Councilors and Associate Zone Councilors of the Society of Physics Students (SPS). The annual selection of "Outstanding SPS Chapter" recipients is based on the level of SPS chapter involvement in physics research, public science outreach efforts, SPS programs such as physics tutoring, community service, hosting and representation at physics meetings and events, and providing social interaction for chapter members.

Who was assessed?

SLO 1

- Method A: Physics majors.
- Method B: Physics majors.

SLO 3

- Physics majors.

SLO 4

- Physics majors.

SLO 5

- Method A: Physics majors.
- Method B: The CWU SPS club (predominately consisting of Physics majors). The SPS club's role in civic engagement is to assist faculty members in a variety of outreach activities.

When was it assessed?

SLO 1

- Method A: Artifacts entered into this section were from upper-division physics courses typically taken during their junior and senior years.
- Method B: GPAs are evaluated throughout the program while the MFT scores are acquired during their senior year.

SLO 3

- Senior Year.

SLO 4

- Typically Junior or Senior Years.

SLO 5

- Method A: Senior year.
- Method B: Most physics majors participate in SPS club activities during their junior and senior years.

2. *List the results for each student learning outcome.*

   a. *Provide results in specific quantitative or qualitative terms for each learning outcome.*
   b. *Compare results to standards of mastery listed above.*
   c. *Provide a concise interpretation of results.*

Evaluation of Student Portfolios can be found in Table A.8.

SLO 1

- Preliminary evaluation via artifacts in the student portfolio indicates the vast majority of students meet the Physics Department's Content Knowledge learning objective.

Table 7
Internal Assessment – Portfolio Results‡ (Department Outcome 1)

	Exceeds	Meets	Fails
Students	1	13	0
Total	(7%)	(93%)	(0%)

‡ In this review period, there were 22 graduates with 14 portfolios evaluated. Evaluation of student portfolios was performed by Dr. Bruce Palmquist.

- Table 8 lists the mean values and distributions for the MRB indices. As the Table 9 suggests, there is a moderate correlation between GPA and MFT score.

Table 8
Mean values for the MRB Indices (see Table A.9 for details)

	MRB Index Intro	MRB Index Advanced	MRB Index Coupled- A	MRB Index Coupled- B
Mean	1.80	1.77	1.74	1.07
Standard Deviation	0.49	0.49	0.37	0.14

Table 9
MFT and GPA Comparisons via the MRB Indices

Number of Students	MRB Index Intro	MRB Index Advanced	MRB Index Coupled - A	MRB Index Coupled - B
within 1 S.D.	11 (55%)	14 (70%)	15 (75%)	14 (70%)
within 2 S.D.				
above	5 (25%)	2 (10%)	3 (15%)	2 (10%)
below	4 (20%)	4 (20%)	2 (10%)	3 (15%)
within 3 S.D.	0	0	0	1 (5%)
Total	20			

Therefore assessment of student performance in the physics curriculum as determined by GPA appears consistent with an independent measure of physics content knowledge as determined by the MFT. In all but a few cases,

the "outliers" can be attributed to student idiosyncrasies (time management, class attendance, "over-achiever" vs. "under-achiever", etc.).

Note: The MRB indices were developed to expose trends that could facilitate discussion about the physics curriculum and should not be used for detailed statistical analysis. The examination of this data was limited to determining whether the committee could understand, in the case of individual students, why there might be a lack of correspondence between their GPA and MFT score. As presented above, in all but a few cases, any significant discrepancies between GPA and MFT scores were attributed to student idiosyncrasies.

One example of a "student idiosyncrasy" is when a student receives an MRB index that is 2 standard deviations above the norm. Such a student typically works very hard and gets mostly A grades because she/he actively seeks feedback and revises assignments until they are of high quality. These skills do not transfer into a 2-hour standardized test. Alternatively, some students receive an MRB index that is 2 standard deviations below the norm. Such a student is typically indifferent to their overall GPA and usually is the student who asks thoughtful, in-depth questions (either in class or as a follow-up to class).

- Despite the curricular review in PHYS 489 (Winter 2009), there was no increase in the average of the physics MFT scores for the 2008-2009 academic year. The distribution was similar to past years with scores ranging from the 90^{th} percentile on down.
- High-percentile scores of students indicate the physics content is being taught. One question is why high-percentile scores are only being achieved by a small fraction of students. Although all students were observed to take the exam seriously, several admitted they did not study for the exam (one rushed out of the exam because they needed to teach a supplemental instructor session). The course instructor also pointed out there were several problems on the MFT that were definition in nature. Therefore, the Department, as it has in the past, will not use the MFT as a sole guide to assess student content learning.
- There was also no emphasis on the MFT sample test. Question: Can we diagnose low scores/weak content knowledge areas using the MFT practice test? Next time, the PHYS 489 course instructor will cover this sample exam in weeks 1 and 2, possibly giving it as a pretest to identify areas of student misconceptions.

SLO 3

- The "Physics Undergraduate Research Assessment" Rubric, adopted at the 2008 Assessment meeting, was used during the 2008-2009 academic year. Based on faculty feedback, the committee modified the form slightly. Feedback received: advisors want to specifically address student's critical thinking skills within the

form; if students were confronted with a problem that was not necessarily framed well, were they able to find a way to overcome it and solve the problem? The data and comments collected from these rubrics will be used to assess SLO #3 at the 2010 Physics Department Assessment Meeting. This is an **Action Item** for 2009-2010 Physics Department Assessment Committee.

SLO 4

- As mentioned previously, the "Oral Presentations" and "Poster Presentations" rubrics will be used in the future to evaluate student presentations and assess this SLO.

SLO 5

- The vast majority of students have met the Department's Civic Engagement learning objective via participation in outreach activities sponsored by the physics department.

Table 10
Internal Assessment – Portfolio Results‡ (Department Goal 4 and SLO 4)

	Exceeds	Meets	Fails
Students	5	8	1
Total	(36%)	(57%)	(7%)

‡ In this review period, there were 22 graduates with 14 portfolios evaluated. Evaluation of student portfolios was performed by Dr. Bruce Palmquist.

- Students are provided with sufficient opportunity to become involved in civic engagement.
- Internal: The "Physics Undergraduate Outreach Assessment" Rubric, adopted at the 2008 Assessment meeting, was used during the 2008-2009 academic year. Department faculty found this form sufficient and no changes were recommended at this time. The Department will continue using this form to assess the performance of physics undergraduates in outreach activities. The PHYS 489 course instructor will continue to evaluate student portfolios, adding the results to the Department's database.
- External: Participation in outreach activities has been a key ingredient to the success of the Department's Society of Physics Students Chapter. The chapter was selected as an "Outstanding SPS Chapter" by the national office EACH YEAR of the self-study. CWU's Chapter has received this award thirteen times in the past sixteen years. Last year, only 58 of the almost 800 chapters in the nation received the award this past year. "Outstanding SPS Chapters" are selected by Zone Councilors and Associate Zone Councilors using criteria that includes (but is not limited to) outreach efforts to grades K-12 or the general public and

participation in community service. External recognition of the Department's efforts of bringing physics to the general public is evidence of the Department's overall efforts in promoting this particular learning objective.

3. *Based upon the results for each outcome listed above describe:*

   a. *Specific changes to your program as they affect student learning (e.g., curriculum, teaching methods.*

   b. *List specific changes related to assessment process if any.*
   **Attach an updated programmatic student outcome assessment plan for the future (i.e., next five year period) (see Sample Table 4).*

Table 11

CWU Student Learning Outcome Assessment Plan Preparation Form for the B.S. program in physics

Student Learning Outcomes (performance, knowledge, attitudes)	Related Program/ Departmental Goals	Related College Goals	Related University Goals	Method(s) of Assessment (What is the assessment?)*	Who Assessed (Students from what courses – population)**	When Assessed (term, dates) ***	Standard of Mastery/ Criterion of Achievement (How good does performance have to be?)
Content Knowledge 1. Graduates demonstrate a comprehensive knowledge base of the major areas of physics and related disciplines.	Goal 1. Promote student learning.	Goals I & II: Maintain and strengthen an outstanding academic and student life at all sites.	Goals I & II: Maintain and strengthen an outstanding academic and student life at all sites. Goal V: Achieve regional and national prominence for the university.	Direct (Major Field Test with a comparison to their GPA in specific Physics courses). Direct (GPA for first-year Physics and Mathematics sequence).	Students enrolled in PHYS 489 - Ellensburg campus. MATH 172, 173, and PHYS 181 – 183 (including labs) - Ellensburg campus (or appropriate transfer institution).	End-of-program with a comparison to their performance throughout the program (F/W/S) Middle-of-program (F/W/S)	Information is documented by the Department. Artifacts are assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard" (explained at the end of this document). Note: MFT "Introductory": PHYS 181 – 183, 317, 318, 342, 351, 363, 381, 382, 383. MFT "Advanced": PHYS 301, 331, 333, 334, 352, 361, 463, 474, 475.
Technical Skills 2. Graduates perform experimental, computational and analytical techniques in solving physics and physics-related problems.				<u>Experimental</u> Direct (Practicum and Project) <u>Computational</u> Direct (Project)	<u>Experimental</u> Students enrolled in PHYS 331 and 333 - Ellensburg campus. <u>Computational</u> Students enrolled in the computational course PHYS 361 - Ellensburg campus.	<u>Experimental</u> Middle-of-program/End-of-program (F/W/S) <u>Computational</u> Middle-of-program/End-of-program (F/W/S)	Information is taken from student portfolios. Artifacts are assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard". Feedback from the course instructor, including the grading rubric, will also be used.
Intellectual Skills 3. Graduates demonstrate critical thinking skills.	Goal 1. Promote student learning. and Goal 2. Faculty and students engage in scholarly	Goals I & II: Maintain and strengthen an outstanding academic and student life at all sites.	Goals I & II: Maintain and strengthen an outstanding academic and student life at all sites. Goal V:	Direct (Research Project)	Students enrolled in PHYS 495 - Ellensburg campus.	End-of-program (F/W/S)	Information is documented by the student and entered into their Portfolio. The artifact is assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard". Feedback from the research advisor, including the grading rubric, will also be used.

	activities.		Achieve regional and national prominence for the university.				
Communication Skills 4. Graduates demonstrate an ability to communicate scientific ideas effectively.	Goal 1. Promote student learning.	Goals I & II: Maintain and strengthen an outstanding academic and student life at all sites.	Goals I & II: Maintain and strengthen an outstanding academic and student life at all sites. Goal V: Achieve regional and national prominence for the university.	<u>Oral Communication</u> Direct (Presentation) <u>Written Communication</u> Direct (Formal Report)	<u>Oral Communication</u> Students enrolled in PHYS 495 - Ellensburg campus. <u>Written Communication</u> Students enrolled in PHYS 363 - Ellensburg campus.	<u>Oral Communication</u> End-of-program (F/W/S) <u>Written Communication</u> Middle-of-program (F/W/S)	Information is taken from student portfolios. Artifacts are assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard". Feedback from the course instructor/research advisor, including the grading rubric, will also be used. For the Written Communication, faculty use the Washington State Discipline-based writing rubric.
Civic Engagement 5. Graduates demonstrate civic engagement.				Direct (Presentation or project)	Students volunteer to assist in an outreach program sponsored by the Department. If it is not performed by senior year, then it becomes a requirement for PHYS 489.	Middle-of-program/End-of-program (F/W/S)	Information is taken from student portfolios. Artifacts are assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard". Feedback from the outreach advisor will also be used.
Life-long Learning 6. Graduates demonstrate an ability to learn new material independently from a variety of resources, to be used throughout their life.				Indirect (Survey of Alumni) Indirect (Survey of Graduates) Direct (Annotated Bibliography that is part of a report/paper).	Five year alumni survey - Ellensburg campus. Seniors applying for graduation - Ellensburg campus. Students enrolled in PHYS 495 or upper division physics course - Ellensburg campus.	Post-program (S) End-of-program (F/W/S) Middle-of-program/End-of-program (F/W/S)	Information is documented by the Department and assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard".

Table 12
CWU Student Learning Outcome Assessment Plan Preparation Form for the B.A. program in physics

Student Learning Outcomes (performance, knowledge, attitudes)	Related Program/ Departmental Goals	Related College Goals	Related University Goals	Method(s) of Assessment (What is the assessment?)*	Who Assessed (Students from what courses – population)**	When Assessed (term, dates) ***	Standard of Mastery/ Criterion of Achievement (How good does performance have to be?)
Content Knowledge 1. Graduates demonstrate a comprehensive knowledge base of the major areas of physics and related disciplines.	Goal 1. Promote student learning.	Goals I & II: Maintain and strengthen an outstanding academic and student life at all sites.	Goals I & II: Maintain and strengthen an outstanding academic and student life at all sites. Goal V: Achieve regional and national prominence for the university.	Direct (Major Field Test with a comparison to their GPA in specific Physics courses). Direct (GPA for first-year Physics and Mathematics sequence).	Students enrolled in PHYS 489 - Ellensburg campus. MATH 172, 173, and PHYS 181 – 183 (including labs) - Ellensburg campus (or appropriate transfer institution).	End-of-program with a comparison to their performance throughout the program (F/W/S) Middle-of-program (F/W/S)	Information is documented by the Department. Artifacts are assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard" (explained at the end of this document). Note: MFT "Introductory": PHYS 181 – 183, 317, 318, 342, 351, 363, 381, 382, 383, MFT "Advanced": PHYS 301, 331, 333, 334, 352, 361, 463, 474, 475
Technical Skills 2. Graduates perform experimental, computational and analytical techniques in solving physics and physics-related problems.				<u>Experimental</u> Direct (Practicum and Project) <u>Computational</u> Direct (Project)	<u>Experimental</u> Students enrolled in PHYS 331 and 333 - Ellensburg campus. <u>Computational</u> Students enrolled in the computational course PHYS 361 - Ellensburg campus.	<u>Experimental</u> Middle-of-program/End-of-program (F/W/S) <u>Computational</u> Middle-of-program/End-of-program (F/W/S)	Information is taken from student portfolios. Artifacts are assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard". Feedback from the course instructor, including the grading rubric, will also be used.
Intellectual Skills 3. Graduates demonstrate critical thinking skills.	Goal 1. Promote student learning. and Goal 2. Faculty and students engage in scholarly activities.	Goals I & II: Maintain and strengthen an outstanding academic and student life at all sites.	Goals I & II: Maintain and strengthen an outstanding academic and student life at all sites. Goal V: Achieve regional and national prominence for	Direct (Research Project)	Students enrolled in PHYS 495 - Ellensburg campus.	End-of-program (F/W/S)	Information is documented by the student and entered into their Portfolio. The artifact is assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard". Feedback from the research advisor, including the grading rubric, will also be used.

			the university.				
Communication Skills 4. Graduates demonstrate an ability to communicate scientific ideas effectively.	Goal 1. Promote student learning.	Goals I & II: Maintain and strengthen an outstanding academic and student life at all sites.	Goals I & II: Maintain and strengthen an outstanding academic and student life at all sites. Goal V: Achieve regional and national prominence for the university.	<u>Oral Communication</u> Direct (Presentation) <u>Written Communication</u> Direct (Formal Report)	<u>Oral Communication</u> Students enrolled in PHYS 495 or PHYS 492 - Ellensburg campus. <u>Written Communication</u> Students enrolled in PHYS 363 - Ellensburg campus.	<u>Oral Communication</u> End-of-program (F/W/S) <u>Written Communication</u> Middle-of-program (F/W/S)	Information is taken from student portfolios. Artifacts are assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard". Feedback from the course instructor/research advisor, including the grading rubric, will also be used. For the Written Communication, faculty use the Washington State Discipline-based writing rubric.
Civic Engagement 5. Graduates demonstrate civic engagement.				Direct (Presentation or project)	Students volunteer to assist in an outreach program sponsored by the Department. If it is not performed by senior year, then it becomes a requirement for PHYS 489.	Middle-of-program/End-of-program (F/W/S)	Information is taken from student portfolios. Artifacts are assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard". Feedback from the outreach advisor will also be used.
Life-long Learning 6. Graduates demonstrate an ability to learn new material independently from a variety of resources, to be used throughout their life.				Indirect (Survey of Alumni) Indirect (Survey of Graduates) Direct (Annotated Bibliography that is part of a report/paper).	Five year alumni survey - Ellensburg campus. Seniors applying for graduation - Ellensburg campus. Students enrolled in PHYS 495 or upper division physics course - Ellensburg campus.	Post-program (S) End-of-program (F/W/S) Middle-of-program/End-of-program (F/W/S)	Information is documented by the Department and assessed by the Department's Assessment Committee as either "Exceeds Standard", "Meets Standard" or "Fails Standard".

III. Faculty

A. Faculty profile – Using attached chart show faculty participation for mentoring student research, professional service activities, scholarly activities including grant writing and teaching? (Designate graduate or undergraduate publications or creative activities.)

Table 13
Tenured and Tenure-track Faculty Profile

	2004-2005		2005-2006		2006-2007		2007-2008		2008-2009				
	# faculty TT - T	% of faculty	# faculty TT - T	% of faculty	# faculty TT - T	% of faculty	# faculty TT - T	% of faculty	# faculty TT - T	% of faculty	**5-yr total**	Annual avg	% of faculty
*** Scholarship Measures:** ***(Use categories applicable to your departmental & college criteria)***													
(e.g. peer reviewed articles)	0	0%	1	40%	0	0%	1	29%	1	29%	3	0.6	20%
(e.g. abstracts/conference proceedings)	0	0%	0	0%	0	0%	1	29%	1	29%	2	0.4	12%
(e.g. conference presentation)	1.5	60%	0.5	20%	0.5	20%	3.5	100%	2.5	71%	8.5	1.7	54%
Other, (seminar) etc.	0.5	20%	0.5	20%	0	0%	0	0%	2.5	71%	3.5	0.7	22%
*** Grants:** ***(Use categories applicable to your departmental & college criteria)***													
External	0	0%	2	80%	0	0%	3	86%	3.5	100%	8.5	1.7	53%
Funded / Unfunded	0/0	0%/0%	0/2	0%/80%	1/0	40%/0%	3/1	86%/29%	3.5/1	100%/29%	7.5/4	1.5/0.8	45%/28%
Internal	1	40%	1	40%	0.5	20%	3.5	100%	1	29%	7	1.4	46%
Funded / Unfunded	1/0	40%/0%	1/0	40%/0%	0.5/0	20%/0%	2.5/1	72%/29%	1/0	29%/0%	6/1	1.2/0.2	40%/6%
*** Service measures:** ***(Use categories applicable to your departmental & college criteria)***													
CWU Committees	2	80%	2	80%	2	80%	3.5	100%	3.5	100%	13	2.6	88%
State Committees	0	0%	0	0%	0	0%	0	0%	0	0%	0	0	0%
Leadership & Service - Professional Organizations	1	40%	0	0%	0	0%	2	57%	3	86%	6	1.2	37%
Community Service	1.5	60%	1.5	60%	0.5	20%	2.5	71%	2.5	71%	8.5	1.7	57%
Other	2.5	100%	2.5	100%	2.5	100%	3.5	100%	3.5	100%	14.5	2.9	100%
*** Faculty Mentored Research:** ***(Use categories applicable to your departmental & college criteria)***													
Undergrad projects / SOURCE	1	40%	1	40%	2	57%	2	57%	3.5	100%	9.5	1.9	68%
Graduate Committees – Supervising thesis/projects	0	0%	0	0%	0	0%	0	0%	0	0%	0	0	0%
Graduate Committees – Participation thesis/projects	0	0%	0.5	20%	0	0%	0	0%	0	0%	0.5	0.1	4%
Other: Source Student Awards	0	0%	1	40%	0	0%	1	29%	1.5	43%	3.5	0.7	23%

A response to all four main categories is mandatory.
The details to support each category should be applicable to your department & college criteria.

Notes:

- For multi-year grants, a grant was listed for each year it was active.
- NTT faculty have also participated on grants (e.g. NSF-STEP), as undergraduate research and curricular advisors, presenting scholarly talks and seminars, participating on CWU committees, taking leadership positions in professional organizations, and participating in outreach activities and other professional service activities to the community.
- Dr. David Laman was a tenure-track faculty member in the CWU physics department through the 2006-2007 academic year. Since his time at CWU was prior to the implementation of activity reports, some information may be missing.
- The last three columns were determined as follows:
  - The "5-yr total" column was obtained by adding the *# of faculty (TT-T)* column that participated in the activity.
  - The "Annual avg" column was found by dividing the "5-yr total" column by 5.
  - The "% of faculty" column was found by adding the respective individual *% of faculty* columns and averaging.

B. *Copies of all faculty vitae.*

See Appendix O.

C. *Faculty awards for distinction: instruction, scholarship, and service*

Faculty Awards for Instruction

- Bruce Palmquist, Crystal Apple Award, CWU Professional Education Advisory Board for Teacher Preparation, 2009.
- Bruce Palmquist, **2005 Washington Professor of the Year**, Carnegie Foundation and Council for Advancement and Support of Education 2005.

Faculty Awards for Scholarship

- Michael Braunstein, Undergraduate Research Faculty Mentor Award, SOURCE, Central Washington University, 2006.

Faculty Awards for Service

- Michael Jackson, "Volunteer of the Year" Award, Council on Undergraduate Research, 2009

D. *Include in appendices performance standards by department, college and university.*

See Appendices I, J, and K.

IV. Students – For five years

A. Student accomplishments (include SOURCE, career placement information, etc.). List students working in field; students placed in master's or doctoral programs.

Presentations (External and Internal)

Oral Presentations

- Kevin Ewell, "A computational study of tsunami run up as a function of coastline morphology," SOURCE 2009 [Advisor: Andy Piacsek].
- Adam Houk, "Scattering of Plane Light Waves," SOURCE 2009 [Advisor: Mike Braunstein].
- Marilyn Magenis, "Binary Stars and Their Light Curves: Using Models to Determine the Sensitivity of CWU Equipment," SOURCE 2009 [Advisor: Mike Braunstein].
- Travis Petersen, "Frequencies and Wavelengths From a New Far-Infrared Lasing Gas: $^{13}CHD_2OH$," SOURCE 2009 [Advisor: Mike Jackson].
- Peter Wojick, "Earthquake Studies," PHYS 499 – Physics Seminar, May 2009 [Advisor: Tim Melborne].

- Sami Abdul-Wahid, "Electronic Realization of the Logistic Map," SOURCE 2008 [Advisor: Mike Braunstein].
- Eric Kangas, "Differential Photometry on SV Camelopardalis," SOURCE 2008 [Advisor: Mike Braunstein].
- Evan Masters, "Comparing Two Methods of Acquiring and Analyzing a Single Slit Diffraction Pattern," SOURCE 2008 [Advisors: Mike Jackson and Mike Braunstein].
- Travis Petersen, "Investigation into the Characteristics and Procedures of Numerical Calculation for the Lyapunov Exponent," SOURCE 2008 [Advisor: Mike Braunstein].

- Eric Kangas, "Laser Induced Bubble Formation in Salt Solutions," SOURCE 2007 [Advisor: David Laman].
- Taylor Kendall, "Blackbody Matching with a RGB LED for Star Classification," SOURCE 2007 [Advisor: Mike Braunstein].
- James Mullen, "Triplet Decay Rates in Poly(3-octylthiophene)," SOURCE 2007 [Advisor: David Laman].
- Blaze Ruud, "How to Unlock a Locking Carabiner," SOURCE 2007 [Advisor: David Laman].
- CWU SPS (Taylor Kendall, Travis Petersen, Chris Parker, Eric Kangas, David Cross, James Mullen, Colin Morton, Sami Abdul-Wahid, Erik Bakke), "Electronic Realization of Chaotic Systems," SOURCE 2007 [Advisors: Mike Braunstein and Sharon Rosell].
- Ian Wright, "Interactive Java Physics Simulations," SOURCE 2007 [Advisor: Andy Piacsek]; and was co-author of "Development of interactive Java-based computer simulations of acoustics phenomena as an educational tool" presentation at 153rd meeting of the Acoustical Society of America (June, 2007).

- David Cross, "The effect of pulse duration on laser-induced damage by 1053-nm light in potassium dihydrogen phosphate crystals," SOURCE 2006 [Advisors: Mike Braunstein and C. W. Carr (CWU Alumnus)].
- Taylor Kendall and David Cross, "Use of a Small Volume Sodium Iodide Detector for Observation of Cosmic Rays," SOURCE 2006 [Advisor: Mike Braunstein].
- Travis Petersen, "Predicted Environmental Noise Impact of the Proposed Kittitas Wind Power Project," SOURCE 2006 [Advisor: Andy Piacsek].
- Anthony Smith, "Elastic and Vibrational Properties of a Regular Tensegrity Structure," SOURCE 2006 [Advisor: Andy Piacsek] and presented at the 151st meeting of the Acoustical Society of America (June, 2006).

Poster Presentations

- Jeff Leiseth, "Operating Characteristics and Research Applications of the Carbon Dioxide Laser," SOURCE 2009 [Advisor: Mike Jackson].
- William Sizemore, "Using the Force Concept Inventory to Improve Student Understanding of Frictional Forces," SOURCE 2009 [Advisors: Bruce Palmquist and Mike Jackson].

- Travis Petersen, Eric Kangas, Chris Parker, Evan Masters, Erik Bakke, Sami Abdul-Wahid, and Jeff Leiseth, "Electronic Realization of Chaotic Systems," SOURCE 2008 [Advisor: Mike Braunstein].
- Chris Parker, Jeff Leiseth, Mike Braunstein, Sharon Rosell, Travis Petersen, Evan Masters, and Eric Kangas, "Electronic Realization of Chaotic Systems," 10th Annual Meeting of the Northwest Section of APS, May (2008).

Grants and Scholarships

- CWU Alumni Award
    a. Travis Petersen, October 2008.
    b. Chris Parker, October 2007.
- Travis Petersen, "Discovery and Frequency Measurement of Far-Infrared Laser Emissions From Optically Pumped $^{13}CHD_2OH$," Undergraduate Research Fellowship program, funded for $500 (2008-2009).
- Travis Petersen was the recipient of a Leadership Scholarship ($2,000) from the Society of Physics Students (SPS) (2008).
- Kevin Ewell, "Numerical modeling of tsunami propagation and run-up," CWU Science Honors Program, $9,000 [Advisor: Andy Piacsek] (2008).
- Travis Petersen, "Discovery and Frequency Measurement of Far-Infrared Laser Emissions From Optically Pumped $^{13}CHD_2OH$," CWU Science Honors Program, $9,000 [Advisor: Mike Jackson] (2008).
- SPS Research Award "Electronic Realization of Chaotic Systems," Advisors: Mike Braunstein and Sharon Rosell] (2007).

Publications and theses

- Kevin Ewell, "A computational study of tsunami run up as a function of coastline morphology," Science Honors Thesis, June 2009 [Advisor: Andy Piacsek].

- Travis Petersen, "Frequencies and Wavelengths From a New Far-Infrared Lasing Gas: $^{13}CHD_2OH$," Science Honors Thesis, June 2009 [Advisor: Mike Jackson].
- James Mullen, "Triplet-Triplet annihilation in isolated conjugated polymer chains," Science Honors Thesis, June 2007 [Advisor: David Laman].
- Anthony Smith, "Wave propagation through a tensegrity structure," Science Honors Thesis, June 2006 [Advisor: Andy Piacsek].

- M. Jackson, Travis Petersen, Lyndon Zink, "Frequencies and Wavelengths From a New Far-Infrared Lasing Gas: $^{13}CHD_2OH$" in the *IEEE Journal of Quantum Electronics*, vol. **45**, pgs. 830-832 (2009).
- David A. Cross, M. R. Braunstein, Christopher W. Carr, "The effect of pulse duration on laser induced damage by 1053 nm light in potassium dihydrogen phosphate," Boulder Damage Symposium XXXVIII, SPIE (2006).

Graduate School and Employment

- Adam Houk (August 2009), Ph.D. program in physics at Texas Tech University; received teaching assistantship (approximately $16,000 per year) and a partial-tuition waiver.
- Travis Petersen (June 2009), Ph.D. program in Optics at the Institute of Optics, University of Rochester; received a full-tuition waiver (approximately $35,000 per year) and research fellowship (approximately $27,000 per year).
- Peter Wojcik (June 2009), Ph.D. program in applied physics at Oregon State University; received teaching assistantship (approximately $18,000 per year) and a partial-tuition waiver.
- Jeff Leiseth (June 2009), contract work for ScienceOps.
- Eric Kangas, (June 2008), M.S. program in physics at University of Idaho.

Awards

- Sigma Pi Sigma Inductees:
    a. Jonah Nelson and Mark Wirth, June 3, 2009.
    b. Sami Abdul-Wahid, Annette Hinthorne, and Peter Wojcik, June 2, 2008.
    c. Chris Parker, Rebecca Perez, Travis Petersen, and Kostya Vallone, May 20, 2007.
    d. David Cross and Jeremiah Eberhardt, June 2, 2006.
    e. Steven Santagelo, Anthony Smith, Nate Stephan, and Jared Fernandez, June 2, 2005.
- John Collins Memorial Prize for Service
    a. Travis Petersen, June 2009.
    b. Eric Kangas, June 2008.
    c. Erin Sheppard, June 2005.
- Travis Petersen, recipient of the "Dean's Award" from the Center for Excellence in Leadership, May, 2009.
- "Outstanding Presentation"
    a. Travis Petersen (oral presentation) SOURCE 2009.
    b. William Sizemore (poster presentation) SOURCE 2009.
    c. Sami Abdul-Wahid (oral presentation) SOURCE 2008.

d. Anthony Smith (oral presentation) SOURCE 2006.

- "Outstanding SPS Chapter" awarded by the national Society of Physics Students
  a. 2008-2009 academic year.
     Citation from the national SPS office: "*The Central Washington SPS chapter has a balanced and active program, including K-12 and community outreach, and have contributed to local and national meetings with student presence and presentations. In addition to giving to the community, they have given to their department by raising funds to purchase equipment.*"
  b. 2007-2008 academic year.
  c. 2006-2007 academic year.
  d. 2005-2006 academic year.
  e. 2004-2005 academic year.

B. Provide one masters project (if applicable); two will be randomly selected during site visit. Available in either the library or through the departmental office.

N/A

C. Describe departmental policies, services, initiatives, and documented results for successful student advising.

All Physics faculty participate in student advising. Typically, students first meet with the Department Chair to discuss their program of interest. If appropriate, the student then maps out a four-year (or appropriate multi-year) plan of study in consultation with the Department Chair. After this initial meeting, students can select an academic advisor (who may also serve as their research advisor). Other examples of Physics Department advising include:

- Maintaining sample schedules and developing articulation/affiliation agreements with engineering programs. These issues are particularly important for students interested in participating in the dual-degree physics/engineering program since it streamlines the transfer process and helps attract a new stream of students to the University (see Appendix N). As mentioned previously, the physics department has received minimal verbal feedback on these agreements (no formal feedback has been provided to the Department). This is not only disappointing but it also hinders the department's ability in recruiting students to CWU and our program.
- Physics faculty participate at freshmen and transfer orientation. At this event, students and their parents/guardians meet with faculty and are introduced to the Department. We subsequently track the students as shown in Table A.14.
- Table A.15 is used to assess our recruitment efforts (via mailed letters).
- Tables A.16, A.17, and A.18 are used to track enrollments in all Physics courses. This allows the Department to predict future enrollments and open/close additional course sections when needed and improves its ability to serve as many students as possible.

D. Describe other student services offered through the department including any professional societies or faculty-led clubs or organizations and their activities.

CWU Astronomy Club

The CWU Astronomy Club serves as a local resource for the general public interested in Astronomy. Along with hosting a variety of outreach programs and night-time observing events, the club writes a weekly newsletter. Members consist of CWU students and the general public. The CWU Astronomy Club is a member of the Night Sky Network and currently has a blue star ranking (a club that has done 30 or more events within a six month period).

For more information about the CWU Astronomy club, please visit the club maintained website: http://www.cwu.edu/~astroclb/club.html

For more information about the Night Sky Network, please visit: http://nightsky.jpl.nasa.gov/

Society of Physics Students (SPS) Club

The Society of Physics Students is the fourth largest physics society in the country. About 5,000 students take part in activities each year. The annual selection of "Outstanding SPS Chapter" recipients is based on the level of SPS chapter involvement in physics research, public science outreach efforts, SPS programs such as physics tutoring, community service, hosting and representation at physics meetings and events, and providing social interaction for chapter members.

For more information, please visit: http://www.spsnational.org/

Sigma Pi Sigma (National Honor Society)

Sigma Pi Sigma exists to honor outstanding scholarship in physics; to encourage interest in physics among students at all levels; to promote an attitude of service of its members towards their fellow students, colleagues, and the public; to provide a fellowship of persons who have excelled in physics.

For more information, please visit: http://www.sigmapisigma.org/

V. Facilities & Equipment by location

A. Describe facilities available to department and their adequacy (program delivery location, size, functionality, adjacencies, lighting, ventilation, finishes, plumbing, electrical outlets, etc.). Describe anticipated needs in the next three to five years.

The current facilities available to the physics department are outlined in Appendix M. Comments regarding these facilities are given below. The physics department greatly appreciates the collaborative nature it has with the Academic Facilities Planning Office. We want to thank Doug Ryder and Linda Mahaney for their assistance in several recent remodels and planning efforts.

Table 14
Adequate and Inadequate Facilities

Adequate Facilities (unranked)	Inadequate Facilities (unranked)
Lecture/Lab rooms [LIND 112/113; this addition was incredibly timely and GREATLY appreciated] and upper division instructional labs (largely adequate).	Traditional lab rooms for introductory course are small and do not permit course enrollments to be expanded. Rooms are arranged in a way that inhibits inquiry-based instruction. Some of the upper division instructional labs are small.
Aesthetics of building	Lecture space is neither large enough to accommodate students nor is it set up for effective instruction. Courses are currently being taught in other buildings. Outreach programs are also difficult to perform in Lind Hall.
Office space	Two physics faculty do not have dedicated research space; although this is currently acceptable due to the nature of their research, this will become an issue in the future.
Storage space	Research space for Department Chair; he left over half of his research program at his former institution due to the lack of space at CWU.
	Electrical system (including grounds) in Lind Hall have been a bit flakey; they are suspected of contributing to the electrical noise observed in a number of experiments.
	There is no space for a permanent planetarium. The observatory is in need of significant repair (a major remodel is what's needed).

	There is no bathroom for women on the second floor of LIND Hall. This does not help the physics department recruit women into the program. The second floor of LIND Hall has also been without a water fountain for over a year.
	Active temperature control would be beneficial.

Given the current composition of the physics department, most of the facilities are adequate. As mentioned in Appendix M however, there is no room for growth (either in Lind Hall or in Science Phase II). There is no need for the physics department to continue with this question unless serious conversations begin to take place regarding space availability in Science Phase II and an interest in investment in the physics department from the University.

B. *Describe equipment available to department include program delivery location and its adequacy (office furniture, instructional fixtures, lab equipment, storage cabinets, specialty items, etc.) Describe anticipated needs in the next three to five years.*

Table 15
Adequate and Inadequate Equipment

Adequate Equipment	**Inadequate Equipment**
Office furniture and storage	Upper and lower division instructional equipment; as outlined in Department Chair's letter endorsed by former Dean and Provost (Appendix H).
	Research equipment; as outlined in Department Chair's letter endorsed by former Dean and Provost (Appendix H).
	Equipment for research and instruction (e.g. Observatory and planetarium); as outlined in Department Chair's letter endorsed by former Dean and Provost (Appendix H).
	Equipment for demonstrations and outreach programs; as outlined in Department Chair's letter endorsed by former Dean and Provost (Appendix H).

The department recognizes some of the above needs must be addressed through external grants and fundraising. Some physics faculty are interested in assisting with funding raising, although training will be necessary. However there has been a sustained lack of investment in the physics department that has led to the current situation.

C. *Describe technology available to department include program delivery location and its adequacy (computers, telecommunications, network systems, multi-media, distance education, security systems, etc.). Describe anticipated needs in the next three to five years.*

Table 16
Adequate and Inadequate Technology

Adequate Technology (unranked)	**Inadequate Technology (unranked)**
Office computers were upgraded while Win-Win program was functional.	Computers in Introductory Labs are extremely old and there is no funding available for an upgrade.
Research computers were upgraded while Win-Win program was functional. The Department also has access to several high performance computer systems for faculty and student research.	Software maintenance costs (for Mathematica, LabView, MatLab, Raven) are becoming unmanageable.
All instructional areas have computer projector systems.	
Wireless internet is present in Lind Hall.	Wireless internet is not available throughout most of Lind Hall.

Could CWU move to a system where students checkout laptops? This has worked for several universities. It would help decrease annual computing costs for the Department. Carmen Rahm mentioned this system would not improve anything, but maybe it is worth a second look given the current budget climate. Now that the WIN-WIN program is gone, how will departments provide faculty and staff with updated computers in the years to come? What about the instructional computer systems?

VI. Library and Technological Resources by location

A. *Describe general and specific requirements for library resources by program and location that assist in meeting educational and research objectives. Indicate ways in which the present library resources satisfy and do not satisfy these needs. Describe anticipated needs as to the next 5 year period.*

To meet physics program requirements the library must provide access to a range of resources. These are listed in their typical order from most to least immediate needs: texts and periodicals in the collection or available online in full text format; databases to search for literature resources; access to literature in larger collections; means to add appropriate texts and periodicals to the collection; expertise in applying library resources to the teaching, scholarship, and service missions of the department.

The library currently meets these needs in the following ways:

1. Texts and periodicals in the collection. The library maintains a collection of 750,000 titles, with approximately 10,000 of these identified as physics or closely allied fields (PCAF) (*we will use the term PCAF to refer to library resources associated with physics, astronomy, some areas of mathematics, and some areas of physical chemistry: library classifications QA, QB, QC, and QD*), and holds subscriptions or provides access to approximately 380 PCAF journal titles. Some of the journal titles currently subscribed to by the library are listed below. The library currently has an annual budget of approximately $3,000 to add to the PCAF collection. The library uses input from physics faculty in determining how to apply these resources for additions to the PCAF collection. These resources are generally adequate to the teaching and service needs of the department. Faculty and students have ready access in the collection to a variety of materials – for instance multiple texts that cover the full range of subjects in the physics undergraduate curriculum - that support the curriculum of the department, and the library has been responsive to requests for additions to the collection in support of these missions. The collection has been less effective in supporting the scholarship needs of the department. A variety of factors are recognized as contributing to this, including trends of rapidly rising costs of periodical literature coupled to a library budget that has not kept pace, and the diverse and changing scholarship needs of the physics department. While faculty have experienced difficulty in accessing current literature given the limited nature of the collection, some of the gaps are filled by other library resources, though it still should be noted that this is an incompletely resolved problem.

   Some currently maintained subscriptions to the Periodical Literature in PCAF:

   American Journal of Physics
   The Physics Teacher
   Reviews of Modern Physics
   Physical Review Letters (after 2003, the subscription is <u>online only</u>)
   Journal of the Acoustical Society of America

   There are approximately 120 PCAF journals titles with online access.

There are also a variety of non-PCAF periodical subscriptions frequently used by and useful to physics faculty and students:

Scientific American
Science News
New Scientist
Science
Nature

Some important research journals are not available to CWU faculty, due to the limited journals budget, necessitating frequent applications for Interlibrary Loan.

2. Databases to search for literature resources: The databases to which the library currently subscribes that are most pertinent specifically to PCAF include: Web of Science, SPIN Web, and ACS publications. In support of other teaching, scholarship, and service missions, the library provides access to additional databases. Those most used by physics faculty and students include: ERIC; Article First – First Search; Research Library Periodicals – Proquest; Oxford Reference Online; Electronic Collections Online – First Search; MathSciNet; Papers First – First Search; Proceedings First – First Search. The library maintains excellent internet access for these databases through the library web site from on-campus computers, and also supports log-in internet access to the databases from off-campus. Further, the library has maintained an excellent record of providing support for these databases.

3. Access to literature in larger collections: The library has two very effective programs for providing access to literature in larger collections: Summit, the ORBIS Cascade alliance; and Inter-Library Loan. In particular, physics faculty have found Summit, which provides rapid access to collections of higher education libraries across the Pacific Northwest, absolutely invaluable. We have high praise for the service provided by Summit with one caution: Summit currently has no feature that allows it to serve the "browsing" role of a physical collection, something that we consider a very important aspect of library support for both faculty and students. We encourage the library to pursue this, perhaps developing an innovative approach to this problem. Inter-Library Loan has also proven useful, although sometimes the response has been slow (see comment in #1 above).

4. Means to add appropriate texts and periodicals to the collection: Physics faculty make recommendations to add to the PCAF collection through a library representative from the department. See #1 above for details of the resources available for this. In general, this approach has proven satisfactory and the library has proven responsive within the limited resources available. However, this work is process on paper rather than electronically. The library should change the way it processes such requests.

5. Expertise in applying library resources to the teaching, scholarship, and service missions of the department: The library provides expertise through its faculty in

support of the physics department mission, and the physics department has found this support generally satisfactory. This expertise is delivered through individual interaction with library faculty (for instance students asking questions of librarians, faculty meeting individually with librarians) and also through library curriculum (for instance, librarians will conduct a class or classes on using library resources as part of a course in the physics department).

C. Describe the information technologies faculty regularly and actively utilize in the classroom. Describe anticipated needs as to the next five year period.

Blackboard is used by all faculty in the physics department. Most faculty only use Blackboard's basic functions for distributing course materials and serving as a repository for links. Outside the University's technology, physics faculty use Mastering Physics and WileyPlus. These on-line systems offered through textbook vendors permit instructors to assign homework problems, quizzes, etc. using this software.

C. Describe technology available to department and its adequacy. Describe anticipated needs as to the next five year period.

The technology available to the physics department (as provided by the University) is Blackboard and Mathematica. Regretfully there are a number of issues regarding their adequacy.

Regarding Blackboard:

1. although faculty are quickly able to grasp most of its basic functions, it would be very difficult to teach an online physics course using Blackboard without a steep learning curve for the faculty member,
2. it is not easy to do on-the-fly problem solving on Blackboard. Faculty have found the Whiteboard function is not easily accessible, and
3. faculty training is lacking. The one Blackboard trainer is not sufficiently familiar with science teaching or innovative pedagogies. Also, certain technology tools are not available unless one goes through "training" even if the faculty member has proven themselves able to use similar tools.

   An excellent example of the difficulty faculty face with our existing technology was the problems experienced by Blackboard users university-wide when the Version 9.0 was implemented.

Regarding Mathematica:

1. there have been no recent updates on the software (until the department found the campus was eligible for one), and
2. while the University has bought 70 licenses, most of them are located up the in library; far from the Physics and Math Departments, making it difficult for the Department to incorporate its use into the curriculum (and requiring the Department to maintain its own computer facility and

maintain the costs of upgrades which are at least $250 per computer). Could the University simply have a server where students could log onto? Remote access in this way could prove useful to the department.

Regarding Sustainability:

1. the University does not have the equivalent to a Win-Win program for software. This places the burden for covering the full cost of software maintenance on the department. Such software includes LabView, MatLAB (both used by WSU engineering departments), and Raven.
2. The Department is also concerned by the (apparent) loss of the Win-Win program; an excellent program that helped defray the cost of computer hardware upgrades which are absolutely necessary for faculty and staff to be productive.

Once the department has completed the above sections, there will be a planned departmental retreat where the last three sections will be discussed. The results of that discussion will be added to the self-study document. These sections are among the most important and will be the basis for academic planning by the department.

VII. Analysis of the Review Period

A. What has gone well in the department and each degree program(s)?

1. *Explain accomplishments of the past five years.*
2. *How have accomplishments been supported though external and internal resources?*

Table 17
Major accomplishments (unranked)

Major Accomplishments	Department Resources supporting accomplishments	College/University resources supporting accomplishments	External resources supporting accomplishments
Drafts of articulation agreements with WSU and UW have been approved by the Department.	Faculty time and effort.	**Negative**: There has been a lack of responsiveness/ communication from the administration on this issue.	
Two research laboratories have been remodeled for new physics faculty.		Significant remodeling provided by the University; good start-up packages for new faculty including release time.	
All undergraduate majors are engaged in research and presented in a public venue.	Faculty time and effort; some department resources.	Science Honors; Office of Undergraduate Research (SOURCE and Undergraduate Fellowships).	NSF, NASA, and Murdock Charitable Trust
Faculty are engaged in research, publishing and presenting their research at professional conferences.	Faculty time and effort; department resources.	Office of Graduate Studies, COTS, Faculty Professional Development Funds (Provost); Office of International Studies and Programs.	NSF and NASA
Expanded access to general education and service courses.		**Negative**: The physics department's budget has been cut. This has limited the number of courses the Department has been able to offer.	
Increased efficiency in offering an appropriate upper-division physics		**Negative**: The physics department's budget has been cut, resulting in	

curriculum while maintaining the same time to degree.		more courses having to be offered on an every-other-year basis.	
Significantly expanded and refined Departmental Assessment Activities.	Faculty time and effort.	No meaningful support has been provided by the University.	
Support staff contribute significantly to the Department.	Faculty time and effort in a prolonged search.	Patient support from the administration while the search was performed was greatly appreciated. Continued support for positions is also greatly appreciated.	
Improved access to pedagogically appropriate teaching facilities.		Remodeling of LIND 112/113. Special thanks to the COTS office and Doug Ryder for making this possible.	
Participation in Interdisciplinary programs.	Faculty time and effort.	College and University support of these programs (such as DHC, SHP, STEP, CESME).	NSF, Murdock Charitable Trust
Good collaborative relationship within the Department and with other COTS Departments.			
Continued efforts by physics faculty to develop and improve pedagogical approaches.	Faculty time and effort.	**Concern**: There is still a lack of adequate facilities and resources to support these initiatives.	
Outreach to educators through mentoring and leading teacher workshops.	Faculty time and effort.	Cornerstone program; Grant workshops for HS teachers; CTS workshops for the campus community.	Via Science Education/ CESME: Yakima Math/Science Partnership; North Central Washington Math/Science Partnership.
Significant outreach activities, university, and community service, as conducted by physics department faculty and staff.	Faculty and staff time and effort; Department funding and resources.	Some support through the CWU Foundation, COTS, and the CWU Student senate (through student organizations).	NASA
Active and productive student clubs.	Faculty time and effort.	CWU Student Senate via the Physics Club.	SPS; NASA (direct funding

			and the Night Sky Network).
External recognition of faculty's teaching activities, service activities, and leadership skills (through awards received by faculty or through elected positions in professional societies).		University	CUR and Carnegie Foundation
External recognition of student clubs.		**Concern**: These types of activities are not promoted by the University to the general public.	Outstanding SPS Chapter recognition and Night Sky Network "Blue Star" recognition (highest recognition possible; NASA).
Student assistance in promoting the Department and advancing its goals.	Department resources.	Supplemental Instruction and tutoring programs (via federal and university funding).	
Faculty are engaged in leadership positions in a variety of professional societies.	Faculty time and Department resources.	COTS/University travel funds.	
Continued efforts to promote visibility of the Department and improve recruitment.	Faculty time and effort (web site revision, development of recruitment materials, meeting with prospective students, open house and registration events, etc.), Department resources (to pay for proof-reading, printing, etc.).	Some University resources and time (via feedback received from various COTS and University personnel) (see Appendix G). **Concern**: there needs to be better coordination of CWU recruitment efforts with department strengths. There are SIGNIFICANT concerns regarding the University's recruitment efforts (Section VII.D and Appendix W).	
Introduced development efforts that include connecting with alumni and forming ties with industry.	Faculty time and effort (web site revision, development of	Some COTS/University resources, feedback from various COTS and University personnel	

	alumni materials, meeting with alumni, etc.), Department resources (to pay for proof-reading, printing, mailing, etc.).	(see Appendix S). **Concern**: there needs to be better coordination of CWU alumni efforts with department strengths.	
Foresight to include a maintenance budget for the laser research lab.		COTS/University. This is greatly appreciated and was one way the University administration demonstrated their willingness to invest in the physics department. **Concern**: no plan for future investments in the physics department has been presented by the administration.	This funding is used by the Department as part of matching funds for its NASA grant; resulting in additional dollars to the university.
Increase in Department Chair release time from 9 to 15 WLU.		COTS. **Concern**: In this budget climate, the Department has been unable to incorporate this additional release time. The Chair's release time is still less than the release time received by some program directors.	
Transition to new staff (Department Chair, tenure-track faculty, technician, and secretary) has contributed to revitalizing the Department.			
Redesigned website (revised content and functionality)	Faculty time and effort.		

The Department would like to praise the administration for its process for redistributing indirect funds from grants, summer school profits, and cornerstone classes. These funds, a portion of which work their way back to Departments, has been timely, beneficial, and highly valued by the physics program.

B. What challenges exist for the department and for each degree program?

1. Explain major challenges of the past five years.

2. List likely causes of each challenge as supported by documented evidence.

Table 18
Significant Challenges (unranked)

Major Challenges	Consequences and Concerns	Suggestion for Overcoming Challenges
Loss of instructional and support personnel.	The 2004 External Reviewer recommended increasing personnel to total 5 (T/TT) FTE; instead the Department has gone from 5.5 FTE to 4.5 FTE with 3.5 FTE of T/TT; budget cuts have in part contributed to this decrease.	Current administration should meet with the Department to discuss the investment plan endorsed by the prior Administration. This is in line with President Gaudino's long-term planning and visioning exercises.
Loss of resources for goods and services.	Lack of budget increases over the years to cover inflation; budget cuts have compounded this problem.	How are COTS/CWU attempting to re-acquire these resources (through state and development avenues)? CWU administration should meet to discuss how the physics department fits within their development plans. The physics department is willing to participate to the extent possible.
Lack of resources for instructional and research laboratory equipment.	Much of the equipment in the Department is old and in a severe state of decay. The lack of investment in (and loss to) the Goods and Services budget has compounded this issue. Limited access to computers capable of operating specialized software for upper division physics courses. There is no general university plan for maintaining instructional and research equipment that includes computers and software.	What are COTS/CWU doing to re-acquire these resources (through state and development avenues)? The Department will write an NSF grant for the introductory courses and will continue to partner with other groups (e.g. CESME).
Significant lack of research facilities.	Two tenured faculty do not have dedicated research labs. The Department Chair left half of his research laboratory at his former institution due to a lack of	An improved Science Phase II that includes the physics department. This is probably the only solution.

	facilities. There is a high probability that the Department Chair will not receive future NSF grants (after over 10 years of continuous funding) since the most significant part of his research lab had to be left at his former institution because CWU was unable to accommodate the facilities and the cost of maintaining the experimental system.	
Some lack of instructional space for current and projected course enrollments, includes a lack of a second intermediate size lecture/lab room, a large lecture room, and the loss of instructional lab (LIND 202A) to a research lab.	Inability to accommodate all students in the introductory courses.	An improved Science Phase II that includes the physics department. This is probably the only solution.
The lack of sufficient funding for Science Phase II (and the uncertainty if physics will even be included).	Lack of sufficient facilities will result in problems regarding student recruitment for the major, accommodating students in general education, service, and upper-division courses, faculty recruitment, and in securing grants.	See Appendix **M** regarding the lack of funding/space for the Science Phase II building that was proposed.
Lack of promoting the need for Science Phase II.	The Department does not recall seeing University support for Science Phase II in the press (e.g. contrary to "Field turf, more stands on wish lists," Nov. 12, 2009, Daily Record).	The University should promote Science Phase II with as much vigor as it does other projects on campus.
Lack of recruiting program-ready students to campus (students prepared to enter the major from a pre-requisite perspective). This refers to a group of students who place high on standardized math exams but may not have	Failure in doing so does not provide a pool of students from which the physics department can recruit. Simply adding more students to the university does not benefit the physics department since the majority of them do not place into MATH 172 (instead many place into MATH 100).	Targeted recruitment by the University and the Department (for Department, resources will be needed); see Appendix **W** for information regarding "calculus-ready" students; math placement exam must be taken by all entering students (this issue should be corrected by next summer). Seek

indicated an interest in physics or engineering – otherwise known as "calculus-ready".		permission from the MATH Department for special consideration regarding students being admitted to the MATH class regardless of whether they took the appropriate math placement exam; purchasing names from ACT/SAT and combining this with the campus' Connect program may be beneficial. The Department is suggesting a 3-year trial. A plan is proposed in part D of this section.
Lack in recruiting physics majors to campus (students already identified as interested in physics and/or engineering). This includes the lack of a coherent recruitment plan.	Failure in doing so does not promote the department and its programs (particularly the dual-degree physics/engineering program which is anticipated at becoming the big ticket draw to the department).	
Lack of resources for technology maintenance; software and hardware.	Failure to address this problem will impact instructional and scholarly activities. This will ripple into decreased efficiencies and production. The suspension of the Win-Win program was particularly disappointing.	How is COTS/CWU going to maintain the technology infrastructure of the physics department (through state and development avenues)?
Lack of responsiveness when the Administration processes Departmental paperwork/requests (e.g. the dual-degree physics/engineering articulation agreements).	Inability to recruit students to and grow the program. The physics department believes this program can be a way to recruit a new stream of students to the university.	Paperwork should be moved along expeditiously unless questions arise. If there are concerns over paperwork submitted, the Department should be contacted and asked for more information. The Department would be happy to answer any questions regarding the dual-degree physics/engineering program.
Lack of consistent communications coming from the administration.	Department Chair is not entirely certain what the administration actually wants (e.g. regarding WLU allocation toward instruction vs. research). This makes it very difficult for planning purposes.	Improved communication within the administration and improved communication from the administration; if meeting departments is a priority for President Gaudino then he should follow through with it. Some examples of communication issues are given later in this section and in Appendix **V**.
Inability for the Department to receive accurate, useful data for university documents	The Department spends a significant amount of hours keeping its own records; this results in a loss of productivity in	Require CWU administration to generate accurate data and deliver it in a timely fashion.

(e.g. SEOIs, enrollments, SCH production, budgetary information needed for the self-study and elsewhere).	other areas such as research. Examples include this document and those listed in Appendix **V**.	
Lack of university's promotion of the physics department (this is true of the sciences, possibly the university, in general).	Inability to recruit students to and grow the program. Lack of visibility limits fundraising abilities.	What are COTS/CWU doing to promote the physics department? The physics department is ready to assist but resources are needed. Some suggestions are given in part D of this section.
Low-enrollment upper division physics courses. Note: We have seen a trend of increasing student enrollment and as a result, there are fewer courses that fall into the low-enrollment category.	The Department Chair must continually justify the physics curriculum to the administration due to its size; inability to expand the curriculum due to small upper division classes (includes inability to offer courses on a yearly basis – this hinders the dual-degree physics/engineering program slightly).	Administration must recognize that Physics Departments are small; this is true nationwide. The administration must recognize the balance the Department maintains between the larger lower division courses and the smaller upper division courses. It is imperative the university recruit "calculus-ready" students (see Appendix **W**) and implement a recruitment plan for the department. Some solutions include promoting the dual-degree program, improving recruitment, and adding faculty to teach a variety of high-demand lower division courses with specialty upper-division courses.

Smaller challenges include:

- Lack of a comprehensive scheduling plan at the university. There are several symptoms we have observed to indicate this is a challenge. They include the difficulty the Department has in scheduling lab courses into weekly schedules, the conflicts that arise in student schedules between science and math departments, and the fact that the Physics Department Retreat has to occur on a holiday (Veteran's day). While some schools discourage classes over a specific hour in the day so informal discussions/official meetings can occur, other schools set aside one or two days during the quarter where these types of activities can take place. Could this not be a path CWU takes? For example, the Provost and Associate Vice President for Undergraduate Studies do not schedule meetings over the noon hour.
- Budget cuts have compromised lower division course quality by requiring large enrollment sections to be offered. For example, there are close to 60 students enrolled in one LAB section

of PHYS 182 for the Winter 2010 quarter. Regardless of the instructor's best intentions, this environment does not contribute to significant student learning.

There are numerous additional challenges the Department currently faces, however we do not want to dilute the importance of those we have currently listed. Therefore, additional challenges the Department faces will be brought to the attention of the external reviewer if time permits.

C. What past recommendations from the previous program review have been implemented?

1. *How has each recommendation been implemented and how have the department and degree programs been impacted?*
2. *Which recommendations were not implemented and why?*

Table 19
2004-2005 External Reviewer Recommendations with the Physics Department's Response

Overall Concern: The recently hired Department Chair presented a plan for how the Administration should invest in the physics program. This plan was presented to Dr. Meghan Miller, COTS Dean and Dr. David Soltz, CWU Provost. Both administrators supported the plan (see Appendix H). Since then, there have been significant personnel changes within the administration: two other individuals have occupied the COTS Deans position; two other individuals have occupied the Provost position, and the University hired a new President. One aspect of President Gaudino's administrative philosophy is a support of long-term planning*; the Department is eagerly waiting to learn how the administration will follow through with the previous administration's endorsement of the physics department's strategic investment plan.

* stated on numerous occasions including "Gaudino closes in on one year at CWU," Nov. 21, 2009, Daily Record.

Recommendation	Actions taken	Future Actions and Existing Concerns
With due regard for the careers and substantial previous contributions of the affected individuals, move as expeditiously as possible to a physics department with 5 tenure-track faculty.	The Department hired a new Department Chair. The number of Tenured/ Tenure-track faculty has gone from 2.5 to 3.5 FTE.	**Concern**: Since the last external review, the overall instructional FTE within the Physics Department has gone from 5.5 FTE to 4.5 FTE. In the opposite direction recommended by the external reviewer.
Make significant improvements in the Department's instructional, research, and office space.	All faculty and student clubs have offices in Lind Hall. Room 112/113 has been remodeled to accommodate an integrated lecture/lab style course. 202A was reassigned from an instructional lab to a research lab. Science Phase II appears to have state support.	**Concerns**: 202A was reassigned from an instructional lab to a research lab. The loss in instructional space has impacted the Department ability to accommodate students. Science Phase II is significantly underfunded, as outlined in Appendix M. Even if Science Phase II is built, there is no guarantee the physics department will occupy it – this is particularly unsettling.

Develop a physics web site that highlights the Department's attributes and generates excitement for physics. Provide advising information on the web site that shows course sequencing for possible 4-year curricula leading to the BS in physics.	The web site has been revised; sample schedules have been developed (rather than being posted, students must meet an advisor to see them); schedule of courses to be offered has been developed and posted on the web; portfolio documents (including assessment tools) have been updated and posted on the web.	Materials will continue to be updated as needed.
Launch a recruiting program targeted at Washington's two-year colleges.	The STEP program has a component for transfer students (this portion of the program is supervised by a Physics faculty member); Physics faculty also partner with faculty from two-year schools performing programs to area teachers (e.g. Yakima Math/Science Partnership).	**Concern**: Lack of time to develop and cultivate these relationships in any meaningful way.
Provide a collection of textbooks for the student study room.	Physics faculty, staff, and others have donated books for the collaborative resource room.	Textbooks will continue to be added when needed.
Develop a campus-wide program to implement more effective pedagogies in the introductory science courses; sharing resources and expertise across departments.	Several Physics faculty participate in curricular development and delivery for the STEP program; physics faculty also participate in programs offered through/sponsored by the Center for the Teacher-Scholar and the Center of Excellence in Science and math Education.	**Concern**: Significant effort would be involved to develop a campus-wide initiative; at present, there is neither time available for physics faculty to spearhead this effort nor are there resources for such efforts. Other mechanisms are in place, so the Department does not consider this a high priority.
Accommodate all students who need physics service courses, and consider enlarging the capacity of the physics lecture hall.	The Academic Facilities Planning Office concluded expanding Lind 215 was not viable; instead Lind 112/113 was remodeled to a 40 student lecture/lab room. This has helped improve the efficiency of course delivery	**Concern**: not all students can be accommodated due to our facilities. NOTE: typically this problem occurs only in the fall quarter and is due to the size of LIND 202A which limits the size of the lab sections. The

	while ensuring quality.	inadequate size of Lind 215 requires the Department to teach the fall sections of PHYS 111 and PHYS 181 in Shaw-Symser. This makes lecture demonstrations difficult, if not impossible, to perform. The loss in offering PHYS 182 (through the loss of resources) in the spring quarter is another example.
Provide better information to majors on the graduate school application process and hints for achieving success in graduate school (this could be done across the sciences).	The DHC has a graduate school preparation program available to everyone. This issue is also addressed during faculty/student advising sessions. The Department also introduced PHYS 489 (Senior Assessment) and re-introduced PHYS 499 (Seminar).	Our actions will continually be evaluated and assessed.
Try to identify specific common deficiencies in math ability that impede student progress in the upper-level physics courses, and consider whether a math methods course targeting those deficiencies would expedite student progress through the curriculum.	No deficiencies that are based on the math methods students learn in courses have been identified.	To address this, the Department (and the University) needs to recruit "calculus-ready" students (see Appendix **W**). **Concern**: While the university has decided to grow itself out of this current budgetary crisis, NO enrollment management plan has been presented outlining how students will be recruited. The concern is that students entering under this plan will be even less qualified. The Department will continue to cultivate scholarship and other opportunities that can recruit quality students.
Organize and label the storage of the lecture demonstration equipment, and provide a manual for faculty if none is now available.	A highly competent instructional technician was recently hired. He has made significant advances in developing/maintaining	There is still significant work that needs to be done in constructing/organizing laboratory and demonstration equipment; the technician

	laboratory and demonstration equipment. He has also forged relationships with other technicians on campus that have led to several recent equipment donations and repairs.	continues to work on this when time permits, however the department recognizes this is a HUGE undertaking. Funding for student assistance may expedite this process.
Consider ways to increase astronomy enrollments by circumventing the size limits imposed by telescope observations, perhaps by coupling observation experiments with on-line analysis and simulations in the laboratory.	The Department now offers its astronomy classes in a lecture/lab format to 40 students.	The Department has determined that additional offerings of astronomy courses are not possible with the resources currently available.
Review the scheduling of math, chemistry, and physics courses to see if time conflicts exist that could cause enrollment problems for students.	Good relationships exist between these departments; Chairs attempt to arrange schedules that are mutually beneficial. The math department has a scheduling program that allows them (and other departments) to view their course offerings.	Some difficulties are: 1. There is no MATH 273 in the winter quarter, 2. MATH 376 is only offered during fall quarter, and 3. MATH 377 is only offered every other year. As with physics courses, these are low enrollment classes and the physics department recognizes this. Another difficulty is that the introductory chemistry lab is a 3 hour lab, typically in the middle of the day. However, there are usually several sections available and with careful scheduling problems can be avoided.

Table 20
Supplemental Recommendations made with the COTS Dean, Dr. Meghan Miller, with the Physics Department's Response

Recommendation	Actions taken	Future Actions and Existing Concerns
Innovation in instruction.	At the time of the last self-study, nearly every lower division physics course incorporated appropriate physics education pedagogy (workshop physics, peer instruction, etc.). The physics department has expanded its activities by offering more courses that use these techniques (e.g. PHYS 106) and has expanded their use to upper-division courses (e.g. PHYS 351). The physics department has also done a better job at articulating its use of proven pedagogical activities to the university community.	**Concerns**: Instructional equipment, including maintenance and facilities for instruction. Time for faculty to implement these techniques.
Economies in program delivery.	At the time of the last self-study, the physics department had already made significant efforts to improve efficiency BEFORE the administration requested departments do so. In this review period, the department further increased efficiency by teaching several introductory labs in an inquiry-based format with larger enrollments and are teaching upper-division experimental courses simultaneously.	**Concerns**: The physics department has been ahead of the curve in program efficiency; will it continue to be penalized as a result? Our concerns stem from the recent 10% budget cut received by the physics department. This has been very problematic, impacting the quality of program delivery, ability to maintain instrumentation, and ability to support faculty research and professional activities.
Better allocation of staff effort.	The physics department was able to hire two excellent support staff. Their contributions to the physics department have greatly improved the program's efficiency.	**Concerns**: The physics secretary only has a 9 month, half-time appointment. The physics technician would like improved safety in the shop (for air handling/ventilation and newer, safer equipment in general) along with an improved method for reallocating equipment on campus. Both individuals are also worried about job security.
Faculty professional development.	The physics department recognizes that professional development is anything that improves one's job performance, which for faculty spans the areas of instruction, research, and service. Physics faculty have participated in local, regional, and national conferences and workshops related to scholarship and teaching.	**Concerns**: Restricted opportunities for faculty and staff to attend these events. There is also a lack of time, resources, and recognition for incorporating professional development activities into courses. The current university culture is not conducive to a comprehensive faculty professional development program.

D. Make a comparison between the last program review and where the department is now.

> *"In summary, the external review accurately summarizes the consequence of the lack of institutional support for this program; at the same time it acknowledges that without a sufficient base of tenure track faculty, a clearly articulated set of goals and a vital departmental culture that supports reaching those goals is also lacking. The Department of Physics has performed well, very well in light [of] the minimal resource base that sustains it. It has a credible major program that needs attention to some areas, but is considered both strong and successful. The department plays an essential and respected role in general education and service courses. Despite its strengths, departmental level efforts are needed; these include innovation in instruction, economies in program delivery, better allocation of staff effort, and faculty professional development. Moving this program forward will require both directed work at the department level and institutional support to put this program on a better resource footing."*
>
> *Dean Meghan Miller*
> *COTS response to the 2005 Physics Program Review*

1. *How have the advances been supported (e.g., internal and external resources)?*
2. *Are there still outstanding, unmet needs/challenges from the last program review? What has the department done to meet these challenges?*

1. In response to the last program review, the physics department elected to pursue a number of recommendations provided in:
   - the AIP SPIN-UP Report,
   - the review submitted by the external reviewer, Dr. Ken Krane, and
   - the review submitted by the COTS Dean (Dr. Meghan Miller).

   The university provided the physics department with an additional tenure-track position which the department applied toward a tenure-track replacement and the hiring of an external department chair. Some of the results of these hires include, among other things, significantly expanded external resources for the department, expanded research opportunities, development and unofficial acceptance of articulation agreements with in-state engineering institutions, trends of increasing enrollments in upper-division physics courses, enhanced outreach opportunities in the community, a revitalized recruitment plan, and improved efficiency achieved through the hiring of two excellent support staff.

These are examples of the dividends that have been reaped from the meager investment made in the physics department over the period of this self-study.

2. Please refer to Table 18 for a complete listing of outstanding challenges. The physics department will use this section to mention the unmet needs we currently face.

Unmet Needs (unranked)

- A significant unmet need is regarding tenure-track faculty. As stated by the last external reviewer: "With due regard for the careers and substantial previous contributions of the affected individuals, move as expeditiously as possible to a physics department with 5 tenure track faculty." The Department currently has 3.5 tenure-track FTE with 1 non-tenure track FTE. This represents an overall DECREASE by 1 FTE from the last program review. However, this is only the start of the problem. Even if the physics department received another tenure-track position, numerous questions arise such as: Where would their lab be located? There is absolutely no space in LIND Hall for such a facility.
- Regarding the previous point, the physics department recognizes the difficult economic climate the university is in. However the most disappointing aspect to this situation has been the lack of communication by the upper administration regarding their plan for investing in the physics program. How do they see physics progressing? What is their plan for investment in the physics program? President Gaudino has repeatedly stated how important it is for him to meet Departments yet he has not met with the physics department even though the Department Chair provided him with a plan for investment along with an offer to meet and discuss the issues (followed by a second request made through the Provost's office as facilitated by the COTS Dean). This apparent lack of interest has been a huge disappointment. How can he advocate/fundraise for the Department without discussing such priorities with the physics department?
- The university does not appear to have a coherent recruitment plan for the physics department. When the recently hired Department Chair arrived, he suggested to Dean Miller that qualified student names be purchased from SAT/ACT in an attempt to recruit students to the program. This was done by the chair at his former institution (about 800 names were purchased and the physics program typically had 40 students entering the program as freshmen). She directed him to Dr. John Swiney, Associate Vice President for Enrollment Management. During the last two years, enrollment management sent recruitment letters out on behalf of the department (although Enrollment Management is uncertain how many letters were sent out – Table A.15). Recently the University went to Hobsons' Connect & Retain program to handle recruitment (both inside and outside the university). The Department is participating in using this program for recruitment. However it was incredibly disappointing to learn that only 50 names were captured from their recruitment list. The reason is that their recruitment list is generated by self-selection; students identify themselves as being interested in a particular area and submit

their information to the University (either in person or by mail/e-mail). Unfortunately this does not significantly improve the department's ability to recruit students to the program. We are not capturing students who may not know about the physics program or who have not yet considered CWU as a place to attend. Recruitment is particularly crucial at this time and can yield large dividends with the recent addition of the articulation agreements for the dual-degree physics/engineering programs. Therefore, the Department would like the following information to be provided by the administration:

- How many recruitment letters were sent in the Fall 2007 and Fall 2008 academic years?
- How did enrollment management obtain these names?

The physics department would like to suggest the following plan for improving the recruitment of students to the CWU physics program. Have Enrollment Management purchase names from ACT/SAT for the Department on a 3-year trial basis. Then Enrollment Management can use the Connect program in an attempt to recruit these students. If this pilot program is successful, it can provide the university with a way to target its recruitment efforts, allowing the university to populate smaller programs that they would like to see grow. For example, this program would not be needed for the Departments of Law and Justice or Music but physics is uniquely suited for such a program. However, if the administration has a better plan, the physics department is more than happy to meet and discuss their plan.

- Lack in a university-wide approach to promoting academic departments, such as the physics department. Rationale: As President Gaudino has repeatedly stated, higher education in general is not perceived as an entity worth investing in by the public or by the legislature (the legislature sees higher education as sluggish and inefficient). Two ways the administration can help promote departments on campus, including the physics department, are:
  - Follow-up support of department activities (scholarship, outreach, and awards) by the administration to the media (or other appropriate outlets). For example, this past fall several departments participated in a week-long outreach activity for area schools. The physics and laser light show made the front page of the Daily Record. It may have been helpful to have had an administrator at the show when the reporters attended to provide a perspective at how further budget cuts to the university would detrimentally impact our ability to reach out to the local community. If that presence is not possible, then a follow-up letter to the editor (or submitted on-line) should be sent to the Daily Record explaining to the public why it is important to support higher education. It does not have to be a long letter; just a quick reminder that we are here and we are worth supporting. It would also be nice if the event were publicized in the campus bulletin (this event was submitted to, but never disseminated in, the campus bulletin). Another example was in past years, the CWU SPS chapter would be recognized in the Daily Record for its selection as an "Outstanding SPS Chapter." Unfortunately the University no longer promotes this award recognition externally.

- Every several months (quarterly), the administration should send a summary of grant activity to the legislature and the local community. This note should explain how these grant dollars further basic research, instruction, the training of future and current teachers, the training of future scientists, how they support the salaries of community members, and the tax base of the community. Again, these should not be long articles, but short reminders to the community and legislature that highlight the value of higher education. At a recent meeting attended by the department chair, there were some disparaging remarks made about CWU faculty "scholarship" by a member of the local business community. Although there is no way to eliminate these perceptions, it is important to not let them go unchallenged.

Finally, the Department would like to reiterate its willingness to work with the administration as they lead the University through this budgetary crisis. However, the University administration must communicate to the department its thoughts on the direction the physics department is heading. For example, the Department Chair is willing to help assist the Department with the Provost's 36 WLU request, the President's request for additional research, and the President's request to be entrepreneurial. However, he cannot do this with his current responsibilities that include managing a Department, participating in university, community, and professional service while conducting externally funded research and teaching over 30 WLUs. CWU administration needs to evaluate the department's plans (as outlined throughout this document and Appendix H), decide how it would like to invest in the physics program, and finally communicate its priorities to the physics department.

Category VIII. Is the single most important category in the self-study document.

VIII. Future directions

A. *Describe the department's aspirations for the next three to five years.*

See Table 21.

B. *In this context, describe ways the department or unit plans to increase quality, quantity, productivity, and efficiency as a whole and for each program. Provide evidence that supports the promise for outstanding performance.*

See Table 21.

C. *What specific resources would the department need to pursue these future directions?*

See Table 21.

Table 21
Future Directions: Aspirations, their effect (with justifying evidence of possible success), and required resources

A. Aspiration	B1. Effect	B2. Evidence	C. Resources
Increase the number of tenure-track faculty in the physics department (e.g. biophysics).	Quality: varied course offerings, increased opportunities for undergraduate research and internships Quantity: SCH production, external funding Productivity: recruiting impact, publications	External Reviewer's comments from 2004 and SPIN-UP.	Funds for a tenure-track position with resources for start-up and maintenance. Space for additional research labs.
Move forward with an improved Science Phase II.	Quality: updated teaching and research equipment, labs designed with faculty research needs in mind, classrooms designed to better facilitate student learning; Quantity: number of classrooms (lecture and lab) and research labs; Productivity: increasing recruiting opportunities, proximity to other science departments facilitates interdisciplinary collaborations;	External Reviewer's comments from 2004 and Project Kaleidoscope (Vol. 1: What Works: Building Natural Science Communities [1991]; What Difference Do Improved Facilities Make? [1998]).	State and private resources for Science Phase II; particularly for a permanent Planetarium, Observatory, and sufficient research space for future Department needs. Other needs: It would be good to meet with the CWU President to discuss fundraising needs

	Efficiency: classroom (lecture and lab) and research lab design, improved maintenance of equipment.		(possibly with Geology at the same time).
A blossoming dual-degree program.	Quality: provides external feedback on curriculum; Quantity: increase enrollment in physics courses, increase number of majors; Productivity: addresses state shortfall in high demand, high tech professions; Efficiency: students receive two degrees in an accelerated amount of time.	SPIN-UP and other success stories (AIP Statistical Research Center and "Why Many Undergraduate Physics Programs Are Good but Few Are Great," R. C. Hilborn and R.H. Howes, *Physics Today*, 56(9), 38, 2003).	Funds for instructional support (faculty, facilities, lab equipment, and software). Other needs: approval by the administration of the documents.
Increase the number of "calculus-ready" freshman taking the PHYS 181-183 introductory sequence.	Quality: less time spent on remedial topics in introductory courses; Quantity: integral to success of our recruiting strategy; Efficiency: decrease time to degree.	SPIN-UP	Resources for Department recruitment efforts (travel, postcards, newsletters, flashy recruitment demos, etc.).
Improve student learning as measured by department metrics (includes validated assessment instruments).	Quality: student learning is the primary goal of the physics department; Quantity and Efficiency: better retention of students; Productivity: less review of introductory material for higher level classes.	AAPT	
Develop an advisory council for the physics department.	Quality: connection of physics curriculum to industry; internship and job placement; Quantity: better recruitment and retention of students; Productivity: increased resources through connections made with the council.	Follow established model of CWU's College of Business (and many other examples).	Faculty time and effort with some Department resources (for travel and hosting of meetings/events).
Increasing number of graduates, improving the	Productivity: faculty research output increases with increased upper-division student collaborators;	"Rising Above the Gathering Storm," National Academy of	An adequate Science Phase II, increased resources for research.

retention of first-year students, and increase the numbers of first-year and transfer students pursuing Physics degree programs.	Efficiency: decrease time to degree.	Sciences.	
Increase the number of majors having internships in research and industry.	Quality: providing a connection for physics and dual-degree students with industry, increased real-world applications; Productivity: increase number of career-ready graduates.	"Rising Above the Gathering Storm," National Academy of Sciences AIP Statistical Research Center	Support for Department Advisory Council and Dual-Degree program
Increase course offerings, particularly upper division offerings.	Quality: better preparation of students for graduate programs and careers; Quantity: accommodate more upper-level students in physics programs; Efficiency: decrease time to degree.	SPIN-UP	
Foster faculty involvement in interdisciplinary programs (e.g. DHC and STEP).	Quality: deliver a physics content to a broader student audience, learn innovative teaching techniques from faculty in other departments; Productivity: increased recruiting opportunities, increased opportunities for scholarly interdisciplinary collaborations.	Project Kaleidoscope (Vol. 1: What Works: Building Natural Science Communities [1991])	
Increase department chair release to 18 WLU.	Quality: increased focus on department needs; Productivity and Efficiency: increased focus on recruitment, fundraising, scholarship, and department service.	To provide equity with other CWU Departments and Programs.	Resources for Department.
Increased dissemination of existing research being performed by the physics department.	Quality: provides external feedback on research being performed.	SPIN-UP	Funds for support of scholarly activities (faculty time, facilities, lab equipment, software, and conference travel).

When appropriate, continued participation in grant funded activities related to instruction, research, and service.	Quality: provides external feedback on activities being performed; Productivity: additional resources become available from grants received, and at times, from the returns of indirect costs.	SPIN-UP	Funds for instructional support (faculty, facilities, lab equipment, and software). Other needs: recognition by the administration that such activities are valued.

D. What do you want us know that is not included in this self-study.

- Going back to the prior self study, we would like to point out that the physics department made significant efforts to improve efficiency BEFORE the administration requested we do so. This has created hardship when we were subsequently asked to further increase efficiencies.
- The physics department has already undergone significant reductions in its budget (see Appendix U). The concessions have had some repercussions on students and student learning. For example, larger lab sections may increase productivity and efficiency but there is a subsequent decrease in the quality of instruction. The physics department needs more faculty, space, and equipment to effectively teach larger lab sections and its curriculum as a whole.
- Physics faculty are represented in inter-department collaborations (STEP, Science Education) and on campus committees at a higher per-capita rate than most other departments on campus.
- Physics faculty members have knowledge about all aspects of campus life (e.g., advising, registration issues, student services) at a much higher per-capita rate than most other departments on campus.
- Other improvements in facilities that are needed include large classrooms designed for collaborative learning,
- Concerns over the fundraising activities directed toward University faculty and staff. For the past several years, faculty have received requests for giving to the university. While the physics department recognizes the necessity to ask for donations from faculty and staff, we believe these funds could be asked for differently. The following are several points we would like the administration to consider when making future requests.
    - The President should always, first and foremost, explain (to the legislature, private donors, etc.) how faculty and staff donate their time and energy to the University, which is far more precious than any monetary gift a faculty or staff member could provide. For example, some faculty have chosen to do more with less (i.e. to teach more while keeping their level of scholarship and service constant). This is equivalent to an in-kind gift. If the Foundation cannot claim this dollar amount, it is worth mentioning to donors and other friends of the university.

- It may be better to make the request in person (at least at a Department or a College-wide meeting). Sending an impersonal letter, a letter that appears Xeroxed with an electronic signature does not convey an attitude of interest on behalf of the institution. Statements made by candidates for the position of Vice President for University Relations, foundation members, and fundraising individuals suggest that one should first find out what a donor is interested in before making the "ask".
- Some faculty have already donated, and so sending them a letter insults their original gift and can be perceived as a waste of resources.

As President Gaudino continues raising funds for the University, we request he reconsider his method of fundraising with regards to University faculty and staff.

- The physics department would like to reiterate the need for the administration to provide coherent and effective communication. The physics department praises President Gaudino and Provost Quirk for improving communication to the campus community since they started their respective positions (both have improved communication from their respective offices with the campus community in comparison to their predecessors). President Gaudino's willingness to discuss difficult issues with the university community and his ability to deliver excellent presentations to members of the community is a highly valued asset to the university.
  - How does this affect the physics department? The physics department is looking forward to having President Gaudino advocate for the department and is willing to assist him in these efforts. To accomplish this, we recommend he follow-through on his plan to meet with the physics department. The physics department is also willing to meet with other members of the administration to discuss the direction in which the department is moving and how future investments will be made in the department.

IX. Suggestions for the program review process or contents of the self-study?

- "*Category VIII. Is the single most important category in the self-study document*." Yet we had to fill in seven sections of data and information to get there. The Department Chair spent well over 80 hours during the summer compiling the first draft of the annual report (more hours were spent by Department faculty and staff as the study took its final form). A portion of this effort was compiling data tables used in the self-study. Fortunately for the Department Chair, most of the tables presented in this document had already been developed over the past two years (and even then it took over 80 hours to compile the first draft). However several questions arise: Is this really the responsibility of the Department Chair and is this an effective use of his time? Why does the Department need to be responsible for this information? In fall 2009, the President and Provost repeatedly cited a failure of the university's ability to collect and disseminate data (financial, SCH, etc.). Although the Department does not advocate resource allocation based solely on the numerical data (such as SCH production, etc.), how has the University made informed managerial decisions regarding resource allocation without accurate data that permits meaningful comparisons between Departments? Given the history of data received by the Department, how can the Department be certain that the data it receives is indeed correct?
- A number of questions (and sections) within this self-study are unnecessary or should have been filled in by the administration (an obvious one is Table 5).
- The assessment portion of this review should be streamlined further to coincide with the annual documents that are generated.
- Prior to the final report on a program review (either at the start of the review or after the external review), there should be a meeting consisting of all affected parties (such as the Department, Dean, AVPUS, and the Provost). The purpose of the meeting would be to provide an overall oral presentation of the document that highlights important points and also provides a time for questions and answers. This would help inform their assessment of our program which may be more beneficial than sitting in front of a long document. This could even be done for an entire college in a particular afternoon.
- Finally, although many Departments would disagree, we believe there is a need for an annual Departmental report, highlighting accomplishments in all areas of teaching, scholarship, and service. HOWEVER, if the University goes to this method of reporting, then a significant revision to the Self-Study process is required. Our suggestion would be for the self-study to simply consist of the annual reports, annual assessment reports, accurate data tables provided by the University, with sections VII, VIII, and IX filled in by departments.