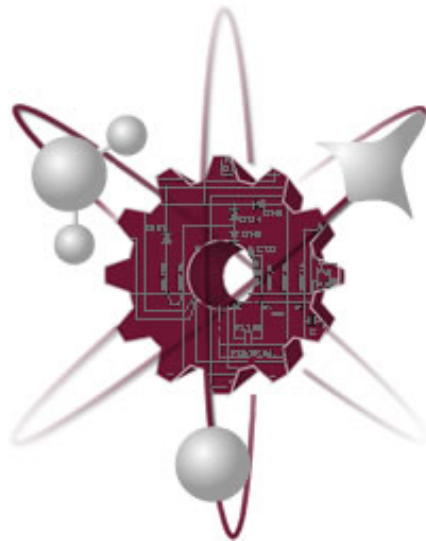


# **Criterion 4: Continuous Improvement**

## **Engineering Physics**

Bachelor of Science in Engineering Physics



## **Self-Study Report**

**New Mexico State University**



**June 2012**

## CRITERION 4. CONTINUOUS IMPROVEMENT

This section discusses improvements of our Engineering Physics program during the last ABET cycle (2006-2012). In general, improvements were made as the result of a whole series of different assessment results, which can roughly be categorized into: program-quality, educational-objectives and program-outcomes assessments. The Department of Physics utilizes a well-defined set of approaches and tools for the different types of assessment, and their timelines are briefly summarized below.

### **Program-Quality Assessment – Tools and Timeline**

Program quality can be closely correlated with a) *quality of instruction* and b) *relevance/extent of course offerings* in the program.

The former is regularly assessed by the following means:

- ***Student evaluations*** (done for every course each semester)  
*NMSU requires that students will be given the opportunity to fill out a student-evaluation form for each course near the end of a semester. Among others, the student evaluation has several questions about the student's perceived quality of instruction.*
- ***Pre-requisite tests*** (done for every physics undergraduate course each semester)  
*The Department of Physics introduced a pre-requisite test to be given in the 1<sup>st</sup> or 2<sup>nd</sup> class period. The main goal of the pre-requisite test is to identify whether previous instruction of necessary pre-requisite material was successful.*
- ***Faculty annual performance evaluations*** (once per year)  
*Each faculty member is required to submit a performance evaluation package every year. Teaching is part of these performance evaluations and the Department Head will discuss ways to address any identified weaknesses with the faculty member.*

The latter relies on input from our constituencies, and it is assessed in the following ways:

- ***Input from External Advisory Board*** (once per year)  
*The Engineering Physics External Advisory Board has members from all of the program's major constituencies. The board meets with physics faculty and other program representatives once every year on campus. The written reports provide guidance for the Engineering Physics curriculum.*
- ***Faculty and Student Input*** (not on a regular basis, occasionally)  
*The Department of Physics has limited teaching strength and therefore course offerings are often limited. On occasion, students and individual faculty members will try to accommodate additional course offerings outside of the regular curriculum.*

### **Educational-Objectives Assessment – Tools and Timeline**

Educational objectives are assessed by various approaches, which will be discussed in great detail in section A. *Program Educational Objectives* (see below). Except for alumni surveys, assessments of educational objectives tend to be mostly qualitative where the level of achievement is often implied. For their assessment, we used (or plan to use) the following tools:

- **Alumni Surveys** (once per year)

*The Department of Physics will approach a representative set of their Engineering Physics alumni once every year for a survey.*

- **Input from External Advisory Board** (once per year)

*The board meets with physics faculty and other program representatives once every year on campus. A re-occurring task for the board is to evaluate whether the program is successful in achieving its Educational Objectives.*

- **Employer Survey** (*proposed to be done* every other year)

*To date, we have not done any formal employer survey. The Engineering Physics Program Committee is presently developing such an adequate survey form.*

### **Program-Outcomes Assessment – Tools and Timeline**

The assessment of program outcomes will be discussed in great detail in section B. *Student Outcomes* (see below). For their assessment, we use (or plan to use) the following tools:

- **Program-Outcomes Measures in Courses** (*done for* every course each semester)

*For each relevant undergraduate course, instructors are asked to measure (one or more) program outcomes, as assigned by the Engineering Physics Outcomes matrix.*

- **Faculty Outcomes Reviews** (once per year)

*Outcome reviews are now due along with the annual faculty performance evaluations, usually in October. Each faculty member is responsible for reviewing one outcome.*

- **Senior-Exit Interviews** (every time when a student graduates from the program)

*The Physics Department Head will perform a formal exit interview using the Senior-Exit Form for each student in the graduating semester. The form has questions directly connected to program outcomes.*

## **A. Program Educational Objectives**

*It is recommended that this section include (a table may be used to present this information):*

- 1. A listing and description of the assessment processes used to gather the data upon which the evaluation of each the program educational objective is based. Examples of data collection processes may include, but are not limited to, employer surveys, graduate surveys, focus groups, industrial advisory committee meetings, or other processes that are relevant and appropriate to the program.*
- 2. The frequency with which these assessment processes are carried out*
- 3. The expected level of attainment for each of the program educational objectives*
- 4. Summaries of the results of the evaluation processes and an analysis illustrating the extent to which each of the program educational objectives is being attained*
- 5. How the results are documented and maintained*

### **Current and Previous Educational Objectives**

As discussed in *Criterion 2*, the *Program Educational Objectives* for the Engineering Physics Program were modified in Spring of 2012 to address the newer ABET definition of objectives.

Current *Educational Objectives* are strongly focused on alumni several years past graduation. The newly formulated *Educational Objectives* are:

- **EP Objective 1: Competitiveness.** Graduates are competitive in internationally-recognized academic, government and industrial environments;
- **EP Objective 2: Adaptability.** Graduates exhibit success in solving complex technical problems in a broad range of disciplines subject to quality engineering processes;
- **EP Objective 3: Teamwork and Leadership.** Graduates have a proven ability to function as part of and/or lead interdisciplinary teams.

Contrary, the previous Educational Program Objectives focused on graduates at the time of their graduation, i.e. in the ability to be fully prepared for joining the workforce. At the time, the Engineering Physics program was new, and there were insufficient graduates who were several years out. The previous Educational Program Objectives had been:

- **EP Objective 1 (old): Skills.** *Develop skills pertinent to problem-solving in physics and engineering, including expertise in design, data collection, analysis and modeling, creative thinking, and effective communication and collaborative-working skills;*
- **EP Objective 2 (old): Career Preparation.** *Prepared graduates to begin productive careers in industry, governmental laboratories and academic institutions, or to continue to advanced study in either a chosen engineering field or in physics;*
- **EP Objective 3 (old): Professional Adaptation.** *Enable students to adapt as needs in the profession change;*
- **EP Objective 4 (old): Ethics.** *Instill in our students an understanding of their professional and ethical responsibilities, grounded in the real life conflicts they will encounter after leaving school.*

Although there are some obvious correlations between the current and previous sets of *Program Educational Objectives*, we feel that the current set better complies with the most recent definition by ABET and it better reflects the needs of our constituents. Nevertheless, it is important to point out the correlations, since past assessment was done with respect to the previous set of Objectives.

The ‘new’ *Educational Objective 1 (Competitiveness)* can be correlated with the ‘old’ *Objectives 1 (Skills) & 3 (Career Preparation)*, although latter do not fully capture its spirit. In particular, we hope to train competitiveness on the long term, not only at the time of graduation.

The ‘new’ *Educational Objective 2 (Adaptability)* is basically the same as the ‘old’ *Objective 3 (Professional Adaptation)* but its definition is now better refined.

The ‘new’ *Educational Objective 3 (Teamwork and Leadership)* includes the ‘old’ *Objective 4 (Ethics)* as one its components (not necessarily a major one). Leadership potential and teamwork abilities have been greatly emphasized by our constituents, and we strongly felt that it is necessary to list them in a separate objective.

Next, assessment processes, their frequency, level of attainment and documentation of the results are discussed first for the set of *'old' Program Educational Objectives* and then for the *'new' set of Program Educational Objectives*.

### **Assessment of 'old' Program Educational Objectives**

In order to assess the level of achievement for the 'old' set of Objectives, we mostly used four (quantitative and qualitative) measures:

- Senior Exit Interviews (quantitative),
- Alumni Surveys (quantitative),
- Faculty Input (qualitative),
- Input from External Advisory Board (qualitative).

#### **Senior Exit Interviews**

1. Typically, graduating seniors will be given a formal exit interview that includes direct multiple questions for each of the standard ABET *Program Outcomes (a)-(k)*. A copy of the *Senior Exit Interview form* can be found at <http://engineeringphysics.nmsu.edu/forms.html>.
  - We used the answers for *Outcomes (a) - Scientific Expertise* and *(b) - Experimental Training* as a measure the level of achievement for the *EP Objective 1- Skills*.
  - We used the answers for *Outcomes (c) – Design Abilities, (e) Problem Solving, (g) Communication Skills* and *(k) – Technical Know-How* as a measure the level of achievement for the *EP Objective 2 - Career Preparation*.
  - We used the answers for *Outcomes (D) – Teamwork, (i)- Lifelong Learning* and *(j) – Contemporary Issues* as a measure the level of achievement for the *EP Objective 3- Professional Adaptation*.
  - We used the answers for *Outcomes (f) – Professional Responsibility* and *(h) – Societal Impact* as a measure the level of achievement for the *EP Objective 4- Ethics*.
2. Senior Exit Interviews are usually administered at the end of the graduating semester of a student. We collected exit interviews from 12 students since Fall 2006.
3. Students answered each question using a scale where 1 = agree, 2 = neutral, 3 = disagree, and 4 = not important. If the average numerical value was higher than 2.0, we used this as an indicator that the target was not met. Table 4.1 lists the results for all *Program Outcomes (a)-(k)* from *Senior Exit Interviews*.
4. The average values for all program outcomes meet the target, except for the individual score for *Outcome (b) – Experimental Training*, which slightly missed its target. Taking into the above assignments between *Program Outcomes* and *Educational Objectives*, this finding indicates that graduates felt at the time of their graduation that all four of 'old' *Educational Objectives* have been met.
5. The Department of Physics keeps electronic copies of all *Senior Exit Interviews*, and hard copies are provided in the *'Black' Objectives Notebook*.

**Table 4.1. Averaged values for responses for *Program Outcomes* received from *Senior Exit Interviews*. The table contains the average of responses (scale: 1 = agree, 2 = neutral, 3 = disagree, and 4 = not important) and the number of students responding.**

	2007		2008		2009		2010		2011		2012		average
		N		N		N		N		N		N	
<b>a. Scientific Expertise</b>	1.0	1	1.0	2	1.7	1	1.2	3	2.0	2	1.7	3	<b>1.4</b>
<b>b. Experimental Training</b>	3.0	1	1.5	2	1.3	1	2.0	3	2.0	2	2.2	3	<b>2.1</b>
<b>c. Design Abilities</b>	2.3	1	1.5	2	1.7	1	1.3	3	1.2	2	2.1	3	<b>1.6</b>
<b>d. Team-work</b>	1.8	1	1.0	2	1.5	1	1.0	3	1.0	2	1.5	3	<b>1.2</b>
<b>e. Problem Solving</b>	1.0	1	1.0	2	1.0	1	1.0	3	1.8	2	1.5	3	<b>1.3</b>
<b>f. Professional Respons.</b>	1.8	1	2.0	2	2.0	1	1.0	3	1.5	2	2.0	3	<b>1.7</b>
<b>g. Commun. Skills</b>	1.8	1	2.0	2	3.0	1	1.3	3	1.5	2	1.8	3	<b>1.8</b>
<b>h. Societal Impact</b>	1.8	1	2.3	2	2.0	1	1.0	3	2.0	2	2.1	3	<b>1.8</b>
<b>i. Life-long Learning</b>	2.3	1	2.0	2	2.7	1	1.2	3	1.7	2	2.1	3	<b>1.9</b>
<b>j. Contemp. Issues</b>	1.8	1	1.5	2	1.0	1	1.0	3	1.8	2	1.9	3	<b>1.5</b>
<b>k. Technical Know-How</b>	1.0	1	2.0	2	1.4	1	1.3	3	1.4	2	2.1	3	<b>1.6</b>
<b>Total Average</b>												<b>1.6</b>	

### Alumni Surveys

Alumni Surveys are used to see whether Engineering Physics graduates continue to feel that they had been well prepared once they have been embedded in the workforce for some period.

1. We developed a formal questionnaire, the *Alumni Survey Form*, which includes direct inquiries about each of the *Educational Objectives*.
2. The Department of Physics tries to stay in contact with their Engineering Physics alumni and attempts to contact them once every year. No survey was attempted in 2010 since the Physics building (Gardiner Hall) underwent major renovation and the faculty members were relocated to temporary housing for all of 2010. Alumni are typically contacted using their last known e-mail address. Responses from alumni can be fairly sporadic at times.
3. Unlike in senior exit interviews, the alumni survey used a different scale where 5 = strongly agree, 4 = agree, 3 = no opinion, 2 = disagree, and 1 = strongly disagree. Responses where the average was below 4.0 were used as an indicator that the target was not met. Table 4.2

lists all the combined average values for the 'old' Program Educational Objectives obtained from Alumni Surveys. Responses from alumni who are more than 3 years past graduation are provided as well.

4. The average values indicate that the targets for the 'old' Educational Objectives EP 1 – Skills and EP 3 – Professional Adaptation are met, while they are narrowly missed for EP 2 – Career Preparation (only in the combined score of recent and 3+ year alumni) and EP 4 – Ethics. The Department of Physics has made changes in order to improve level of achievement in those areas (see C. Continuous Improvement).
5. The Department of Physics keeps electronic copies of all Alumni Survey Interviews, and hard copies are provided in the 'Black' Objectives Notebook.

**Table 4.2.** Averaged values for responses received from Alumni Surveys concerning Program Educational Objectives. The table contains the average of responses (scale: 5 = strongly agree, 4 = agree, 3 = no opinion, 2 = disagree, and 1 = strongly disagree) and the number of students responding. The numbers in brackets are the responses from alumni who graduated more than 3 years prior to the survey.

	2008		2009		2011		2012		Avg.
		N		N		N		N	
<b>EP 1 Skills</b>	4.5 (4.0)	4 (1)	4.1 (4.5)	7 (4)	3.0 (4.0)	2 (1)	4.4 (4.3)	5 (4)	<b>4.2</b> <b>(4.3)</b>
<b>EP 2 Career Prep.</b>	4.5 (5.0)	4 (1)	4.0 (4.8)	7 (4)	2.5 (3.0)	2 (1)	3.8 (3.8)	5 (4)	<b>3.9</b> <b>(4.2)</b>
<b>EP 3 Prof. Adapt.</b>	4.5 (5.0)	4 (1)	5.0 (5.0)	7 (4)	4.5 (5.0)	2 (1)	3.8 (4.0)	5 (4)	<b>4.5</b> <b>(4.6)</b>
<b>EP 4 Ethics</b>	3.8 (3.0)	4 (1)	4.1 (4.0)	7 (4)	3.5 (4.0)	2 (1)	3.6 (3.5)	5 (4)	<b>3.8</b> <b>(3.5)</b>

### Faculty Input

The Department of Physics and the participating Engineering Departments have very diverse faculties, many of whom have collaborations and other interaction with potential future employers of our Engineering Physics graduates (see *Criterion 6 – Faculty*). Subsequently, many of the faculty members are well equipped judging whether our students are indeed adequately prepared, and the Engineering Physics Program Committee continuously seeks faculty input.

1. The Department of Physics holds a number of regular meetings, during which there may be discussion of issues related to EP Educational Objectives, such as
  - EP Committee meetings,
  - regular faculty meetings,
  - student assessment meetings,
  - faculty retreats.

2. In the Department of Physics, Engineering Physics Program Committee and faculty meetings are held at least once every month (or more often, if needed), student assessment meetings are held once per year and there is a faculty retreat just prior to the beginning of each semester.
3. The faculty in provides important input in the following areas related to the *Program Educational Objectives*, such as
  - help with the assessment of program outcomes and evaluate the different assessment tools,
  - point out weaknesses or areas of concern and suggest ways to address them,
  - evaluate the appropriateness of *Program Educational Objectives*.
4. While the faculty members provide quantitative outcomes measures (see section 4B. *Program Outcomes*), their contributions to *Program Educational Objectives* are mostly qualitative (for example, anecdotal information). Even so, such information has had some impact on the way the program is administered.
5. The Department of Physics keeps electronic copies of all meeting minutes.

#### Input from the External Advisory Board

As outlined in *Criterion 2- Educational Objectives*, the External Advisory Board has members from all major constituencies of the Engineering Physics program. Therefore, the role of the board on the EP program in general cannot be overstated. Recommendations and advice of the board in any area is always be taken very seriously by the Department of Physics and the Engineering Physics Program Committee.

1. The board's main tasks are to evaluate the quality of the program and identify areas of opportunity or improvement. The board also provides indispensable feedback about the choice and level of attainment of the *Program Educational Objectives*
2. Except for 2010 (when the Department of Physics was displaced from Gardiner Hall), the department has held External Advisory Board meeting each year since 2007.
3. All of the past External Advisory boards provided increasingly positive feedback about the program's progress overall and in achieving its *Educational Objectives*. The most recent board meeting (2011/2012) also helped to re-define and re-write the *Educational Objectives*.
4. After an External Advisory Board meeting, the board provides a written report about findings and recommendations, and past boards tended to provide very detailed reports (10+ pages). In addition, the Engineering Physics Program Committee takes minutes and keeps copies of all presentations during the board meetings.
5. The Department of Physics keeps electronic copies of the External Advisory Board Reports and the meeting minutes, and hard copies are provided in the '*Black' Objectives Notebook*. Copies of the presentations given at board meetings are stored electronically/



## **Assessment of ‘new’ Program Educational Objectives**

As mentioned above, the ‘new’ *Program Educational Objectives* have been implemented just recently, and subsequently previous assessments were not geared toward these ‘new’ targets. However, a substantial wealth of information is found in records from past assessments as well as records about alumni, which in turn does allow to get at least some rough ideas about level of achievement for each of three ‘new’ *Program Educational Objectives*. For future assessment purpose, we plan to utilize three major assessment tools:

- ***Alumni Surveys.***

*Regular surveys of alumni will provide the following data: 1) quantitative results about level of attainment for each individual Program Educational Objective, and 2) updated employer information and job descriptions.*

- ***Input from External Advisory Board.***

*The External Advisory Board will continue to be the main assessor of the Engineering Physics program.*

- ***Employer Surveys.***

*To date, we have not performed any employer surveys. We intend to contact present employers of alumni after they have been employed for more than 1 year. A survey form is presently being developed.*

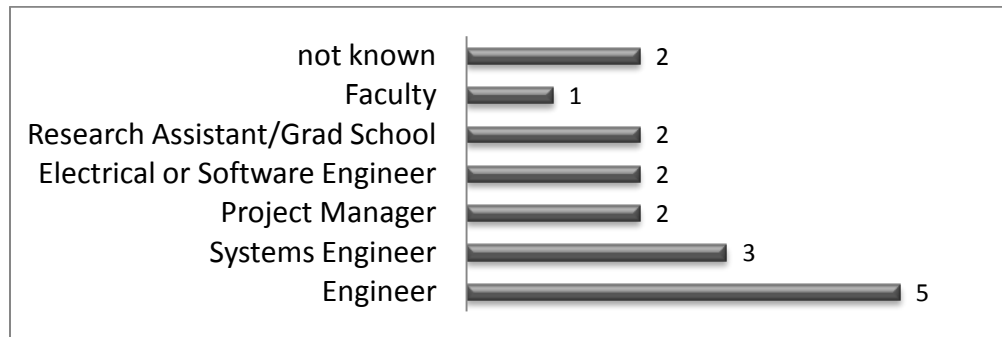
With the implementation of ‘new’ *Program Educational Objectives*, we modified the *Alumni Survey Form* to reflect those. A copy of the most up-to-date *Alumni Survey Form* can be found at <http://engineeringphysics.nmsu.edu/forms.html>, and it is also provided in *Supplementary Information*.

However, even the past alumni surveys can be used to assess level of achievement for each of the ‘new’ *Program Educational Objectives*. For example, this is clearly the case for the ‘new’ *EP Objective 2 – Adaptability* (as it is essentially the same as the ‘old’ *EP Objective 3*). It was already pointed out that also the other two ‘new’ objectives can be somewhat correlated to ‘old’ ones.

More importantly, alumni surveys also allowed keeping up-to-date employer information and current job descriptions of our alumni.

To date, the Engineering Physics program graduated 19 students. Two of those students graduated in the most recent semester (Spring 2012) at the time this document was written (one in Engineering Physics with the *Mechanical concentration* and the other with the *Aerospace concentration*) and they just started looking for jobs. A recent survey revealed that our Engineering Physics alumni are recruited for diverse jobs in science and engineering, and they are frequently hired for well-paid and high-level positions, as evidenced by the job titles given in Diagram 4.1. This provides evidence that the ‘new’ *EP Objective 1- Competitiveness* is achieved. In addition, all alumni indicated that they work as part of teams and three of the alumni indicated that they are leaders of a major project. This can be taken as evidence that the ‘new’ *EP Objective 3- Teamwork and Leadership* is achieved.

**Diagram 4.1. Job titles of Engineering Physics alumni who graduated prior to Spring 2012.**



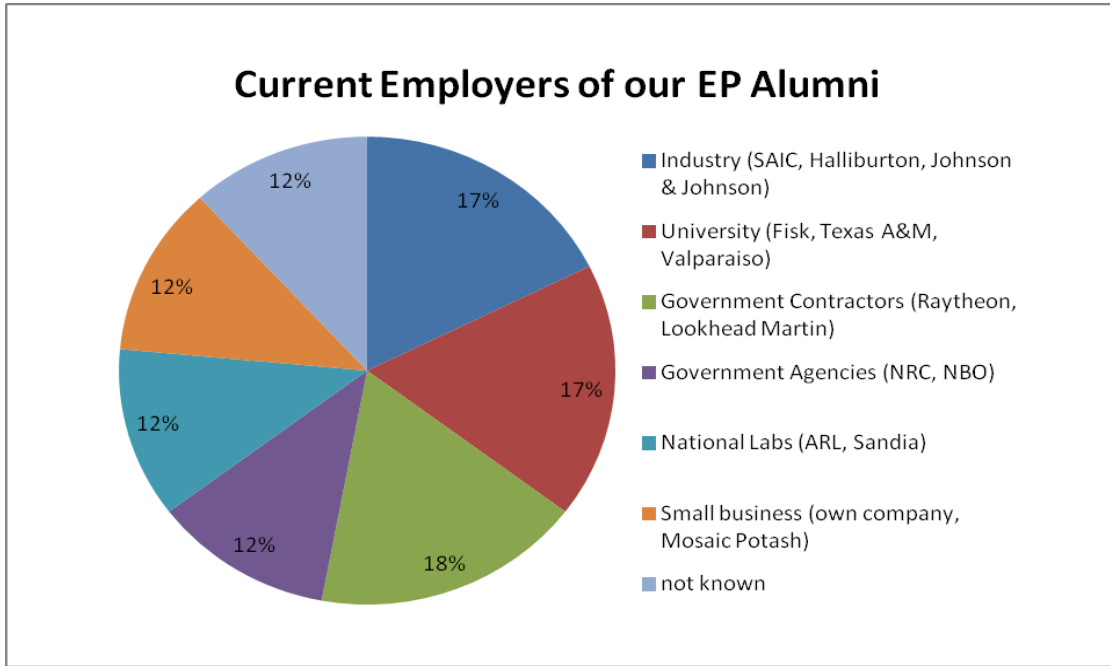
The alumni surveys also provide up-to-date employer information. Of the 17 alumni prior to Spring 2011, 7 have completed (or are pursuing) advanced graduate degrees (1 PhD in Physics, 1 PhD in Nuclear Engineering, 1 MS in Physics, 2 MS in Electrical Engineering, 1 PhD student in Physics, 1 PhD student in Mechanical Engineering) and another 7 found employment with industry, small business, government agencies or national laboratories (see Diagram 4.2). The diagram provides ample evidence that our Engineering Physics alumni are clearly competitive and that they find employment in many different research and technological areas, which gives further evidence that ‘new’ objectives *EP 1 – Competitiveness* and *EP 2 – Adaptability* are attained.

In addition to the more formal alumni surveys, the Department of Physics tries to connect with alumni in person, whenever possible. Alumni are invited to the departmental picnics and on occasion faculty members or the department head set up meetings with alumni when they happen to visit locations near an alumni’s new affiliation. These meetings provide important anecdotal information. As an example, Dr. Zollner (Physics Department Head) met with one of our early alumni recently, and below is the report of his interaction with the alumni:

*In June 2012, the Physics Department Head visited one of the earliest alumni of the program, who graduated in the spring 2005 semester. The alumnus has worked for several companies over the years and has been very successful. Currently, he works as a civilian at a Navy Air Base in Southern Maryland. His job responsibility addresses electromagnetic effects on Navy aircraft. The alumnus provides specifications to air craft suppliers and works with suppliers during the R&D process to make sure the specifications are met. When manufacturing is completed, the alumnus performs extensive tests, before the new air craft is released to the squadron. The test facilities for these air craft are quite impressive. The alumnus does not have direct reports, but has access to a technician pool for his work. The alumnus seemed very happy in his current position. He holds a civilian rank in the Navy equivalent to Lieutenant Commander. He is interested in rising to a higher position in the Navy, but this will take some time. He is interested in a technical MS degree, but it would have to be mostly online. Unlike engineers, who follow prescribed paths towards resolving technical problems, our engineering physics alumnus says that he tries to understand WHY something does not work and follows a less structured approach towards problem resolution. This sometimes works better than a canned solution. The alumnus offered a suggestion for a capstone project on electromagnetic effects (paper shredder*

and cathode ray tube television) and said he was willing to provide his experience, advice, and guidance to students on such a project.

**Diagram 4.2. Employers of NMSU’s Engineering Physics alumni who graduated prior to Spring 2012.**



## B. Student Outcomes

*It is recommended that this section include (a table may be used to present this information):*

1. *A listing and description of the assessment processes used to gather the data upon which the evaluation of each student outcome is based. Examples of data collection processes may include, but are not limited to, specific exam questions, student portfolios, internally developed assessment exams, senior project presentations, nationally-normed exams, oral exams, focus groups, industrial advisory committee meetings, or other processes that are relevant and appropriate to the program.*
2. *The frequency with which these assessment processes are carried out*
3. *The expected level of attainment for each of the student outcomes*
4. *Summaries of the results of the evaluation process and an analysis illustrating the extent to which each of the student outcomes is being attained*
5. *How the results are documented and maintained*

While the *Senior Exit Interviews* (discussed in the previous section) provide some rough ideas about the level of achievement for different program outcomes, those are primarily at the course level (see *Criterion 3 – Program Outcomes*). Each course instructor knows which program outcomes are assigned to be measured in that course. They are then asked to design a quantitative measure for each program outcome, if none exists. Instructors’ results are documented in the Instructors Notebooks each time the course is taught. In 2008, we started a process where individual faculty members are asked to summarize the findings for one

particular outcome. That way we made sure that all faculty members are not only aware but also involved in the assessment process. The summaries are collected annually and documented in the *Program Outcomes Notebook*. An example of an Outcomes Assessment is provided in *Supplementary Information*.

The program-outcome assessment process focuses on courses offered by the Department of Physics. In conjunction with this, assessment of required outcomes in Aerospace, Chemical, Electrical, and Mechanical Engineering is conducted in done in the respective engineering departments as part of ABET accreditation for their majors (see *Criterion 3 – Program Outcomes*). Engineering faculty is represented on the Engineering Physics Program Committee, which helps to align the curriculum and outcomes assessment for their majors with the ones of the Engineering Physics program. It should be noted that this makes for a particularly strong Engineering Physics program, with ABET *Program Outcomes (a)-(k)* being assessed in multiple departments.

Below, we summarized the results for each of the program outcomes, which were measured as part of the Engineering Physics program.

#### **Program Outcome (a) - Scientific Expertise**

1. This program outcome was assessed using the national *Force Concept Inventory* test (Hestenes, Wells, and Swackhamer, 1992; Hestenes, D., and I. Halloun, 1995), final exam results, embedded questions, *Mastering Physics*<sup>®</sup> skill building problems, and final exam results. In addition, the *Educational Testing Service (ETS) Physics Major Field Test* was administered in Spring 2012. The *ETS* has two sections, and the introductory section was used to assess *Program Outcome (a)*.
2. Typically, data are collected in relevant classes each time they are taught, i.e. *Physics 213, 214, 215, 216, and 217*.
3. The target level is set by instructor depending on method used. Occasionally, instructors used nationally administered tests, in which case the national norm was used to define the target. For example, some instructors used the *Force Concept Inventory*, which was given at the beginning and end of the class in order to gauge improvement. The target level was set at 48% by the instructor based on national expectations for a course using a traditional-instruction approach; for an active-learning based course, the national average is 23%. The target for the *ETS Physics Major Field Test* was set at 50% as rated nationally.
4. The results are displayed in Diagram 4.3.a. All of the measurements indicate that the level of achievement is between 80% and 110% of target. *Program Outcome (a)* is one of the more straightforward measures for a program in physics or engineering physics. courses,. On the *ETS Physics Major Field Test* introductory section, the median student was the 47<sup>th</sup> percentile, slightly below national target.
5. Results are documented in the *Instructors Notebooks* for relevant classes and summarized in the *Program Outcomes Notebook*.

#### **Program Outcome (b) - Experimental Training**

1. This program outcome was assessed using final exam grades, laboratory homework, embedded final exam questions, and individual lab reports.

2. Data were collected in relevant classes each time they are taught, i.e. *Physics 213L, 214L, 215L, 216L, 217L, and 475*.
3. The target level is set by instructor depending on method used. In many cases, the departmental average or the B grade value, and several instructors used this as the target value. In other cases, however, the instructor set the standard based on their expectations.
4. The results are shown in Diagram 4.3.b, and it is apparent that almost all results are near the target levels.
5. Results are documented in the *Instructors Notebooks* for relevant classes and summarized in the *Program Outcomes Notebook*.

#### **Program Outcome (c) - Design Abilities**

1. This program outcome was assessed using students' *Experimental Design Reports (Physics 315L)* and instructor's observations during the assembly of a muon-decay experiment.
2. We expected data to be collected in relevant classes each time they were taught, i.e. *Physics 315L, 471, 475, and 476*.
3. The target was set by instructors who measured this outcome at 80%.
4. As can be seen in Diagram 4.3.c, unfortunately only two courses were able to report results for this particular outcome. The few available results were near target level. *Physics 471 - Experimental Optics* was not offered since 2006 because the instructor of that course retired. *Physics 476 - Computational Physics*, a possible EP elective, is cross-listed with the graduate *Physics 576*, and it too little undergraduate enrollment in order to do a meaningful assessment. In order to boost the number of assessments for this particular outcome in future assessment, the Engineering Physics Program Committee decided to add this outcome to the list of expected measures in *Physics 217L - Heat Light and Sound Lab*.
5. Results are documented in the *Instructors Notebooks* for relevant classes and summarized in the *Program Outcomes Notebook*.

#### **Program Outcome (d) - Teamwork**

1. This program outcome was typically assessed *Peer Team Evaluations* in laboratory courses. Students ranked contributions and participation of their peers on a scale of 1-4.
2. We expected data to be collected in assigned classes each time they were taught, i.e. *Physics 315L, 471L, and 475*.
3. The targets were set by the instructors.
4. As can be seen in Diagram 4.3.d, the targets were generally met. The students usually get along well, even there is the occasional problem student. *Physics 471L- Optics Lab* was last taught in Spring 2008 and it will be taught again in Fall 2012. In future assessments, *Physics 217L - Heat, Light and Sound Lab* will provide an additional measurement for this outcome.
5. Results are documented in the *Instructors Notebooks* for relevant classes and summarized in the *Program Outcomes Notebook*.

#### **Program Outcome (e) - Problem Solving**

1. This program outcome was assessed almost entirely by using *Graduate Record Exam (GRE)* questions inserted into quizzes and tests. In *Physics 451*, Fall 2011, this was supplemented by using the *Force Concept Inventory* test. Moreover, in Spring of 2012, the *Educational*

*Testing Service (ETS) Physics Major Field Test* was administered. It has two sections, and the advanced section was used to assess *Program Outcome (e)*.

2. Data are collected in assigned classes each time they are taught, i.e. *Physics 451, 454, 455, 461, 462, and 480*.
3. All instructors used the national norm as the target for GRE questions. We acknowledge that the standard *GRE test* limits the time students can spend on each problem, and this is quite difficult to repeat in a regular classroom setting. Therefore, it can be expected that students would typically perform at levels above the national norm. For the *Force Concept Inventory* the level was set at 85%, which is considered the Newtonian Mastery level. The *ETS Physics Major Field Test* target was set at the 50<sup>th</sup> percentile for the advanced physics section
4. As can be seen in diagram 4.3.e., using *GRE* questions, targets were typically met and often exceeded. Most students met the Newtonian Mastery level on the Force Concept Inventory test, although a few students scored well below it. On the *ETS Physics Major Field Test* the median student score was at the 68<sup>th</sup> percentile, again well above the target.
5. Results are documented in the *Instructors Notebooks* for relevant classes and summarized in the *Program Outcomes Notebook*.

#### **Program Outcome (f) - Professional Responsibility**

1. Assessment of this program outcome was done using essays and/or student use of citations in essays, although other measures were used as well. For example, in *Physics 473*, homework completion rate and in-class worksheet completion rate were used (percent of homework and worksheets completed by students). This indicates if the students were being responsible for homework completion and class attendance.
2. This outcome is measured each time a relevant course is taught, i.e. *Physics 315, 315L, 470, 471, 473, 475, 488, and 489*.
3. Targets were set by individual instructors of each course.
4. As can be seen in diagram 4.3.f, the targets were typically met. *Physics 470 - Physical Optics* and *Physics 471 - Modern Experimental Optics* are no longer part of the curriculum, and these courses have been replaced by *Physics 473*, which was first taught in Spring 2012.
5. Results are documented in the *Instructors Notebooks* for relevant classes and summarized in the *Program Outcomes Notebook*.

#### **Program Outcome (g) - Communication Skills**

1. Assessment of this program outcome was done using written reports in lab courses with an emphasis on writing quality and grammar, and from oral presentations.
2. We expected that this outcome would be measured each time a relevant course is taught, i.e. *Physics 315, 471, and 475*.
3. Targets were set by instructors.
4. As can be seen in diagram 4.3.g, students' communication skills are good. *Physics 471 - Physical Optics* is no longer part of the curriculum as the instructor has retired..
5. Results are documented in the *Instructors Notebooks* for relevant classes and summarized in the *Program Outcomes Notebook*.

#### **Program Outcome (h) - Societal Impact**

1. Assessment of the program outcome was done through essays, specific homework assignments, and class participation.
2. This outcome was measured each time relevant classes were taught: *Physics 315, 470, 488, 489, and 305V*.
3. Targets were set by the instructors.
4. As can be seen in diagram 4.3.h, targets were generally reached. *Physics 489 - Modern Materials* was particularly relevant to this outcome. *Physics 470 - Physical Optics* is no longer part of the curriculum and was not taught during this time period.
5. Results are documented in the *Instructors Notebooks* for relevant classes and summarized in the *Program Outcomes Notebook*.

#### **Program Outcome (i) - Lifelong Learning**

1. This program outcome was assessed with essays, selected homework problems, and oral presentations.
2. This outcome was measured each time the relevant classes were taught, i.e. *Physics 315, 488, 489, and 305V*.
3. Targets were set by instructors.
4. As can be seen in diagram 4.3.f, targets were not met in early years, but there are indications of improvement in more recent semester.
5. Results are documented in the *Instructors Notebooks* for relevant classes and summarized in the *Program Outcomes Notebook*.

#### **Program Outcome (j) - Contemporary Issues**

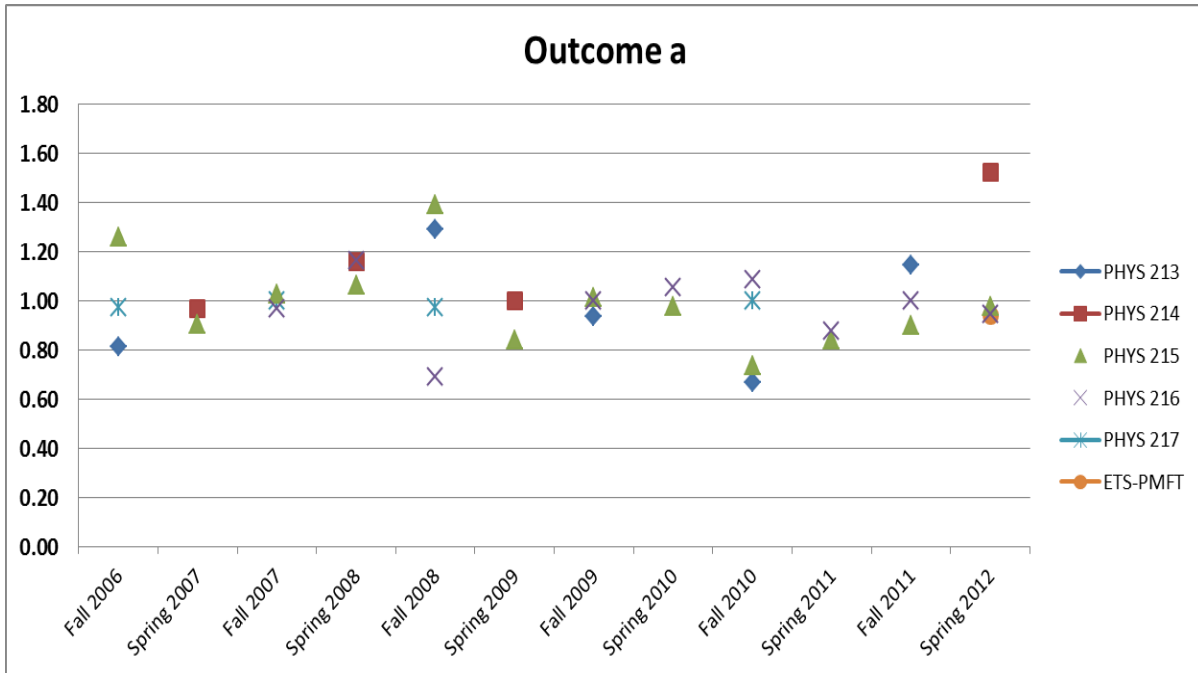
1. Assessment of this program outcome was done using essays, often with an emphasis on the choice of presentation topic, and oral presentations.
2. This outcome was measured each time the relevant classes were taught, i.e. *Physics 315, 470, 488, 489, and 305V*.
3. Targets were set by instructors.
4. As can be seen in diagram 4.3.j, targets were generally met.
5. Results are documented in the *Instructors Notebooks* for relevant classes and summarized in the *Program Outcomes Notebook*.

#### **Program Outcome (k) - Technical Know-how**

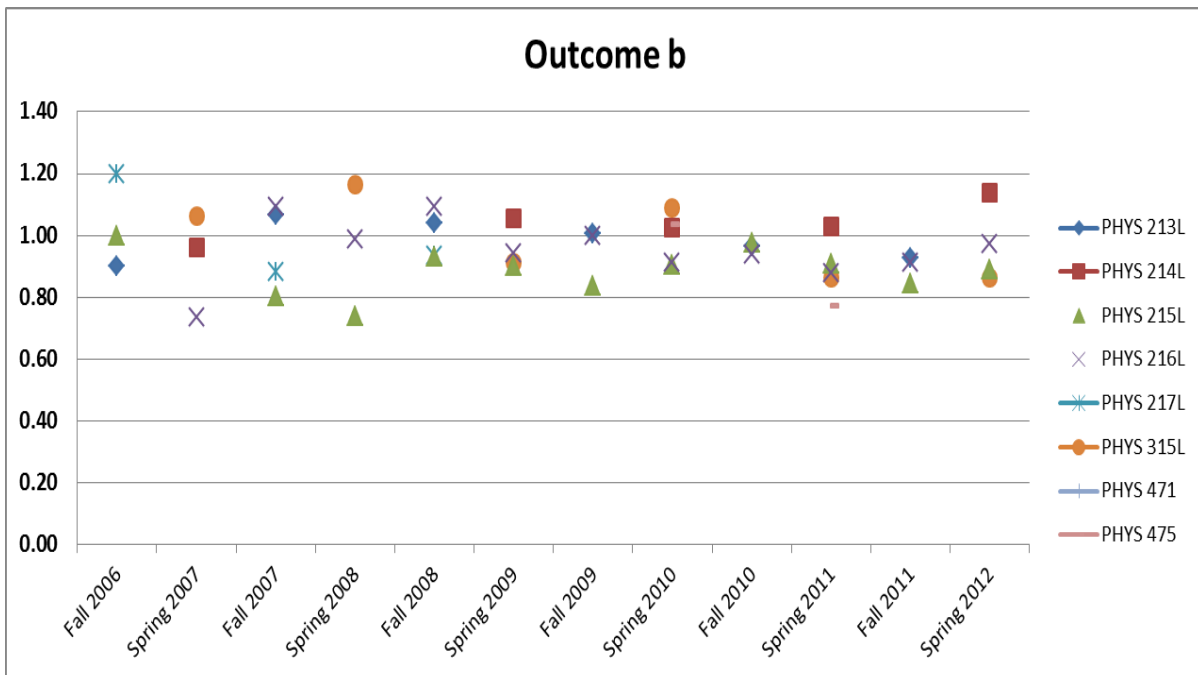
1. Assessment of the program outcome used in-lab observations in the lab courses and exam questions or standardized questions from the *Fundamental Engineering* exam (FE).
2. This outcome was measured in lab courses each time they were taught, i.e. *Physics 315L, 471, 475, 476, and 495*.
3. Targets were set by instructors.
4. As can be seen in diagram 4.3.k, targets were generally met.
5. Results are documented in the *Instructors Notebooks* for relevant classes and summarized in the *Program Outcomes Notebook*.

Below, we display the Diagrams 4.3.a-k, which summarize the results discussed above.

**Diagram 4.3.a. Measured level of achievement (normalized to the stated target) of all courses for *Program Outcome (a)* since Fall of 2006.**

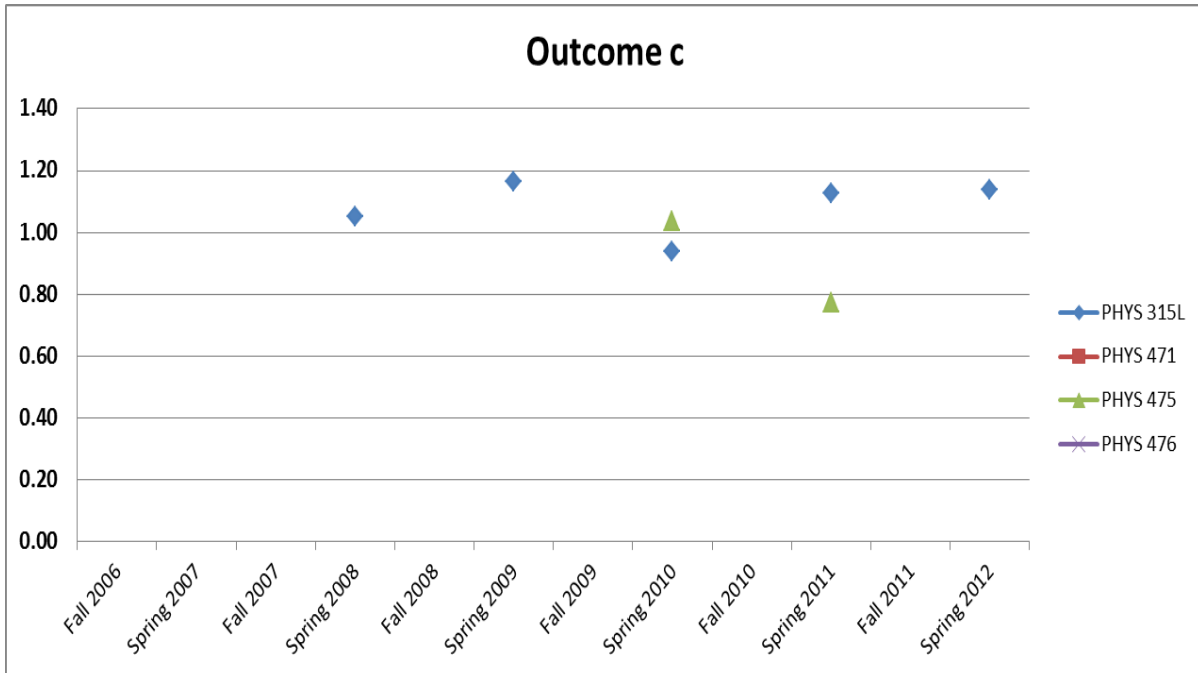


**Diagram 4.3.b. Measured level of achievement (normalized to the stated target) of all courses for *Program Outcome (b)* since Fall of 2006.**

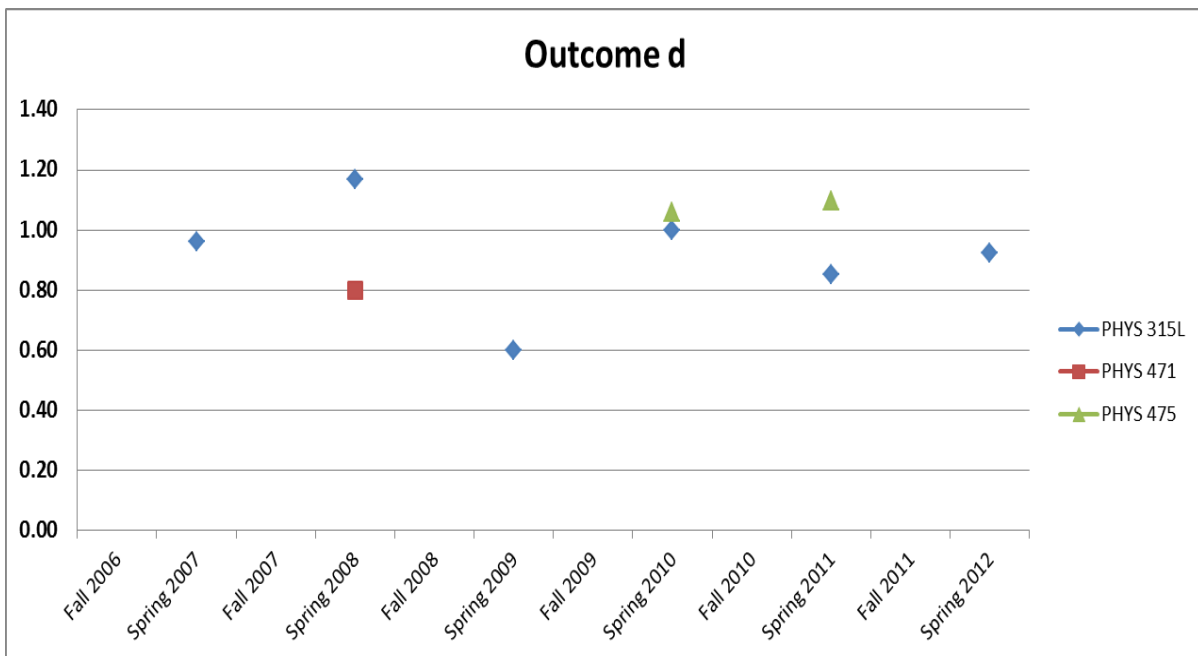




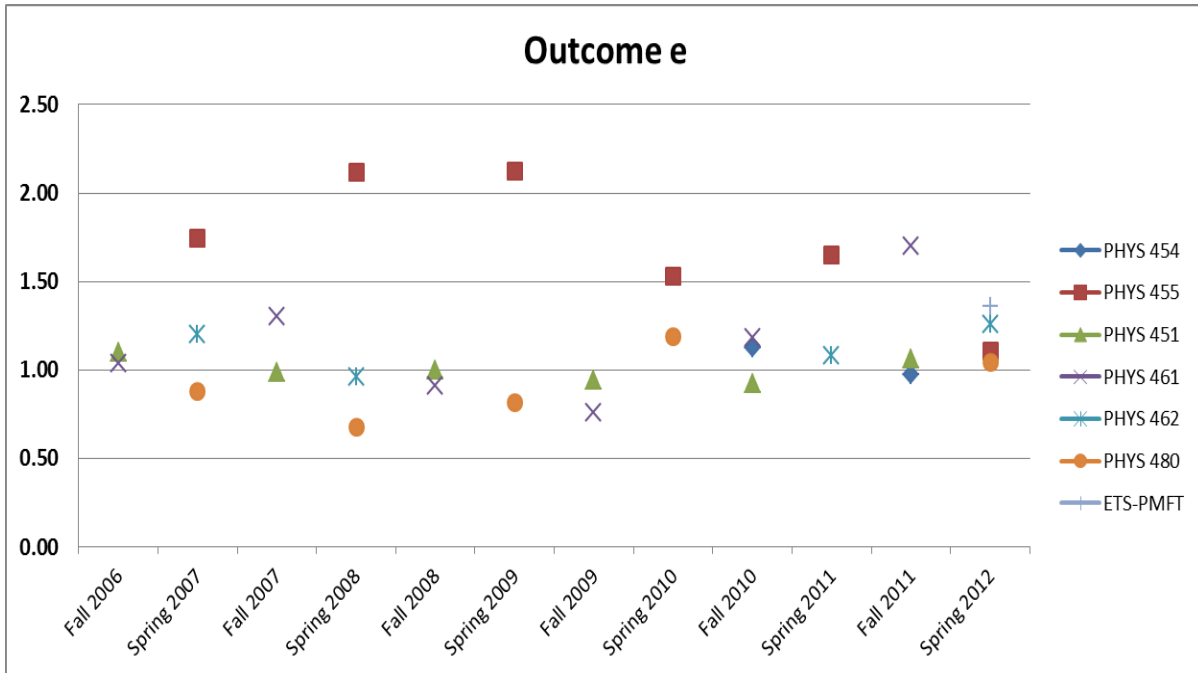
**Diagram 4.3.c. Measured level of achievement (normalized to the stated target) of all courses for *Program Outcome (c)* since Fall of 2006.**



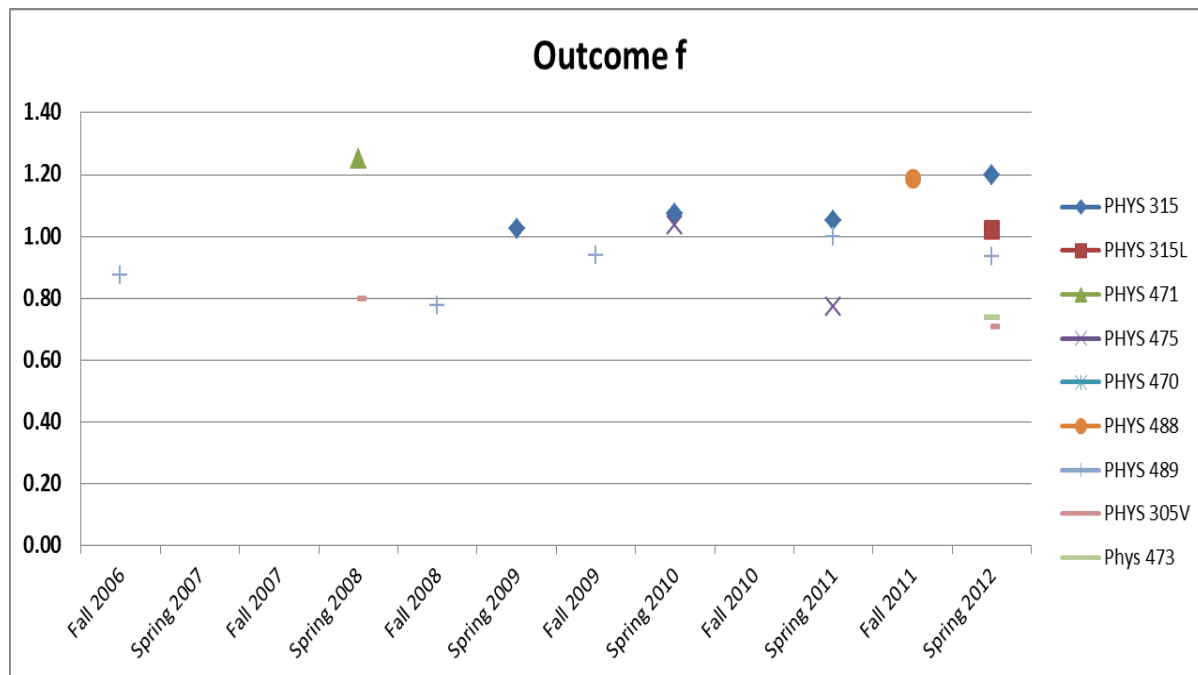
**Diagram 4.3.d. Measured level of achievement (normalized to the stated target) of all courses for *Program Outcome (d)* since Fall of 2006.**



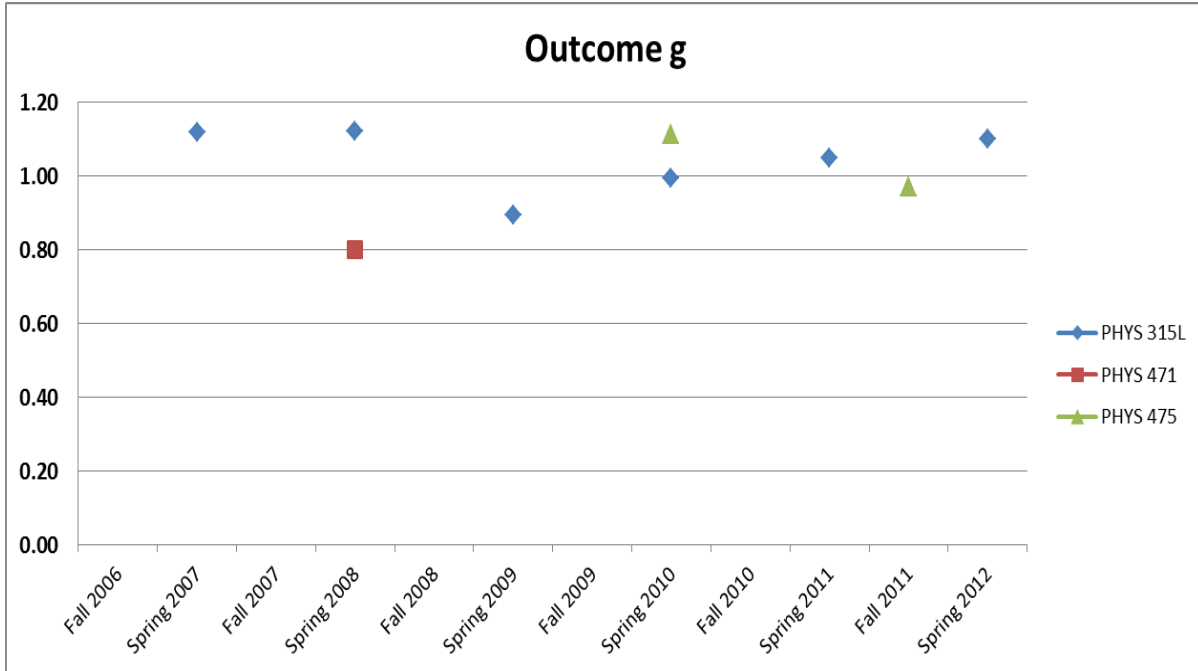
**Diagram 4.3.e. Measured level of achievement (normalized to the stated target) of all courses (and other measures) for *Program Outcome (e)* since Fall of 2006.**



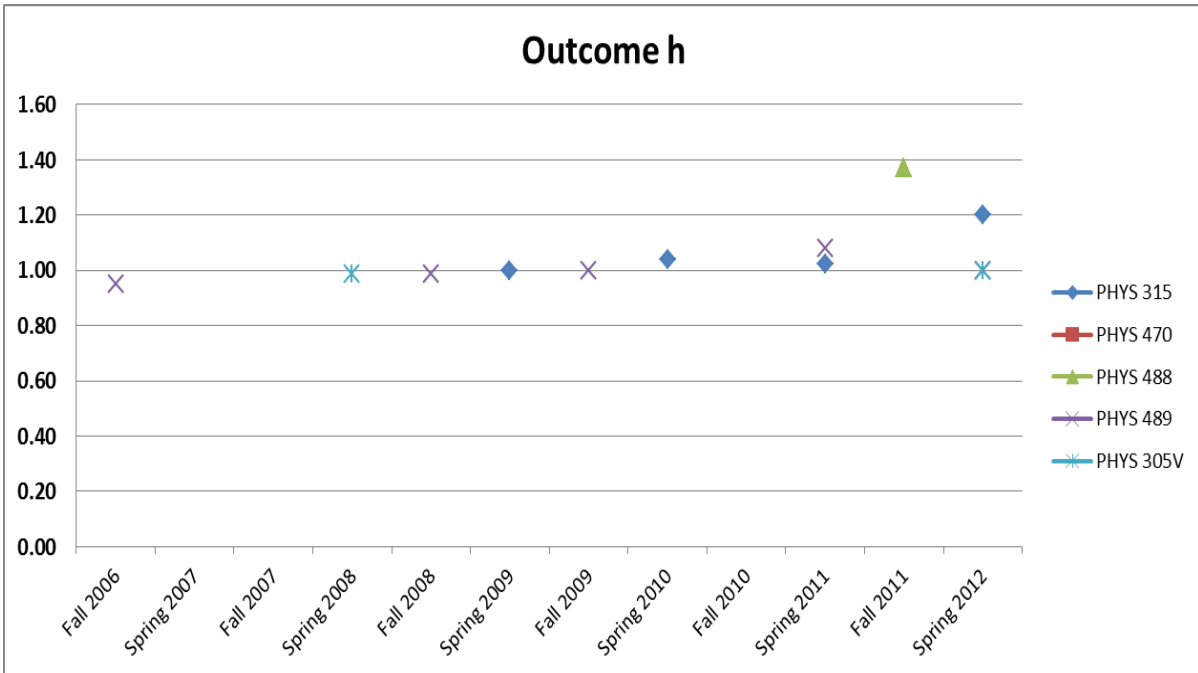
**Diagram 4.3.f. Measured level of achievement (normalized to the stated target) of all courses for *Program Outcome (f)* since Fall of 2006.**



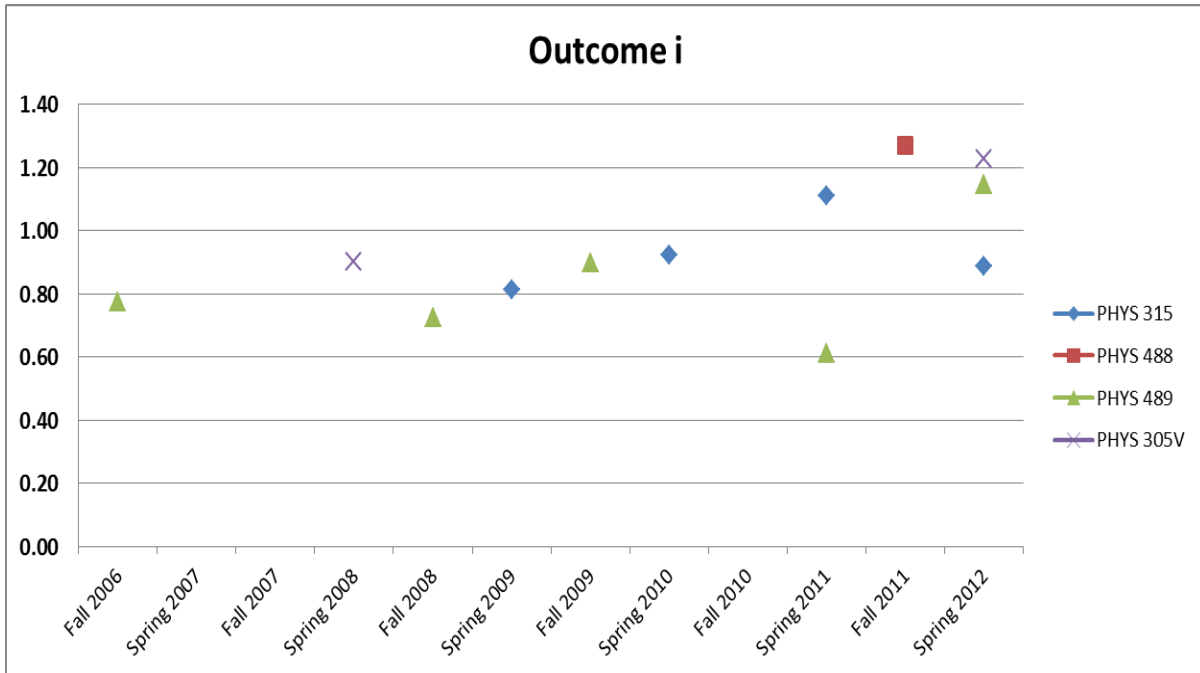
**Diagram 4.3.g. Measured level of achievement (normalized to the stated target) of all courses for *Program Outcome (g)* since Fall of 2006.**



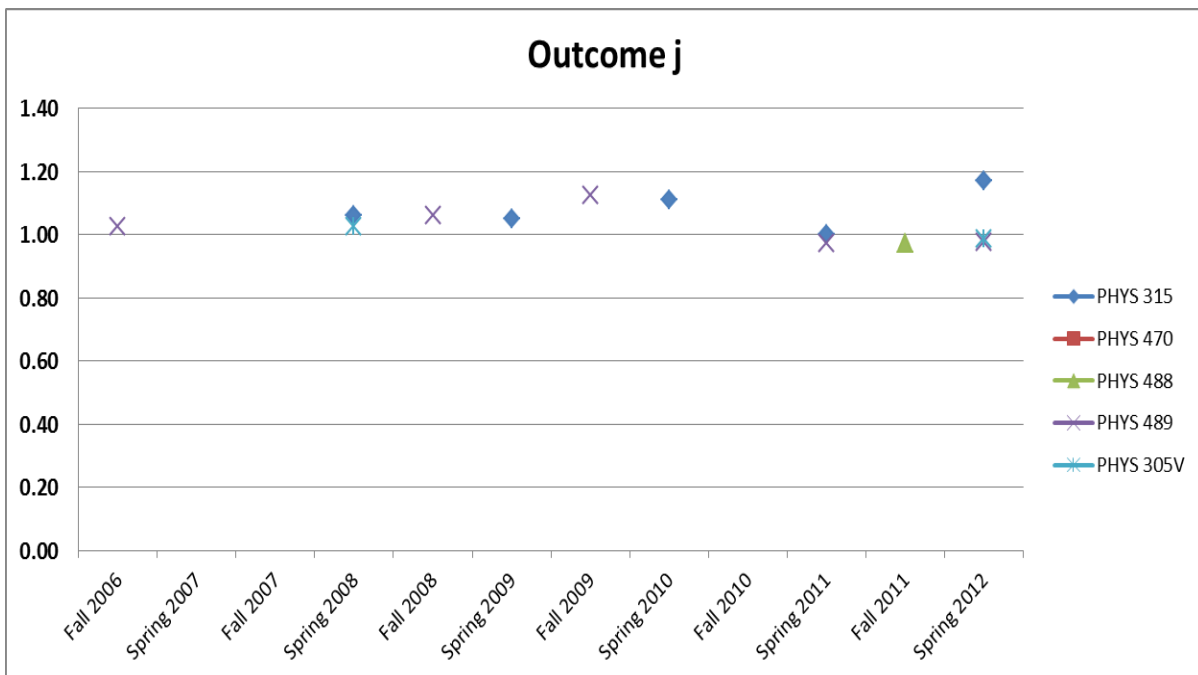
**Diagram 4.3.h. Measured level of achievement (normalized to the stated target) of all courses for *Program Outcome (h)* since Fall of 2006.**



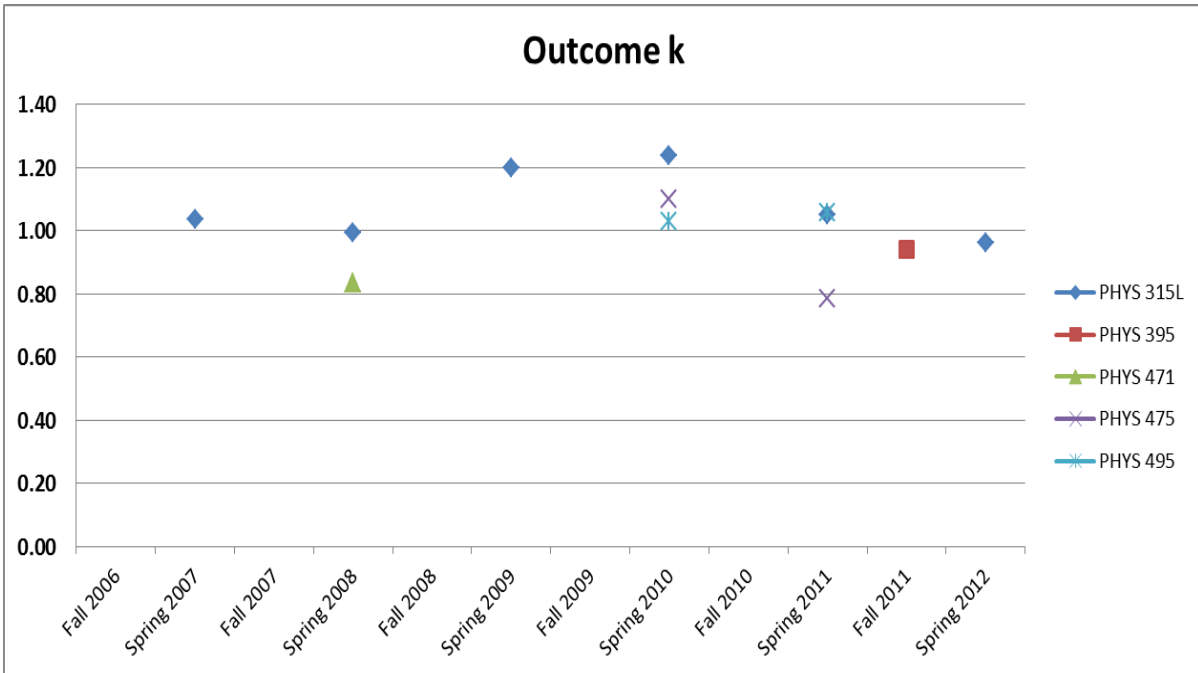
**Diagram 4.3.i. Measured level of achievement (normalized to the stated target) of all courses for *Program Outcome (i)* since Fall of 2006.**



**Diagram 4.3.j. Measured level of achievement (normalized to the stated target) of all courses for *Program Outcome (j)* since Fall of 2006.**



**Diagram 4.3.k. Measured level of achievement (normalized to the stated target) of all courses for *Program Outcome (k)* since Fall of 2006**



In principle, several of above program outcomes, i.e. (f) - *Professional Responsibilities*, (g)- *Communication Skills*, (h) -*Societal Impact*, and (j) - *Contemporary Issues*, are also addressed by classes that are part of the New Mexico State Common Core. The State Common Core is extensive and explicitly requires courses in Communications (9 credits), Social and Behavioral Sciences (6-9 credits), and Humanities and the Fine Arts (6-9 credits). All Common Core courses are being assessed on a regular basis as part of the State Common Core program.

### C. Continuous Improvement

Describe how the results of evaluation processes for the program educational objectives and the student outcomes and any other available information have been used as input in the continuous improvement of the program. Indicate any significant future program improvement plans based upon recent evaluations. Provide a brief rationale for each of these planned changes.

Continuous improvement has occurred primarily as a result of faculty meetings, Engineering Physics Program Committee meetings, faculty review meetings, and Engineering Physics External Advisory Board meetings. In this section, we discuss the various changes in the program that have been made to correct deficiencies in our outcomes and objectives (closed loops). The closed loops are given in random order, not necessarily in sequence of importance.

#### **Introduction of *Physics 395 - Intermediate Mathematical Methods* to replace *Physics 495 - Mathematical Methods* - addresses *Program Outcomes (a)* and (e)**

- This deficiency was identified by instructors in upper division classes. It was discussed in the 2007, 2009, 2011 faculty retreats.
- The first two years of physics, while highly mathematical, focus primarily on the physical concepts. In more advanced classes, however, students often find a leap in the

mathematical levels of classes; furthermore, they are often introduced to mathematical concepts that are not taught in the standard series of required math classes. For example Fourier Transforms, complex variables, Taylor Series, and tensors are not covered in the math classes. Our previous course in Mathematical Methods, Physics 495, was not taken by students until their senior year and could not be applied to earlier classes.

- c. Physics 395, Intermediate Mathematical Methods, is now required of all Engineering Physics majors and should be taken by students at the end of their second year or beginning of their third year so that this knowledge can be applied to future courses.
- d. Change implemented in Fall 2011. PHYS 395 is now required for all Engineering Physics majors. Engineering Physics curricula and associated flowcharts were also adjusted.

**New textbook for Physics 213, 214, 215, 216, 217 and 315** – addresses Program Outcomes (a) and (e)

- a. Instructors were disappointed with the previous textbook, Knight, *Physics for Scientists and Engineers* and this was first brought up at the 2007 faculty retreat. Student evaluations of this book were dismal.
- b. The Knight textbook was adopted in 2005 after careful review by faculty that included outside recommendations. It was written by a leading expert in educational physics. Nevertheless, faculty complaints began immediately. Several key subjects were missing and subject order was confusing. Student evaluations of this book are the worst on record.
- c. Physics adopted the book by Young & Freedman, *University Physics*. This is one of the most widely used textbooks for calculus based physics. The book is working out well.
- d. Change adopted in 2007.

**Physics 216L - Introduction of more Hands-on Labs** – addresses Program Outcome (b)

- a. This weakness was identified in the 2009 faculty retreat,
- b. Currently, we use the text “McDermott & Schaffer, *Tutorials in Introductory Physics*”. Several of the Electricity & Magnetism Labs required only pencil and paper, no real equipment. These make for great tutorials, but do not constitute proper laboratory instruction. The Department of Physics has equipment, and this makes our programs better than many, especially on-line programs. We need to take advantage of this strength.
- c. Pencil and paper labs from this book have been reduced and replaced by other labs in the book that use real wires, batteries, and magnets.
- d. Dr. Steve Kanim (whose research is in Physics Education research) was charged with implementing changes to the labs. Those began in late 2007 and additional modifications are still continuing.

**Introduction of Physics 280 - Supplementary Instruction for Physics 213** – addresses Program Outcome (a)

- a. This need was identified in Spring 2011 Faculty Program Outcome review.
- b. Students were getting worse on the Force Concept Inventory exam despite the introduction of active teaching methods. They needed more problem solving practice (outcome e).
- c. Physics 280, *Supplementary Instruction for Physics 213* (1 credit) was introduced.
- d. This one credit course will be first taught in Fall 2012.

**Teaching Assistant (TA) Teaming for introductory labs** - addresses *Program Outcome (b)*

- a. *Identified in Spring 2011 Faculty Program Outcomes meeting.*
- b. *There were too many inexperienced TAs for introductory labs and more experienced TAs were not available.*
- c. *Inexperienced TAs were teamed with experienced TAs.*
- d. *Introduced Spring 2011.*

**Teaching Assistant assigned for Physics 315L** - addresses *Program Outcomes (b), (f), (g) and (k)*

- a. *Identified Spring 2011 Faculty Program Outcome review.*
- b. *The 315L instructor simply could not supervise simultaneous experiments effectively. This is an advanced laboratory and requires more detailed supervision from faculty.*
- c. *TA was assigned to this laboratory*
- d. *Implemented Spring 2011.*

**Improved apparatus and a grading rubric were introduced for Physics 315L** - addresses *Program Outcomes (b), (g) and (h)*

- a. *Identified Spring 2011 Faculty Program Outcome review.*
- b. *The equipment was old. The introduction of written and oral reports on outcomes g, communication, and h, societal impact required new grading schemes.*
- c. *Improved apparatus and a grading rubric for oral and written reports were introduced for Physics 315L.*
- d. *Implemented Spring 2011.*

**Introduction of Educational Testing Service – Physics Major Field Test** - addresses *Program Outcomes (a) and (e)*

- a. *Identified in Spring 2011 by the Department Head as a good way to test our outcomes.*
- b. *Currently, outcomes a, scientific expertise, and b, problem solving, rely on embedded questions in tests and the Force Concept Inventory exam. Physics has used Graduate Record Exam (GRE) questions for many of the embedded questions and compared them to national scores. However, the testing environment is not the same and questions are picked according to what is covered in class. It is feared that this leads to unrealistic targets.*
- c. *The ETS – Physics Major Field Test was implemented. This is a commercial test with national-norm scores. Part 1 of the test is the introductory section and is used to assess outcome a; part 2 of the test is the advanced section and is used to assess outcome e.*
- d. *Implemented Spring 2012.*

**Introduction of new Program Educational Objectives for ABET 2012** – addresses *Program Educational Objectives*

- a. *Initiated at 2012 Fall Engineering Physics Advisory Board meeting.*
- b. *ABET 2012 requires that the objectives be more specifically related to information from students who have already graduated, and not simply a remapping of ABET outcomes.*
- c. *Three new ABET objectives were designed by the advisory board to replace the old ones.*
- d. *Implemented Spring 2011 for preparation for ABET 2012.*

**Creation of Student Engineering Physics Society (SEPh)** – indirectly addresses *Program Educational Objectives*

- a. *Recommendation of the Engineering Physics External Advisory Board (EPAB) in 2010*

- b. *The EPAB recommends that the Society of Physics Students (SPS) be resurrected and provided dedicated space within the department for study groups. Engineering Physics students should be encouraged to become fully enabled members and, if appropriate, leaders of this society. The sense of community and department identification is expected to improve the program, for example, in retention. A larger, more vital SPS is in the department's interests, as well.*
- c. *The Department has always run a branch of the Student Physics Society with associated space. Although Engineering Physics Student had been part of this, it was recognized that they need their own identity. Thus the Student Engineering Physics Society was born. Although this group continues to work with the Student Physics Society, they also have independent meetings and a separate advisor (Dr. DeAntonio).*
- d. *SEPh was formed in 2010 and it is now an officially registered organization.*

**Improve Student Retention** – indirectly addresses Program Outcome (g)

- a. *Recommended by Engineering Physics Advisory Board (EPAB) in 2010*
- b. *The EPAB recommends that the Department of Physics take measures to produce a home department identity for the Engineering Physics students. Providing dedicated space for Engineering Physics students will help this situation by improving peer support. This space must be in the Department of Physics, because of the diversity of the partnering engineering departments. Additional measures could include Society of Physics Students involvement, informal monthly meetings (e.g., lunches) for students and faculty, departmental colloquia, etc. Participation should be open to include all students of the department, so that Engineering Physics students identify with all who have parallel interests and concerns.*
- c. *In the past six years the Department moved out of Gardiner Hall for two years while it was renovated, only to return to a building that was shared with another department. Every administrative post from Department Head to President has seen at least two changes during this period. These changes have been very demoralizing for both the department and the University. The Department now has a department head, dean, provost and president that have lasted more than two years. It is hoped that this trend of stability at NMSU continues.*
- d. *Our current department head has lasted two full years, so have the deans, provost and president.*

**Own Capstone Projects for Engineering Physics Students** – addresses Program Outcomes (c) and (k)

- a. *Recommended by Engineering Physics Advisory Board 2010*
- b. *The department has relied heavily on capstone projects in the associated department of Electrical Engineering, Mechanical Engineering, and Aerospace Engineering. (Chemical Engineering does not have capstone courses). However, this does not help the identity of the Engineering Physics program and internal capstone projects are needed. This has been difficult due to the minimum enrollment requirements of the university.*
- c. *For example, in spring 2012 Dr. Kane ran a capstone project course with four students in it. The student developed new physics demonstration equipment for the department.*



- d. *The most capstone project course with Dr. Kane was successful, and it established capstone reporting requirements for the department. We look forward to developing future capstone projects as the Engineering Physics enrollment increases.*

**Modifications of Course Structure and Content Delivery for Engineering Courses** – indirectly addresses all of the programs outcomes, but *Program Outcomes (a), (c) and (k)* in particular

- a. *Identified by participating engineering departments (particularly, Electrical Engineering)*
- b. *The participating engineering departments identified the need to modify the courses and content delivery to better serve their own majors.*
- c. *While the Engineering Physics Program Committee had only marginal input into the re-design of the course structure and curricula of the engineering majors, the changes affected Engineering Physics students with concentrations in particular engineering departments. This led to a (sometimes substantial) re-design of the engineering portion of the Engineering Physics program*
- d. *Implementations of subsequent changes were initiated in 2009 and were essentially completed in 2011.*

**Reduction of Course Load** – indirectly affects all of the program outcomes, but *Program Outcomes (f), (h), (i) and (j)* in particular.

- a. *The University discontinued the 9-credit rule as an option to replace one of the Viewing-the-Wider-World (VWW) course requirements starting with the 2011/12 catalog.*
- b. *The Engineering Physics Program Committee felt the strong need to address this effective increase in total credit hours, such that the program does not lead to an excessive amount of total credit hours required for the program.*
- c. *The Engineering Physics Program Committee removed the following requirements as a response: Engineering Physics students with the Aerospace concentrations are no longer required to take PHYS475 – Advanced Physics Laboratory (they already take a great number of other labs as part of their curriculum), the ones with the Chemical concentration are no longer required to take Chemistry 371 – Analytical Chemistry (this had also been abandoned for the Chemical Engineering majors), the ones with the Electrical and Mechanical concentrations will take one fewer technical electives*
- d. *Changes were implemented in 2012, and they will appear in the 2012-2013 Undergraduate Catalog.*

#### **D. Additional Information**

*Copies of any of the assessment instruments or materials referenced in 4.A, 4.B, or 4.C must be available for review at the time of the visit. Other information such as minutes from meetings where the assessment results were evaluated and where recommendations for action were made could also be included.*

Display materials include several sets of folders and binders, all of which have been introduced already in *Criterion 2- Educational Objectives* and *Criterion 3- Program Outcomes*. There will be four different sets of binders: the instructor's, the course, the outcomes and the objectives notebooks.

The contents of the different binders are summarized below. Textbooks, manuals and other materials are also available during the ABET review visit.

- **'Maroon' Instructor's Notebook** (prepared at the end of each course)
  - completed *Post-Course Instructor Comment Form*.
  - supporting material for Program Outcomes Assessment (a)-(k) (questions, tests, etc.).
  - syllabus and actual schedule followed
  - copies of exams, quizzes and homework, or references thereto.
  - copies of other class materials
- **'White' Course Notebook** (prepared for ABET review each cycle)
  - course outline and syllabus
  - copies of all assignments, i.e. pre-req. test, exams/labs/quizzes/homeworks/projects
  - exemplary copies of student work for each assignment (typically: high/medium/low)
  - hand-outs and other material used
  - summary of student evaluations
- **'Blue' Outcomes Notebook** (summarized yearly)
  - Yearly summaries of program-outcomes assessment meetings (implemented in 2008)
  - Yearly student progress reports
- **'Black' Objectives Notebook** (filled in as needed)
  - Engineering Physics Program Committee meeting minutes
  - External Advisory Board Reports and meeting minutes
  - Survey Interviews
  - Exit interviews for graduating Engineering Physics students
  - Other material (employer surveys, statistics etc.)