LABORATORY ASSESSMENT AND FUNDING PLAN (2008-2013)

SCHOOL OF ENGINEERING

UNIVERSITY OF PORTLAND

PORTLAND, OR 97203

Spring 2009
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1.0 SUMMARY

This document provides a summary of the laboratory facilities available to undergraduate engineering and computer science students at the University of Portland. This plan does not address the general computing needs of the students in the school. Computing needs are addressed in a separate document prepared by the Computer Committee of the School of Engineering. However, computing resources needed in individual laboratories, such as data acquisition and analysis systems, are addressed in this plan. The departmental laboratory plans address the history of continued laboratory development, effectiveness of present equipment and facilities, and adequacy of present maintenance, replacement, and upgrading practices. The goal of each department’s laboratory plan is to ensure that current laboratory equipment is maintained and that replacement and new equipment is acquired to meet the objectives of the laboratory experience for our students.

This laboratory development plan is an evolving document to be reviewed, modified, and updated periodically.

Laboratories have been developed with the following goals in mind:

- to provide introductory measurement experience with basic instrumentation, stressing measurement concepts, error sources, and accuracy estimation;

- to provide more sophisticated measurement experience with modern data acquisition of the type normally found in industrial practice, including computer-based data acquisition and analysis;

- to provide experience with computer-based control of modern instrumentation with appropriate automatic testing techniques;

- to provide access, where appropriate, to sophisticated simulation devices and systems; and

- to provide access to computer software packages capable of improving students’ analytical skills, design perspectives, and presentation skills.

In short, the intent is to provide our students a wide range of exposure to measurement practice, initially at such a level that the fundamentals of measurement are not lost in the sophistication of modern instruments. The more sophisticated instrumentation can be used by students to gain an appreciation for the speed and accuracy of these newer technologies. The use of computer systems for data acquisition, analysis, and effective presentation is also stressed in the laboratory experience.

There are 19 (nineteen) laboratories supporting the three departments of the School of Engineering. The faculty of the school and the administration of the University are committed to providing an excellent laboratory experience in each of our programs. The detailed funding needs for each of the departmental laboratories are to be
found in Appendices A, B, and C. A summary of the funding needs is presented here.

The laboratory equipment needs for the School of Engineering between 2008 and 2013 are presented in the table below:

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>2008-2009</th>
<th>2009-2010</th>
<th>2010-2011</th>
<th>2011-2012</th>
<th>2012-2013</th>
</tr>
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<tr>
<td>Funds Needed</td>
<td>$181,400</td>
<td>$154,430</td>
<td>$150,000</td>
<td>$163,840</td>
<td>$168,760</td>
</tr>
<tr>
<td>Amount Funded by the University</td>
<td>$110,000</td>
<td>$110,000</td>
<td>$113,000</td>
<td>$113,000</td>
<td>$116,000</td>
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<td>External Sources/Fundraising/Endowment</td>
<td>$71,400</td>
<td>$44,430</td>
<td>$37,000</td>
<td>50,840</td>
<td>$52,760</td>
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The funding needs over the next five years exceed the expected funding from the University. We envision receiving support for the unfunded portion of our equipment needs from manufacturers, alumni, government agencies, foundations, major engineering firms and professional engineering societies. Historically, the University has received external support from alumni, benefactors, and friends. The University has provided the School of Engineering with sufficient funds to provide an excellent laboratory experience for our students in support of their degree programs. We foresee this trend to continue in the future.

This report is organized in the following manner:

Section 2 presents a discussion of laboratory experience in the curriculum. Section 3 provides an overview of the School of Engineering laboratories. Section 4 provides a description of the School of Engineering funding philosophy and identifies funding sources in support of our laboratory plan. Appendix A presents the Department of Civil Engineering Laboratory Development Plan; Appendix B presents the Department of Electrical Engineering and Computer Science Laboratory Development Plan; and Appendix C provides the Department of Mechanical Engineering Laboratory Development Plan.
2.0. LABORATORY EXPERIENCE IN THE CURRICULUM

2.1 School of Engineering Mission, Program Educational Objectives, and Program Outcomes

The School of Engineering mission is integral to and supportive of the mission of the University. The School’s mission is to provide the best possible engineering and computer science education to its students, thus enabling them to become highly adept and capable practicing engineers and computer scientists. The students are provided with a foundation for both graduate study and life-long learning in support of evolving career objectives. These career objectives include being informed, effective, and responsible participants in the engineering profession and society.

The School of Engineering endeavors to develop qualities that are essential for the practice of engineering. These qualities include knowledge of engineering principles, the ability to apply those principles to solve real world problems, and the development of professional, personal, and social values.

To fulfill its mission, the School provides a personalized and caring learning environment for its students, enhanced by high quality faculty, staff, and facilities. The environment includes: exceptional instruction; frequent opportunities for relevant laboratory experience; practice of communication and teamwork skills; the challenge of undertaking realistic engineering projects; and the personal attention, guidance, and example of faculty and staff. This environment is also enhanced by students with the aptitude and motivation for engineering study, as well as general intellectual curiosity.

The primary goal of the School of Engineering is to provide an excellent engineering and computer science education consistent with the mission, goals, and objectives of the University of Portland as articulated in the University’s Bulletin. To achieve this goal, the school has established the following program objectives:

1. Prepare students for entry level positions and graduate school.

2. Prepare graduates who have a broad background in fundamentals and the ability to solve problems.

3. Prepare graduates who possess technical proficiency and sound judgment.

4. Prepare graduates who are competent in written and oral communication, and computer proficiency.

5. Prepare graduates who have an understanding of professional issues such as economics, ethics, teamwork, and leadership.

To fulfill its mission and objectives and to comply with the Accreditation Board for Engineering and Technology (ABET) accreditation requirements, the School has established the following program outcomes:

a. An ability to apply knowledge of mathematics, science, and engineering.

b. An ability to design and conduct experiments, as well as to analyze and interpret data.

c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

d. An ability to function on multidisciplinary teams.

e. An ability to identify, formulate, and solve engineering problems.

f. An understanding of professional and ethical responsibility.

g. An ability to communicate effectively.

h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

i. Recognition of the need for, and an ability to engage in life-long learning.

j. A knowledge of contemporary issues.

k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

l. An ability to develop a sense of personal, social, and moral responsibility.

We attempt to insure that our program content and process prepare a University of Portland-educated engineer or computer scientist with these attributes. Part of the program requirement is appropriate laboratory experience that serves to combine elements of theory and practice, and is an integral component of each of our programs. Every student develops competence to conduct experimental work such as is expected of engineers in the discipline represented by the program. We envision that laboratory instruction will remain a vital part of engineering education in the foreseeable future. To maintain a high quality and dynamic engineering program, a clearly established and ongoing annual budget for laboratory equipment is essential. We must prepare ongoing long-range laboratory development plans and continue to implement them.
2.2 Role of Laboratory Experience in Individual Programs

Laboratory experience in the School of Engineering programs takes on one or more of the following forms:

- hands-on experience in using equipment and instrumentation relevant to the discipline;
- open-ended projects where students develop, formulate, design, and implement a project;
- computer modeling and simulation, either as a part of evaluating a design prior to implementation or when physical implementation is not feasible;
- computational laboratory experience where students work on the analysis and design of problems under guidance and supervision of the faculty member in charge of the laboratory; and
- observing physical phenomena to facilitate the understanding of how theoretical models are used to represent real devices and systems, and to facilitate an appreciation for the limitations of theoretical models in predicting measured results.

2.3 Expected Outcomes

Depending on the specific type of laboratory experience and experiments, expected student outcomes from the laboratory experience are generally one or more of the following:

- a better understanding of the theories covered in the lectures through illustration and/or validation of theories in the laboratory;
- a first-hand experience with some of the more complex concepts associated with the discipline through physical demonstration of the application of these concepts;
- experience with working in teams;
- training on some of the experimental techniques and/or standard equipment used in the discipline;
- acquisition of an appreciation for tolerances on physical parameters and measurement accuracy;
- acquisition of some experience in planning and executing projects;
• instruction and practice in communication skills, specifically in writing technical reports and making oral presentations;

• introduction to safety and health aspects of engineering; and

• first-hand experience in troubleshooting real systems.

2.4 Teaching Strategies for Laboratories

Teaching strategies for laboratories evolve as technology in the discipline changes. The evolution of these strategies is not uniform across the disciplines and within individual programs. Individual faculty members have the primary responsibility to keep themselves current on teaching strategies associated with laboratories in their respective fields.

The general trend of teaching strategies followed in our laboratories is governed by the expected outcomes outlined above. Following is a list of some of the teaching strategies that are emphasized in our laboratories:

• teamwork - students are encouraged or required to work in teams so that they can tackle more complex problems and learn the value of teamwork;

• pre-laboratory preparation - laboratory assignments are distributed ahead of time so students can plan their laboratory time more effectively;

• reports - students are asked to write a variety of reports ranging from simple data sheets and technical memos to formal laboratory projects;

• use of computers - emphasis is placed on using computer software to analyze and process the data used to generate graphics and plots;

• mini projects - one or two mini projects are included in the laboratory to expose the students to project planning and implementation; and

• oral presentations - many projects lend themselves well to oral presentations where students receive practice making presentations and using visual aids.

2.5 Strategies for Improving Laboratory Experience

Faculty members in charge of specific laboratories have the primary responsibility for upgrading the quality of the laboratory experience. They propose changes to their respective department chair and colleagues. Once these proposals are approved, a plan for implementation is developed, approved, and funded based on departmental priorities.

The majority of laboratories within the School of Engineering support more than one course in the curriculum. The school maintains a comprehensive list of equipment
needs for its instructional laboratories. This list is part of the school-wide laboratory development plan and is updated regularly.

At the beginning of each fall semester, the Academic Council of the Engineering School (ACES), consisting of the department chairs and associate chair of EECS, the associate dean, and the dean, review the equipment needs and allocate funds to each of the three departments. The internal funds are primarily allocated to cover the high priority items. Generally, required laboratories are given higher priority than elective laboratories. Furthermore, throughout the year faculty and administration write equipment grant proposals to the various benefactors of the School of Engineering to help with the replacement of old/obsolete equipment and the purchase of new equipment.

3.0 THE SCHOOL OF ENGINEERING LABORATORIES AND FUNDING NEEDS

In this section, a brief description of each of the laboratories within the School of Engineering is presented. Appendixes A, B, and C provide an in-depth assessment of each laboratory and the course(s) they support as well as the funding needs over a period of five years.

3.1 Department of Civil Engineering

The primary purpose of laboratory experience in the civil engineering program is twofold: to reinforce the coursework in theory and design by means of laboratory experiment illustrations, and to enable the students to gain hands-on experience by using laboratory equipment. The experiments also help the students to better understand the various experimental techniques, instrumentation, laboratory procedures and laboratory work. The civil engineering laboratories are truly extensions of the classroom, places where the information being presented in the class may be further explored for greater understanding. Indeed, many difficult concepts can only be made readily understandable by using demonstrations and hands-on experiences. But beyond their role in the instruction of technical ideas, our laboratories also serve as the setting for broader education needed to fulfill some civil engineering program goals. For example, communication skills are developed primarily in the context of laboratory teams and through writing and speaking assignments.

A brief description of each of the laboratories follows:

3.1.1 Construction Materials Laboratory

This laboratory is required for the civil track students in the civil engineering program. A newly remodeled Materials Testing Laboratory is shared with the mechanical engineering program. It includes a 200,000 lb. capacity load testing machine with computer data acquisition and a 100,000 lb. servo-controlled dynamic load testing machine. The laboratory supports the Construction Materials Laboratory course (CE 372) and is used for testing the strength of concrete, steel and wood specimens and for loading simple structural elements. Students use the construction
materials laboratory in the required construction materials course in their junior year. Also, students use the laboratory to prepare asphalt samples in the elective pavement design course.

3.1.2 Environmental and Hydraulics Laboratory

The primary purpose of the environmental and hydraulics laboratory is to support the educational objectives of three courses: Environmental Engineering Laboratory (CE 376), Hydraulic Engineering (CE 362) and Environmental Laboratory (ENV 387). The latter is a course required for the civil engineering students in the environmental track.

3.1.3 Geotechnical Laboratory

The geotechnical laboratory is used with the required laboratory course. Laboratory work is closely coordinated with the material that is presented in the geotechnical lecture course. Without this laboratory, many concepts presented in the lecture course could not be understood by the students.

3.1.4 Surveying Laboratory

The main purpose of this laboratory is to acquaint the students with practical aspects of basic land surveying. This laboratory supports the required surveying course in the civil engineering program and explores determining dimensions on the earth’s surface by the measurement of distances, directions, angles, and elevations.

3.1.5 Transportation Laboratory

The main purpose of the transportation laboratory is to evaluate the properties of highway materials including aggregates, asphalt, and additives. This laboratory is used for the instruction of the pavement design course which is a technical elective.
3.2 Department of Electrical Engineering and Computer Science

The primary goal of the laboratories in our Electrical Engineering and Computer Science (EECS) programs is to provide the students with the opportunity to introduce themselves to the art and science of electrical and computer phenomena via a set of measurements and observations. To achieve this goal, students are required to take several laboratory courses.

The Department of Electrical Engineering and Computer Science maintains nine (9) laboratories including space in two (2) laboratories for the senior capstone design projects in support of their program offerings.

3.2.1 Circuits and Electronics Laboratory

This laboratory is primarily used for both sophomore-level and junior-level EE laboratory courses which are EE 271 (Electrical Circuits Laboratory) and EE371 (Electronic Circuits Laboratory). Both of these courses are required for all undergraduate students enrolled in the electrical engineering program.

3.2.2 Digital Systems and Microprocessor Laboratory

The purpose of the Digital Systems and Microprocessor Laboratory is to provide electrical engineering students with an integrated development environment for gaining valuable, modern hands-on experience with digital logic design and microcontroller/microprocessor-based design.

3.2.3 Computer Vision and Mobile Robotics Laboratory

The purpose of the Computer Vision and Mobile Robotics Laboratory is to provide engineering students, especially EE and CS students, an integrated development environment for gaining valuable modern hands-on experience in digital image processing, computer vision and intelligent mobile robotics.

3.2.4 Communications and Fields Laboratory

This laboratory is a multipurpose, senior-level laboratory for the study of communications systems and electromagnetic fields.

3.2.5 Power and Control Systems Laboratory

The purpose of the Power and Control Systems Laboratory is to provide students experimental experience with power and control systems equipment, including power electronics equipment, in order to complement lecture courses in these areas of specialization.

3.2.6 Electrical Engineering Projects Laboratory
The purpose of the EE projects laboratory is to provide out students a comprehensive experience in design. Funds are made available to each team of students to cover expenses (up to an approved maximum) incurred in purchasing hardware and software for the implementation of their capstone design projects.

3.2.7 Computer Science Laboratory

The purpose of the Computer Science Laboratory is to provide our students an appropriate level of educational and practical experiences with computer systems, tools and programming languages as well as to provide research facilities for the students and faculty.

3.2.8 Computer Systems Laboratory

The primary purpose of this laboratory is to expand upon and complement the lectures in the operating systems (CS 446), computer networks and internet-working (EE 445), software engineering (CS 441), and computer systems security (CS 448) courses.

3.2.9 Computer Science Projects Laboratory

The primary purpose of this laboratory is for use by students working on software-related senior design projects in the two-semester EE/CS 480, EE/CS 481 sequence.

3.3 Department of Mechanical Engineering

The objectives of the mechanical engineering laboratory activities are:

a. to support coursework in theory and design with real illustrations to clarify the subject matter and enhance student interest;

b. to familiarize the student with the instrumentation, techniques, procedures, accuracy, and reliability of experimental work in mechanical engineering; and

c. to develop the skills necessary to specify, plan, supervise, evaluate, perform and communicate experimental work.

The Department of Mechanical Engineering maintains a total of five (5) laboratories in support of its program offerings.

3.3.1 Materials Laboratories

The materials laboratories consist of a mechanical testing and thermal processing laboratory, as well as a metallography laboratory. The primary purpose of this laboratory is to support undergraduate education in the civil and mechanical engineering programs. A secondary purpose is to support graduate-level education and research in similar fields.
3.3.2 Experimental Mechanics Laboratory

This laboratory consists of instrumentation for strain gages and photoelasticity that are used primarily in elective courses at the senior level.

3.3.3 Thermal/Fluid Sciences and Systems Laboratories

This laboratory supports the thermal and fluid sciences systems in the mechanical engineering program. The equipment in these laboratories mainly supports two required laboratory courses at the junior/senior level.

3.3.4 Automated Manufacturing/Motion Control Laboratory

This laboratory supports two areas of education in the mechanical engineering program. It supports senior-level courses in robotics and manufacturing automation and a junior-level required laboratory course in motion control.

3.3.5 Vibration Laboratory

This laboratory supports mechanical vibrations (ME 453) and noise and vibration control (ME 454) courses. This laboratory is an efficient and productive tool for our students in supplementing the classroom lectures when teaching the courses mechanical vibrations or noise and vibration control.

4.0 FUNDING PHILOSOPHY AND SOURCES

The continued maintenance and development of laboratories at the University of Portland School of Engineering is predicated on a number of reasonable assumptions.

The first assumption is that the need for basic introductory measurement and instrumentation will continue at approximately the same level as is currently required. The primary implication of this assumption is that since most of this type of instrumentation is in place, it is not necessary to replace it with newer equipment. The area of introductory measurement will not require major replacement funding over the next five years.

The second assumption is that the trend toward lower computing costs will continue and the school will provide increased computing power to its students. The availability of increasingly powerful personal computers and workstations will also help insure that students will be exposed to state-of-the-art computing technology.

The third assumption is that simulation and modeling of physical phenomena will play an increasingly larger role in engineering education, supplementing and replacing some of the traditional measurement-based learning experiences.
The final assumption is that the rapid growth in the area of automated data acquisition and analysis will continue and that laboratory development in this area should receive relatively high priority for future resources.

Funding needs in support of laboratory maintenance and development in the School of Engineering are determined by each department’s particular attention to the above assumptions. There are a number of funding sources, both internal and external, that are utilized to provide the necessary resources for our laboratories.

4.1 Funding Philosophy

The funding philosophy of the School of Engineering is simple. The funding needs are categorized into:

a. 

essential equipment and resource needs; and

b. 

desired resource needs.

The University’s funds will be allocated based on the priorities identified by individual department faculty. In the beginning of the fall semester, the Academic Council of the Engineering School (ACES), consisting of the chairs of the three departments, the associate chair of EECS, the associate dean, and the dean, reviews the equipment maintenance and development needs of the three departments and allocates the school’s resources accordingly. This method of distributing funds works well for us. The other internal and external funding sources are utilized to provide for the desired level of funding needs for individual laboratories. In the allocation of funds, required laboratories are generally given higher priority than elective laboratories.

4.2 Internal Sources

The School of Engineering has received and expects to receive about $110,000 per year, adjusted for inflation, through the University’s budget. This resource will be used primarily to purchase first priority items.

Recognizing that the funds allocated to the School of Engineering from the University’s budget will not be sufficient to meet the needs of the laboratories, the School has established an endowment fund to supplement the University’s budget. Our goal is to secure a $2,000,000 endowment in support of laboratory equipment. The income from the investment of this endowment fund will be used to purchase equipment in support of our laboratory programs.

The University budget also provides for funds in support of the computing facility which is addressed in a different document entitled the School of Engineering Computing Plan.

4.3 External Sources
a. Laboratory equipment manufacturers: We continue to approach industry for donation of equipment and discounts on purchased equipment. Potential donors are identified through direct faculty contacts, the University of Portland Engineering Advisory Council, alumni, and local professional society chapters.

b. Alumni: Our graduates are a valuable resource whom we continue to tap in a significant way. They can help the program by taking on development of a laboratory as a special project or by helping develop contacts with their employers, a possible potential source of equipment or funds. Employers often have matching donation programs that can double the contribution of alumni to the school. Since alumni are often familiar with the equipment and needs of the laboratories, they can also identify equipment available for donation at their workplaces that may be useful to us.

c. Government agencies: A complete list of federal and state funding agencies and the guidelines for their various programs is maintained by the University Relations Office and is readily available to the faculty of the School of Engineering. Furthermore, the University Relations Office assists the faculty in preparing proposals to these agencies.

d. Nonprofit foundations and major engineering firms interested in engineering education: The School of Engineering has received funding in support of its laboratory and facilities improvements from a number of corporations and foundations. These entities will continue to be approached for support of our laboratories.

e. Professional engineering societies: Some chapters of the local professional societies have funds for the establishment and development of specific laboratories as a chapter project. It is potentially one of the avenues for us to pursue, given that it meshes well with our related objective of educating engineers to become competent practicing professionals in industry.