University of Washington

Department of Bioengineering

Ten-Year Review: Self-Study Report

December 1, 2010

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Executive Summary

Bioengineering as a discipline is a work in progress, which is both its strongest feature and its greatest challenge. While it is a source of endless debate among those of us who call ourselves bioengineers, a working definition for our field might be "the interface where the physical sciences and engineering contact biology and medicine." Its work is both basic and applied, fundamental and translational. Bioengineers have historically been a collection of refugees from more established disciplines—almost none of our faculty today has a bioengineering degree. As a consequence we are academically more uninhibited than some of our colleagues in other departments; this leads to research that has both great innovation and great risk. This helps us attract some of the brightest young minds to this dynamic enterprise.

The Center for Bioengineering was founded in 1967 by Robert Rushmer as a joint research enterprise of the College of Engineering and the School of Medicine. That joint affiliation continues to this day, and has been a great source of strength. Initial development of ultrasound for monitoring the cardiovascular system turned into technologies that became the basis for a strong local ultrasound industry. Under a sequence of inspired leaders who made both excellent choices in hiring and found ways to obtain state funds for tenure-track faculty lines, the Center grew in size, research support and prestige, and became the Department of Bioengineering in the late 1980's, allowing it to grant PhD degrees. An undergraduate program was created within the College of Engineering in 2001; it was accredited by ABET in 2008 (retroactive to 2006). Our students go to industry, professional schools, and graduate schools, and are beginning now to populate the middle ranks of a wide range of professions. Despite explosive growth in the number of bioengineering and biomedical engineering departments in the US in the last 15 years, recent rankings of the department continue to put its academic programs within in the top 5-10 bioengineering/biomedical engineering departments in the country.

Today we are some 39 active core faculty, 43 adjunct faculty, 49 postdoctoral fellows, 66 staff (including research scientists), 106 on-campus graduate students, 150 undergraduate students, and a growing number of off-campus students through two professional Master's programs. In 2006 we moved into a wonderful new research facility—the Foege Building, and this year we brought in over $32 million in research funding, most of it from federal sources. Many of our faculty have been very successful in their academic careers, and hold or have held the most prestigious positions in their professional organizations. Our educational programs are being used as models for those of many new BME departments worldwide. In most ways, we are doing very well indeed.

And yet, we continue to reinvent ourselves. We are implementing a new round of substantial changes (improvements, we hope) to our undergraduate program, as well as considering a substantial upgrade in our graduate course offerings. Today, like all departments at UW, we are vulnerable to planned substantial cuts in state funding that pose a serious risk to our ability to compete with our peer departments. As a consequence, we are identifying sources of funding that have not previously been tapped, and considering further changes to our educational portfolio that would bring in more income. We are actively assembling a Corporate Affiliates Program as our first collective approach to industrial partners as a source of funds, research partnerships, and enhanced industrial opportunities for our students. Creating this will require an initial investment from on- or off-campus sources. We are also considering a substantial on-campus non-thesis Master's program to enhance tuition-based revenues. Finally, as our small alumni base grows, we are hoping to create an alumni network so they can help each other, help their *alma mater* through small-scale giving, and, eventually, contribute to a substantial endowment.

Part A. Mandated Information

Section I. Overview of Department Organization

The Department of Bioengineering (BIOE) at the University of Washington continues to be considered by our peers to be one of the strongest departments of bioengineering and biomedical engineering in the world. As a consequence, we have an obligation to lead, and lead well. We see the mission such a leading department to be to perform excellent and innovative bioengineering research, education, and service, to develop novel clinical applications, and to promote the transfer of new technologies to industry so they can have clinical impact.

BIOE is in both the College of Engineering (COE) and the School of Medicine (SOM), with administrative offices and most of the faculty housed in the northern half of four-year-old Foege Hall. Additional faculty research and office space is provided in Benjamin Hall and the South Lake Union medical campus. The proximity of these spaces to Health Sciences and UW clinical departments, along with our long tradition of collaboration with clinicians and clinician scientists, has been a significant factor in our leadership role in bioengineering, blending interdisciplinary basic, applied and translational research and education programs.

The number and scope of academic bioengineering programs has seen explosive growth over the past 15-20 years. This has been fueled by technological developments, expanding bioengineering frontiers and funding opportunities, high student demand and rapidly growing job opportunities. In response, our department has grown significantly in the past 10 years to meet these opportunities and demand, instituting a new undergraduate program (2001) and developing new Masters and certificate programs (details provided below).

As we approach this 10-year review, we and the rest of the university face an unprecedented financial threat. The challenge for us in the next 10 years will be to find ways (and funds) to allow us to continue to lead despite lean times. What follows a description of what we have been doing for the last decade, how things stand today, and how we plan to move forward into the next decade. Note that this document is a product of the administration, faculty and staff of the department, not just that of the chair.

Bioengineering (BIOE) Educational Programs

a. Undergraduate and graduate Bioengineering degrees offered include:

- BS in Bioengineering
- MS in Bioengineering
- Combined BS/MS in Bioengineering
- MS in Medical Engineering (MME: fee-based evening program)
- MS in Pharmaceutical Bioengineering (PharmBE: fee-based evening program)
- PhD in Bioengineering

b. Certificate programs offered through UW Educational Outreach include:

- Basic Bioscience
- Basic Medical Sciences
- Biosensors & Biomaterials
- Medical Devices & Commercialization
- Medical Diagnostics

c. Student enrollment and graduation patterns.

BS BIOE program. When this program was created 10 years ago the plan was to manage enrollment to produce steady growth to a maximum cohort size by 2010. Enrollment numbers reflect that plan; we are now fully enrolled at 50 students per cohort. Demand for the BS program currently exceeds available openings by about 2-3 fold. In July 2010, 50% of the students we turned down had prerequisite GPAs in the 3.2 – 3.6 range and could have performed well in our program. Additional resources (faculty and advising FTE) would allow us to admit these strong students while maintaining the high quality of the program.

MME program. As a fee-based program, enrollment is sensitive to the local economy, as well as the extent to which UW Educational Outreach (UWEO) advertises the program to major employers in the region. Boeing engineers have provided many of our MME students, so recent changes to Boeing's educational benefits have reduced our enrollment. Enrollment in 2010 was 19 students compared to 28 and 29 in the prior two years. The recent retirement of the founding faculty director, Kirk Beach, has also had an impact. He will be replaced in the next year.

PharmBE program. This program launched during winter quarter 2010. Students have the option of pursuing one of three certificates or a MS degree. Since the launch of the PharmBE program, 13 students have been enrolled in the MS degree track and an additional 22 students are enrolled in certificate tracks.

PhD program. Applications numbers for this program are very high each year; for the past 3 years applications have ranged from 303 to 423 (current year). The number of offers made each year reflects the capacity of our faculty to accept new students into their laboratories, and assuming a capture rate of 0.3 to 0.5. Enrollments for the past three years have averaged 22 students per year (range 14-32).

The HEC table in Appendix D and the table in Appendix Q show enrollment and graduation figures for the programs. Note the very substantial growth in the last 10 years.

Academic and Non-academic Staffing

Staffing and Organization

Please refer to the Chart A-1 of Appendix A (Organizational Structure/Governance)**,** which illustrates the overall organizational structure of BIOE.

Academic staffing as of October 2010

There are 28 tenured and tenure-track faculty in BIOE, including five jointly appointed faculty with primary appointments outside BIOE; there are also 9 research track faculty. Additionally, two full full-time lecturers instruct in the undergraduate program, and 43 adjunct faculty advise graduate and undergraduate students. Seven emeritus faculty remain involved in the department at various levels of activity. Typically, we have 16 quarters of support each year for Teaching Assistants. Non-faculty academic support is provided by the advising team (3 FTE) with one lead undergraduate advisor, one graduate advisor, and a full-time advising assistant.

Operational support (human resources, grants management, fiscal operations, computing, facilities, communications, and office support) is performed by a team of eight individuals under the supervision of the Administrator. The Administrator also has responsibility for compliance and human resources affecting all classified and professional staff positions in Bioengineering.

Finally, the large research enterprise is staffed by 49 senior fellows and 54 professional and classified staff with primary appointments in BIOE, along with 106 academic student employees in research roles.

Leadership

The BIOE department leadership team is headed by the Chair, who is appointed jointly by the Deans of Medicine and Engineering. The Chair is responsible for the operation of the Department. Because the Department is in both COE and SOM (and all faculty are considered jointly appointed in both units) the Chair is responsible for implementing the policies of both units. When a new Chair is needed, the Deans appoint a committee that performs an international search. This position is reviewed every five years by a committee appointed by the Deans.

The Chair is assisted by the Vice Chair, who is appointed by and serves at the pleasure of the Chair, and has primary responsibility for the Student Affairs and educational aspects of the department. The Chair is also assisted by the Administrator, who is responsible for all administrative details delegated by the Chair and the Deans. The Chair and Administrator work closely, meeting at least weekly to carry out the mission of the Department; these two consult with the Vice Chair on most matters, and on all matters concerning its educational mission.

The three-person administrative team is responsible for:

- Obtaining adequate resources to support existing and new activities of the department
- Planning all aspects of departmental operations
- Reporting to the department's two Deans and all higher officials at UW
- External communications for the Department (including publicity)
- Management of all human resources issues
- Ensuring compliance with governing policies
- Financial and resource management and reporting
- Facility management and assignment of department-controlled space
- Compensation
- Allocating department resources (financial, HR, facilities)
- Making all decisions that cannot wait for a faculty vote

Departmental Governance

Departmental governance works through a combination of internal and external committees and a democratic process that relies on the active participation of all faculty. Chart A-2 in Appendix A (Organizational Structure/Governance) provides a graphic representation of the department's approach to shared governance.

As described in Section 13-23 of the Faculty Handbook (Legislative Authority of the Faculty), university faculty share responsibility for:

- Educational policy and general welfare
- Policy for the regulation of student conduct and activities
- Scholastic policy, including requirements for admission, graduation, and honors
- Approval of candidates for degrees
- Criteria for faculty tenure, appointment, and promotion
- Recommendations concerning campus and University budgets

Implementation of existing departmental policies is carried out by the annually-appointed standing committees. Changes in policy are recommended to the whole faculty by individual faculty or appropriate committees, and instituted by a majority vote of the whole (core) faculty.

Department policy is generally developed at the committee level, either through periodic review or specific issues that arise, or in response to external requirements and changing conditions. Generally, committee members research issues and propose new policies or

procedures during committee meetings. The proposals are brought to the full faculty at monthly faculty meetings, where the faculty discuss and further refine the proposals. Voting is conducted following "Robert's Rules of Order". If a quorum is not present the vote is continued with voting via email.

Faculty appointments (new hires, promotion and tenure, endowed chair/professorships) are carried out in accordance to specific rules of SOM or COE, as appropriate. For faculty recruitment and for promotion and tenure cases, an *ad hoc* recruitment committee is formed and members are named by the Chair. The recommendations of the committee are presented to the Chair and faculty to vote. If approved, the Chair's office acts on behalf of the faculty to implement the decision. Exceptions to this process may occur in cases of joint hiring with other departments. All faculty appointments are subject to faculty votes, however.

The faculty have delegated some decision making directly to the Chair. For example, the Chair has been delegated authority to commit department resources (as needed) to retain critical faculty members. Similarly, the faculty periodically vote to delegate to the Chair decision making on faculty compensation; this includes merit and retention salary increases, endowed and administrative supplements, and compensation and start-up commitments for new faculty.

Bioengineering faculty are active in University committees, including the Faculty Senate, Councils of COE and SOM and college/school committees such as promotion and tenure and *ad hoc* committees. For example, Professor Patrick Stayton is currently a member of the Presidential Search Committee.

In addition to faculty committees, the department seeks advice from key constituents *via* a Student Advisory Board and an External Advisory Board.

- **The Student Advisory Board** meets quarterly to advise the Chair on issues of student concerns. SAB members self-nominate but are chosen by the Department based on their potential for leadership. SAB members are frequently tapped to represent the student body as a whole when the department needs student opinion on an issue.
- **The External Advisory Board** was instituted in the last decade, and has no specific schedule, but has met every three years in the recent past. We are now in the process of developing a charter for the group. Based on recommendations of that last meeting, we anticipate that industrial members of the external advisory board will meet yearly, with full board meetings only every three years. Members of the most recent external advisory board that met in 2010 were David Auth (former UW faculty, now industry), Lonnie Edelheit (industry), Linda Lucas (University of Alabama, Birmingham), Thomas Norris (UW-SOM), Jay Rubinstein (alumnus and UW-SOM), Nitish Thakor (Johns Hopkins University) and Paul Yock (Stanford University).

Budget & Resources

Budget

The department's research enterprise is funded primarily from extramural grants, especially from NIH: grants and contracts comprise 86% of the department's overall budget. State appropriations (General Operating Funds or GOF) are the second largest source of funding for BIOE at 8% of the total annual budget. Research cost recovery supports operations and is an important source of revenue at about 2% of the budget.

The severity of budget cuts in this biennium (7/2009 to 6/2011) was somewhat mitigated by commitments made as part of Paul Yager's start-up package because five new tenure lines were committed prior to the cuts. However, the cuts have caused reductions in staff FTE and the transfer of formerly GOF funded positions for auxiliary teaching, advising assistance, and admin staff to other sources of funds. This will impact our ability to build reserves for future hires and new initiatives. This trend is represented in Chart B-4 in Appendix B (Budget Summary).

Significantly affecting our departmental budget is the cost of supporting PhD students during their first year. Three quarters of laboratory rotations is the norm in most Basic Sciences departments, and used to be the norm in UW BioE until the first round of budget cuts two years ago. The department now guarantees RA support for only the first two quarters; a third quarter may only be supported in case of an emergency. All subsequent quarters are paid from research grants. The average annual cost to the department for rotations is about $222K during this biennium. The source of this support is now recapture of faculty salary.

To evaluate the use of financial and human resources, the Administrator creates metrics and comparison reports using data available from the American Society of Engineering Education and the UW Office of Research's annual report. The Engineering Dean's office also creates metrics of COE departments. For staffing models, the Administrator relies on informal metrics from the SOM basic science administrators group. These reports provide an important baseline for the Chair's review of funding and human resources. Similar reports and metrics are used to evaluate space assignments and utilization.

Fund-raising/development plan and grant/contract strategies

1. *Increase enrollment in the UWEO-BIOE professional masters programs.* The Masters in Medical Engineering (MME) program, administered through UW Educational Outreach (UWEO), targets employed engineers in the Seattle region who are interested in developing their knowledge in bioengineering. It has been a substantial source of revenue for the department in the past 15 years, with a peak yearly level of support of over $250K. In recent years, the enrollment has dropped, with concomitant decreases in revenue to the department. A new evening Master's program was added in FY2010 in Pharmaceutical Bioengineering (PharmBE). One option under consideration to increase enrollment in the MME program is to move to a distance-learning model so that it is accessible to students outside of Puget Sound region. The current format is a combination of on-line content and on-site labs/lectures.

2. *Obtain educational grants*. To support this goal, Alyssa Taylor (F/T Lecturer of BIOE) recently submitted a proposal to MathWorks to support curriculum development in our undergraduate program. She and Chris Neils (F/T Lecturer of BIOE) will continue to look for other grant opportunities to support undergraduate education.

We have a long history of NIH training grants for graduate education; such funding has traditionally reduced both the requirement of faculty support from their grants and the need for departmental funds to support of first-year graduate students during rotations. At this time we have only one active NIH training grant (Regnier's Cardiovascular training grant), supporting seven students per year, although our students have been very successful in obtaining graduate fellowships from multiple competitive, national foundations and agencies (see Appendix K, Center and Training Grants in BIOE).

3. *Establish a Corporate Affiliates Program*. As described in section IV of this self-study document, we are now planning to launch a Corporate Affiliates Program in 2011, with the goal that revenue from memberships will exceed costs and will become a source of funds for the department. However, it is clear that this CAP will not provide additional operational funds for at least 2 years.

4. *Advancement/Endowments & Gifts*. The department has a few named endowment funds that pay partial salaries for a few faculty, including the Chair. However, creation of endowment support has not been adequately pursued to date. Our financial situation would be greatly eased if we had additional endowment funding for student fellowships, professorships, and discretionary funding. We have a very small endowment compared to other departments at UW, in part because our alumni base is small and young, in part because these have been hard economic times, and in part because the SOM Advancement Office does not appear to understand how to raise funds for a basic sciences department. Since being appointed, the

current Chair has met monthly with the major gift officers from COE and SOM, and participates in events with existing and potential sponsors. However, at the time of this writing BIOE does not have a major gift officer: the SOM gift officer left the UW in the fall and the COE gift officer was recently reassigned. We have not been informed yet if there will be a replacement major gifts officer from either office. We have had an excellent experience with the COE Advancement office with respect to creation of the CAP, and it seems that this will be our only opportunity for raising funds in the immediate future. This fall we have been finalizing a marketing/communication plan to build stronger relationships with alumni and key stakeholders, and hope to make that the basis of our own approach to private sources of funding.

Section II: Teaching & Learning

Student Learning Goals and Outcomes

The following are the learning goals for each undergraduate and graduate degree and certificate program.

BS BIOE

The goal of this BS program is to prepare our students for graduate programs in bioengineering and medicine, and for jobs in industry. Students who graduate from our BS BIOE program are prepared to:

- Apply fundamental principles from mathematics, physics, chemistry, computing, engineering, and biology to solve biomedical and biotechnological problems.
- Derive design principles from nature and apply them to solve biomedical problems and to develop bioengineering technologies.
- Work in multidisciplinary teams and communicate problems and their solutions effectively with physicians, scientists, and other engineers.
- Take ethical and social issues into consideration in solving bioengineering problems
- Continue to develop technical knowledge, awareness, and leadership abilities to address domestic or global issues in human health.

Our BS BIOE graduates will have:

- An ability to apply knowledge of mathematics, science, and engineering to biological problems.
- An ability to design and conduct experiments, as well as to analyze and interpret data.
- An ability to design a system, component, or process to meet desired needs.
- An ability to function on multi-disciplinary teams.
- An ability to identify, formulate, and solve engineering problems.
- An understanding of professional and ethical responsibility.
- An ability to communicate effectively.
- The broad education necessary to understand the impact of engineering solutions in a global and societal context.
- A recognition of the need for, and an ability to engage in, life-long learning.
- A knowledge of contemporary issues.
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- An understanding of biology and physiology.
- The capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve the problems at the interface of engineering and biology.
- The ability to make measurements on and interpret data from living systems, addressing the problems associated with the interactions between living and non-living materials and systems.

BS/MS and MS

The student learning goals of the BS/MS and MS programs are as follows:

- To learn to work as an engineer and researcher.
- To show evidence of independent investigation.
- To be able to present the results of that investigation cogently .
- To successfully complete significant course work (with a 2.7 or higher).

- To complete a thesis that describes an independent project.
- To successfully complete and pass a final examination of the research underlying the thesis.
- In addition, see outcomes of the PhD program below.

MME

The student learning goals of the MME program are as follows:

- To learn human cellular and molecular biology, physiology and gross anatomy.
- To learn how clinicians use imaging, physical exams, observation and statistical tools to identify, classify and treat diseases at the individual and community levels.
- To learn how biological systems interact with internal and external sensors, devices and materials at the molecular and cellular level and how medical device design must account for these interactions to meet their design goals.
- To learn how to approach business development, regulatory affairs and the fundamentals of good manufacturing principals in a highly regulated environment so they can assume leadership roles in the development of medical devices.

Pharm BE

The student learning goals of the Pharmaceutical Bioengineering program are as follows:

- To learn the molecular and cellular biological principles to the development of pharmaceuticals.
- To learn the pharmaceutical principles behind the scientific and industrial processes in the development of therapeutic products.
- Develop analytical and experimental design skills to interpret, evaluate, and communicate biomedical research.
- To learn the science and processes in the formulation of therapeutics from preclinical development to clinical development.
- To learn to use systems biology tools and bioinformatics principles in drug discovery and research.

PhD

The main goal of our PhD program is to prepare our students for careers in industry and academia by learning a set of core educational principles and approaches common to all bioengineers, and through performance of research that is published in high impact peer-reviewed journals in the applicable field. Graduating students are expected to:

- Have an in-depth understanding of research relevant aspects of mathematics, engineering principles, physics, chemistry, and molecular, cellular, and organ system physiology and biology.
- Have expertise in the area of their specialization, and strong knowledge in relevant areas necessary to the completion of their thesis work. These latter include mathematics, statistics, engineering principles, physics, chemistry, biochemistry, cellular biology, and organ system physiology.
- Be able to apply basic science and engineering principles to medical and biological problems.
- Be able to recognize and provide engineering solutions to clinical problems, with consideration of cost effectiveness.
- Be prepared for teaching bioengineering at the graduate and undergraduate levels.
- Be able to apply bioengineering research to commercially viable problems.

Evaluation of student learning

BS

The BS Bioengineering degree is now accredited by Accreditation Board of Engineering Teaching (ABET). The accreditation process requires an extensive evaluation of how each student and the program as a whole is meeting each of ABET's defined outcome. We are also required to document continuous improvement.

Outcomes are assigned to various courses, and course assignments provide specific measures of each outcome. Each student is evaluated for competency on each outcome. Competency means that a student meets or exceeds a grade of 2.5 on all outcomes. Each student is expected to pass all outcomes by time of graduation. The Accreditation and Continuous Improvement (ACI) committee looks at both individual and program data and suggests changes to assignments, courses, and the program as a whole.

BS/MS and MS

Quarterly, students are expected to complete courses with a minimum 2.7 GPA and keep their cumulative GPAs above 3.0. Students have regular (weekly to quarterly) meetings with their PIs to monitor academic progress related to research and lab notebooks are frequently checked and reviewed.

A Supervisory Committee is established by the fourth quarter. The Committee and the student, along with the PI, review and approve the student plan (a written document which tracks courses taken, grades earned, and plans for which future courses to take). This is also approved by the Department's Vice Chair. Master's students may begin taking BIOEN 700 after their student plan is approved, and the student must successfully complete at least 9 credits of BIOEN 700 in order to defend. The student and the Supervisory Committee determine when the student is ready to defend.

The final outcome of the BS/MS and MS track is the thesis. The faculty advisor must first review and approve of the thesis, which is then given to the Supervisory Committee. After, the thesis is defended orally and if the student passes the oral exam, the committee signs both the paper thesis and the student's exam warrant. By signing the exam warrant, the committee certifies that the student has met all departmental requirements.

MME

Students are evaluated using graded homework exercises, self-evaluations, and periodic exams tied to course learning goals and program objectives. Advanced courses are assessed using individual and team projects, presentations, literature/regulatory document reviews, and project presentations that judge assimilation and integration of basic concepts.

PharmBE

Students will continually demonstrate learning through examinations, course assignments, papers and projects that are tied to course learning objectives and overall program outcomes.

PhD

Course and research progress as for BS/MS and MS, above. The academic counselor helps the faculty monitor student progress to degree. PhD students have three exams they must successfully pass in order to be granted their degree: the Qualifying Exam (QE), General, and Final exams.

The QE is completed over a 5-week period by the end of the second year. The student is evaluated in four specific areas: 1) scientific merit of the written and oral presentations of the

proposal, 2) general knowledge and reasoning ability as demonstrated in the question/answer session, 3) presentation (quality of oral and written presentation, style, organization, clarity), and 4) knowledge and understanding of expected prerequisites. The student will be scored as either “Excellent,” “Good,” “Fair,” or “Poor,” and each ranking as clearly defined on the student’s evaluation paper and in the student handbook. Based on the committee’s final scores, the student will either “pass,” “conditionally pass,” “resubmit” or “fail.” Students cannot take the QE more than 2 times.

The General Exam is used to assesses the following features: Scientific and scholarly quality, oral presentation (approximately 2 hours), NIH “Guiding principles for research involving animals and human beings,” and ethics, as well as the written presentation (writing, references, data, tables, figures, titles, abstracts, units of measure). The outcomes include, “pass,” “conditional pass,” “fail and retake,” “fail.” This is the committee’s opportunity to correct deficiencies in the student’s overall educational program.

The final assessment is a public oral defense of the thesis, after it has been reviewed by the Reading Committee. The Supervisory Committee judges whether the oral exam has been successful.

Evaluation of Student Satisfaction

BS BIOE

CIDR conducts annual reviews with the junior and senior cohorts. The junior cohort review happens in spring at the end of junior core. It is qualitative and addresses student satisfaction in the program, including suggestions for improvement. The senior cohort review happens in spring of the senior year, at the end of the BS program, and is a mix of quantitative ratings on our objectives and outcomes and qualitative feedback. The results of the CIDR review are shared with the Chair, Vice Chair, Academic Counselors, and Curriculum and Student Affairs committees for follow-up and action. Over the years a number of program improvements, most consistently curricular improvements, have stemmed from the CIDR review.

The Student Advisory Board meets quarterly with the Chair and has three undergraduate members. SAB members are responsible for identifying issues of student concern and bringing them to the attention of the Chair. These meetings result in action steps for both students and the administration. Follow-up is communicated via email to the student body, either by the Chair or the Academic Counselor.

One undergraduate representative serves on the Student Affairs Committee (supervises student progress and student life in department) and another on the Curriculum Committee.

Students independently bring issues to the Lead Academic Counselor who reports to the Vice Chair and Chair and assists with follow-up as needed. Follow-up has included: discussion in faculty meetings; items brought before Student Affairs or Curriculum; Focus Groups with undergraduates; decisions made by Chair and communicated to students.

BS/MS and MS

CIDR conducts a qualitative review with first-year MS and PhD students at the end of the first year of the program. The Student Advisory Board (see above) has 4 graduate student members. Two graduate students serve on the Student Affairs Committee and two on the Curriculum Committee. In addition, students often bring issues directly to the Senior Academic Counselor, who reports them to the Lead Counselor, Vice Chair, and Chair.

MME

Anonymous evaluations are conducted at the end of each course and at the end of each 3-course sequence. End of program and alumni surveys are conducted as well as individual student consultation and advising.

PharmBE

Courses have anonymous end-of-course student evaluations. These and alumni surveys will be utilized in the future to assess student satisfaction. Student body meetings and one-to-one consultation and counseling with students are also used.

PhD

Same as for BS/MS and MS. In addition, the Vice Chair conducts an exit interview with each PhD graduate and reports any thematic issues to the faculty.

Assessment findings for student learning

BS BIOE

As of Autumn 2009 all students are meeting competency in program outcomes, as assessed by the processes described above.

BS/MS and MS

Students are evaluated via the exam and committee process to meet competency in program requirements.

MME

The students who successfully complete the courses and the overall program are demonstrating in their evaluations that they learning the principals being taught. Student feedback after completing the program indicates that the knowledge gained is valuable in their careers.

PharmBE

The Master of Pharmaceutical Bioengineering degree was approved in November 2009. No assessment results are yet available.

PhD ~95% of students eventually pass the qualifying exam. Some of these student pass on a second exam after failing the first exam. Those students who do not pass are normally offered the option to complete an MS.

Use of findings to bring about program improvements and decisions on resource allocation

BS BIOE

A selection of recent program improvements includes:

•A thorough curriculum revision, to be implemented beginning WIN 2011, incorporating several years of student comments, and involving student leaders in every step of the revision.

- Numerous individual course revisions.
- A quarterly letter from the Chair to the Student Body, begun AUT 09, at the request of the Student Advisory Board.
- Creation of the Bioengineering Student Design Fund (BSDF), to seed out-of-class design projects initiated and conducted by students. This was a response to the need, expressed to the Student Affairs Committee, for more esprit-de-corps amongst undergraduates and the desire of our majors to engage with students ahead and behind them in the program.
- Creation of a second capstone option for seniors, and the hiring of a second Instructor to handle the increased program workload and to offer better scientific mentoring.

BS/MS

Since its inception this program had been restricted to students who could complete both the BS and MS in 5 calendar years. At the request of our undergraduates, the faculty reconsidered the nature of an "accelerated" program and decided that the BS portion could take more than 5 years as long as the MS portion took only one additional year.

MME

Yearly review of student performance and course evaluations with course instructors and the program director has led to updates and minor revisions in course content and emphasis.
Based on recent course feedback, the instructor was changed and course content of Medical Chemistry was revised to be more in-depth and relevant to human biology.
Based on program feedback shortly after the last review, the subject matter, course content and instructor of the medical imaging course were revised to emphasize clinical content.

PharmBE

End-of-course evaluations are examined with instructor and program directors to identify areas of curricular improvement on an on-going basis until full program in operation.

PhD

The PhD curriculum was greatly revised 3 years ago based on student feedback from the CIDR reviews and the Student Advisory Board. We continue to make a strong financial commitment to the Recruitment Weekend based on student feedback about how that weekend influenced their decisions to attend our program.

Courses typically taken by undergraduates who are not BIOE majors

In previous years, the 300-level courses were generally not accessible to non-majors; senior electives were accessible on a space-available basis (some are joint-listed with other COE departments). As we implement the new undergraduate curriculum, we have planned for some COE students to take our lecture courses. BIOEN 215, the new introductory course, will be open to anyone with interest.

Instructional Effectiveness

BS BIOE

Each instructor prepares a Course Improvement Memo for the ACI Committee assessing how the course helped students meet learning outcomes and summarizing the planned improvements for the following year. The ACI Committee reviews the memo and suggests additional changes as necessary.

BS/MS and PhD

The IAS evaluations are reported to the Chair, who follows up directly with faculty whose evaluations are low. In addition, comments about individual courses and instructors surface in the CIDR reviews and are reported to the instructors as needed. Peer teaching review is conducted on a periodic basis and for promotions cases.

MME

End-of-course evaluations, peer course review and course observations are periodically used to evaluate quality of instruction and effectiveness of instructional methods.

PharmBE

End-of-course evaluations, course observations and peer reviews are utilized to assess quality of instruction

Opportunities for training in teaching

BS BIOE

Seniors are allowed to work as undergraduate graders in sophomore and junior courses; these are paid positions but strictly limited to an average of 10 hours per week. They may grade papers, manage a course website, or serve as an extra pair of hands in the lab, depending on instructor need. They are directly mentored by the course instructor.

PhD

A one-quarter TA-ship is required for the PhD. TA assignments are made in the summer for the following year. Assigned TA's are required to attend the Graduate School's annual TA conference (with suggestions for specific workshops). Interested students are encouraged to TA more than once if space permits. During the 08-09 and 09-10 academic years graduate student TA's were encouraged to attend a special topics course on Brain Rules and Science Education taught by John Medina.

Faculty have access to the resources of CIDR and CELT and use them on an elective basis.

PharmBE

Faculty are able to learn alternate instructional styles and methods through peer course observation and participation. Access to resources of Institute for Instructional Design & Research and COE's Center for Learning & Teaching is available.

Instructional changes made by instructors in response to evaluation of teaching

BS

It would take pages to detail changes made over ten years; the most notable is the implementation of our new curriculum. Prior to that some changes included: The introduction of BIOEN 201 (BIOE Tools) at the request of our students; adding labs to senior electives (again, based on student feedback); creating BIOEN 481 (now 401) and further revising it to support creating a capstone proposal; and many other changes.

MME

Faculty learn alternate instructional styles and methods through peer course observation and participation. Instructors have access to resources of Institute for Instructional Design & Research and COE's Center for Learning & Teaching. BIOE has also worked with instructional designers at UW Educational Outreach to develop courses and train instructors in online and distance teaching methods.

PharmBE

This program has increased use of instructional and online technology in the classroom. Course assessments have led to a change from exam-based to project assessments and presentations that benefit the audience of working professionals in direct application of concepts.

PhD

An evaluation similar to the one conducted for our undergraduate program led to revision of our graduate classroom curriculum (by our Curriculum Committee) that was instituted three years ago. Changes to the 501-502-503 core sequence continue to be made annually.

Teaching and Mentoring Outside the Classroom

Research

By far the largest non-classroom component of faculty involvement in undergraduate and graduate student learning is through mentoring of laboratory research. At the undergraduate level, this occurs in three ways: 1) required senior capstone research and design (semi-independent project); 2) independent study (BIOEN 499); and 3) volunteer work in labs. During Spring quarter of 2010, for example, we had 40 capstone students enrolled, 13 independent study students, and 9 lab volunteers. Our volunteer numbers have been underreported; recent measures taken to assure compliance with SOM rules governing lab volunteers will allow better accounting; we expect our SPR 11 numbers to be substantially higher. Many of our undergraduates research for 2, 3, or 4 years.

MS and Ph.D. students choose a research laboratory by the end of their second or third academic quarter and are directly supervised by faculty from that point onward. MME and PharmBE students have no required research.

Independent study

Dr. Daniel Ratner has supervised three undergraduate global health internships, which have ranged in variety from rural and urban healthcare in Ecuador, HIV/AIDS care in South Africa, and healthcare delivery in India. For the record, the three students who conducted these projects were women and two were underrepresented minorities.

Advising student groups

Faculty advise student groups who compete in national and international competitions. iGEM (International Genetic Engineering Machine Contest) is an annual event held at MIT where undergraduate students compete to build devices made from biological components. Prof. Herbert Sauro of Bioengineering has helped UW participate in iGEM with two interdisciplinary teams in 2009 and one combined software and wet lab team in 2010. These teams have won bronze, silver and gold medals respectively. In 2009, the Department of Bioengeering also hosted the youngest team member ever in iGEM, 11 year old Gabriel See who won the bronze medal for his liquid handling robot. The UW 2010 team won the coveted Best Health and Medicine Project Track for their work. MIT was the only other US team that won a track award. It should be noted that obtaining funding for summer stipends, registration, and consumables has been difficult in the current economic climate.

Bioengineers without Borders (BWB) is a student-run organization that addresses challenges in global health by developing and deploying cost-effective healthcare solutions in low-resource settings. Dr. Daniel Ratner serves as faculty coordinator of this group. This highly productive and successful group won the student design competition at the NAE regional Grand Challenges Summit held in Seattle, competed at the national competition in early October 2010, and filed their first provisional patent on a smart phone-based portable diagnostic suite. This group is actively engaged with UW C4C, as well as the UW Entrepreneur in Residence, Tom Clement. For more information, please see Appendix E (NAE Application) and Appendix F (Bioengineering Design Fund Proposal).

K-12 Outreach

During the ten years of its NSF funding, UWEB ran a number of successful educational outreach programs, including: LEHSS (Laboratory Experience for HS Students); STI (Summer Institutes for Middle School and High School Science Teachers); SFS (Science for success; YTH(Youth Take Heart); and SET-UP (Scholarship in Engineering Training in the UWEB Program. Details are available on the UWEB website.

For 3 summers Bioengineering offered a 5-day non-residential BIOE Summer Camp to local HS freshmen and sophomores. Using heart disease as a focus, students were taught heart physiology and pathology and were introduced to solutions via the major areas of bioengineering research. BIOE faculty developed the curriculum together with local HS biology teachers. Though this program was highly reviewed by students and parents (and one of our current Goldwater scholars discovered BIOE through this program), it was discontinued for lack of permanent funding.

Current outreach efforts include BIOEN 497, developed by Dr. Dan Rather to teach BIOE juniors and seniors the pedagogical skills required to effectively design and conduct outreach modules. The course enrolls an average of 15 students per quarter during the academic year. BIOEN 497 students have developed a series of math, physics, chemistry and biology-themed modules drawing on BIOE research topics such as nanotechnology, biosensing, global health, and glycomics. Our students teach these modules in local classrooms. BIOEN 497 targets low-resource setting schools, highlights the frontiers of biomedical science and engineering, and promotes scientific literacy through direct engagement. Over the past year, 19 classroom modules have been deployed, reaching over 400 high school students. These numbers are expected to expand significantly over the next 10 years. In the future, these teaching modules presented by BIOEN 497 students will be made publicly available on the web so that the materials can be copied and taught elsewhere.

Community College Outreach

The NIH-funded "Building Bridges to Bioengineering" (B3) program, directed by Dr. Eric Chudler, works with underrepresented minority students from Seattle Central Community College as they transition to baccalaureate degree programs at the University of Washington (UW) and other four-year universities. B3 includes an academic course that focuses on using bioengineering and biotechnology to solve global health problems. B3 students receive mentored research experiences as well as workshops and seminars to provide students will experience giving scientific presentations.

Dr. Daniel Ratner serves on the Technical Advisory Committee (TAC) for the newly created Nanotechnology Associate's Degree program at NSCC. Some of Dr. Ratner's postdoctoral fellows have gained teaching experience by lecturing in NSCC courses. He has also served as a mentor to a student from the NSCC degree program who interned in his laboratory to advance proficiency at the bench in a biomedical setting.

Student Recruitment

Undergraduate students

The departmental website is the primary written source of information. The Academic Counselor meets with prospective students (HS, college, and transfer) and their families on request. We ran a very successful BIOE summer camp for 3 years and some camp attendees later became students here. BIOEN 497, Bioengineering Educational Outreach (described above) exposes area high school students to bioengineering. The department offers a Direct Admission option to capture high-achieving high school seniors and admit them directly to the BS program. We work closely with Honors, Emerging Leaders, and other UW recruitment partners. We maintain a pre-bioengineering listserv for UW freshmen who have expressed an interest in Bioengineering; this is used to disseminate information and to distribute invitations to recruitment events. We participate in all recruitment events sponsored by the COE and SOM (such as open house during Washington Weekend and Engineering Special Sessions during summer registration and orientation).

Graduate students

Recruitment efforts are made through multiple venues, including our Departmental website and counselor meetings with prospective students. Our high national rankings are an asset. We have a booth and hold a reception at the annual BMES meeting. Our faculty and students represent our program when they are speakers at other institutions and professional meetings. Faculty contact their professional colleagues to remind them that UW BIOE would be a good place for their best students. The most successful applicants are invited to campus for our Recruitment Weekend, where they have at least 2 days of contact with students and faculty; this usually coincides with a major annual event, the Rushmer Lecture, which further spotlights the prominence of the department. Offers of admission are made based on candidate interviews with faculty during the Weekend.

MME and PharmBE

Students are recruited through traditional printed and online media advertising, open houses, online information meetings, local professional organizations and groups, information sessions offered at local businesses and campuses, and recruitment opportunities provided by the program's advisory board members and their companies.

URM recruitment

We are actively recruiting URMs to our graduate program. This fall, Mike Regnier (Vice Chair) attended the Society for Advancing Chicanos and Native Americans in Science (SACNAS) annual conference along with others from UW. BIOE was grouped with other UW representatives. The goal for UW is to develop visibility about science and engineering programs at the undergraduate and graduate level. The annual BMES meeting, while not specifically a URM event, is another venue where we have put efforts to recruit URM students. The Senior Academic Counselor is active in the SOM Biomedical Minority Recruitment Task Force, which is present at all on-campus recruitment functions, pools funds for a booth at URM-targeted conferences, and offers a way to share best practices.

Ensuring academic progress and efforts to support students

Undergraduate students

Student Services staff check major enrollment in check-point courses, during the junior and senior years. Students who do not enroll are contacted. All students are checked for satisfactory progress 3X per year and a summary report is prepared for the Student Affairs Committee. Students in difficulty are brought in for advising, as are students who are technically making satisfactory progress but whose grades have dropped. Students whose schedules appear unrealistic are also advised *via* email. Probation or drop letters are reviewed by the Vice Chair; petitions are reviewed by the SAC and written responses include specific conditions for reinstatement.

Progress in the senior capstone course is monitored by the Academic Counselor, the capstone group session instructor, and each student's PI. Anyone not progressing is asked to meet with the Academic Counselor, who involves faculty as necessary.

Students are referred to campus resources (study skills support, tutoring, personal counseling, etc.) as needed and are encouraged to see the Academic Counselor or a trusted faculty member whenever they are in difficulty.

Graduate students

First-year students have an assigned faculty advisor. There are required meetings with the Graduate Academic Counselor at beginning of the 2nd quarter in the program and after the Qualifying Exam. Students also have regularly scheduled meetings with their PI's. Students have

a suggested schedule for when to take their exams: QE by the end of the second year, GE – in the third/fourth year, FE – by the 4th/5th year. Any students who do not meet this timeline are called into the Academic Counselor's office for individual advising sessions. All students are also encouraged to collaborate with peers through social and academic events and through clubs, such as BMES and SACNAS

Preparing undergraduate and graduate students for the next phases of their academic or professional lives

BS BIOE

BS students normally intend to enter graduate school (MS, PhD), professional school (medical, dental, law) or industry (including research institutions and hospitals). All juniors are required to participate in a résumé workshop that is customized for BIOE students. The counselor reviews and marks each student's draft resume. Additional career workshops are supported by Career Center staff and scheduled by student request.

The Academic Counselor asks each major about intended career direction, offers basic information, and refers to appropriate campus resources. Pre-medical students receive particular advising attention because of their educational planning needs, including mock medical school interviews as requested. Students receive regular email updates *via* the majors' listserv about campus workshops and events that will provide career support. The Academic Counselor helps the BMES officers with their pre-medical, industry, and grad school panels. Faculty are the primary mentors for PhD-bound students.

Graduate

Faculty are the primary mentors with respect to academic jobs, and, in some cases, jobs in companies with whom they have extensive contact. In addition, faculty usually support student attendance at conferences and at professional meetings where networking and jobs fairs are common. The department actively assists both the Science and Engineering Business Association (SEBA), which offers the largest campus jobs fair every year, and the student BMES chapter. Students are also directed to helpful website and career resources.

MME and PharmBE

The Medical Engineering and Pharmaceutical Bioengineering programs are designed to address the needs of working professionals. Students in each course are encouraged to bring real-world problems they have encountered to add to the relevance of the course material. Regular outside speakers bring problems of relevance to class discussions and projects. Program directors and counselors support students in further identifying areas for academic and professional growth.

Section III: Scholarly Impact

Impact of BIOE faculty research and creative work

The long-term excellent reputation of BIOE is based on more than four decades of high-impact publications (both journals and texts), effective garnering of large research grants from NIH, NSF and private foundations, national and international service, endless air travel to give seminars at high-impact meetings and prominent universities around the world, and successful commercialization of innovative technologies through start-ups and licenses to prominent multinational corporations. It has been the case that most of the senior faculty have continued to publish at a high rate right up to and beyond retirement. This high impact continues today.

Technology

A significant impact on the region has been the development and continued success of the local medical ultrasound industry. Today there are a number of local companies that derived their IP from UW BIOE developments in ultrasound, imaging, biomaterials, drug delivery, and microfluidics. New outreach to the clinical departments in translational research (catalyzed by funding from the Coulter Foundation and more recently, by Washington Research Foundation and UW C4C) is bringing a new generation of young MDs into close collaboration with BIOE faculty and students, thereby revitalizing SOM's translational activities.

Impact on the field

One simple measure of impact and productivity is the H-index, which calculates an investigator's most cited papers and the number of times they have been cited by other authors. For this self-study, we obtained H-index values for all research, tenure track and active emeritus faculty; we used the "citations-gadget" available at *http://code.google.com/p/citations-gadget/*. The values for all faculty members are included in Appendix P (BIOE Faculty – H Index (grouped by rank)).

The distribution of h-index values for BIOE is low 13 and high 54, with 26 the median and 29 average. For full professors, the average and median is 34. Scores above 45 are considered by some to indicate very high impact, and five BIOE faculty (including one emeritus) have exceeded this value.

While we cannot highlight all BIOE faculty due to page limitations, the following is a sample of the impact of BIOE faculty from the ranks of full, associate and assistant professors (two each).

Professor Buddy D. Ratner has been researching biosurfaces and biomaterials for over 40 years. His work has been considered seminal in the development of the fundamental understanding of the biointerface. Interfacial reactions between proteins and cells at the biointerface are critical for diagnostic arrays, biosensors, medical implants, cell culture surfaces, biochromatography, stem cell technologies and non-fouling surfaces, to name some of the areas of interest. In 1983, he established with NIH funding the National ESCA and Surface Analysis Center for Biomedical Problems (NESAC/BIO). This center brought modern surface analysis tools from the catalyst and microelectronics communities to biomedical problems. The center is still active and funded over 30 years later (though no longer directed by Professor Ratner), and has assisted hundreds of students and researchers in studying the biointerface. In the early 90s Professor Ratner became interested in improving the healing and integration of medical devices. Based on concepts he evolved, an NSF Engineering Research Center, University of Washington Engineered Biomaterials (UWEB), was funded. This 11 year multidisciplinary effort developed new ways to improve biomaterials healing, and these have now spun off into a company that is taking the ideas to the clinic. The study of healing and integration led to a program on tissue

engineering that is now studying heart, bone, sclera, esophagus, bladder and other tissues. The goal of this most recent effort is not just to heal in the body, but to actively regenerate new tissues and organs.

Professor Patrick Stayton joined UW BIOE in the early 1990's and leads a large research and education program. His eclectic research group works at the interface of fundamental molecular science and applied molecular bioengineering. The group has a strong interest in translating university research and a startup company in Seattle, PhaseRx Inc., has been formed on the basis of the group's drug delivery technologies. Dr. Stayton has won the Clemson Award from the Society for Biomaterials and in 2009 he received the Community of Innovators Faculty Research Award from COE that honors a single faculty member each year for outstanding research contributions. Dr. Stayton is currently the Director of the UW Center for Intracellular Delivery of Biologics, founded in part by a $7.2 million grant from the Life Sciences Discovery Fund. He was also recently named the Director of the new Molecular Engineering and Science Institute, whose goal is to bring together world-class faculty working at the forefront of chemical and biological science with leading engineering faculty to develop novel medical applications and sustainable energy and materials technologies. Many graduate students and postdoctoral associates trained in his group have gone on to impactful academic careers in bioengineering and chemical engineering departments across the country and world.

Associate Professor Suzie Pun focuses on the development of new materials that incorporate biomolecules such as nucleic acids, peptides and proteins into synthetic polymers for more efficient and effective delivery. Her research involves active collaborations within COE (Electrical Engineering, Chemical Engineering) and SOM (Neurological Surgery, Otolaryngology, Gastroenterology, and Pathology). Recent research advances include demonstration of non-invasive tumor imaging by near-infrared fluorescence in murine xenograft models and targeted gene delivery to neural progenitor cells in the brain. Mentoring and training of undergraduate researchers in the laboratory is especially emphasized. To date, 25 undergraduate researchers have been trained, of which 7 have been co-authors on peer-reviewed manuscripts and 3 have been recognized as Goldwater Scholars.

Associate Professor Herb Sauro does research in a highly collaborative discipline involving the design and construction of new biological systems (synthetic biology) that can lead to solving problems in health, energy and the environment. Synthetic biology encompasses many different disciplines, including bioengineering, computer science, electrical engineering, biology, microbiology, chemical engineering and biochemistry. UW has a growing presence in the synthetic biology community and is considered one of four main US centers for this emerging and exciting new field of research. Dr. Sauro works with Eric Klavins (EE),Georg Seelig (EE/CSE) and Jennifer Nemhauser (Biology) in leading this effort. In Bioengineering, Dr. Sauro leads the development of community-wide synthetic biology engineering standards and design software, and understanding the evolutionary forces that determine how engineered organisms are robust to natural selection. Several faculty from Bioengineering and other UW departments have a growing interest and involvement in the application of synthetic biology to their research efforts and Dr. Sauro has worked with these core faculty to develop an initial synthetic biology curriculum at UW that included courses at the graduate and undergraduate level together with UW undergraduate teams for the iGEM competition. This curriculum was greatly facilitated by a grant to Drs. Klavins and Sauro from the School of Engineering to provide dedicated synthetic biology laboratory facilities for undergraduates. Furthermore, a new UW synthetic biology web site is nearing completion to provide a centralized entry point for all UW related activities.

Assistant Professor Kim A. Woodrow joined the BIOE as an Assistant Professor in January 2010, and her research and other activities are an example of the broad impact and innovation of our junior faculty. Within the first six months here, Dr. Woodrow received a prestigious NIH research grant to support young investigators that are new to the field of HIV/AIDS research. The Creative and Novel Ideas in HIV Research (CNIHR) program provides support of $150,000

per year in direct costs for up to two years, and was awarded to only four U.S. scientists. Kim will use the CNIHR funding to support her research on nanoparticle-based topical microbicides to prevent sexual transmission of HIV-1. To date, microbicide clinical trials for preventing transmission of HIV-1 have focused primarily on conventional gel-based systems for intravaginal delivery of monotherapies, which do not take advantage of the ability to combine potent antiretroviral agents with different mechanisms of action, or to deliver these agents using strategies that can overcome physiological barriers and target the drugs to their specific site of action. Dr. Woodrow's laboratory is developing nanoparticle-based intravaginal drug delivery systems to overcome these obstacles and afford significantly more flexibility in combining two or more antiretroviral drugs into a single topical product. Her research uses engineered materials to enhance understanding of pathogen transport at mucosal surfaces (e.g., sexual transmission of HIV-1), to design multifunctional materials for disease applications (e.g., VLP vaccines, topical microbicides, diagnostics), and to develop health technologies for low-resource settings (e.g., vaccine and adjuvant delivery, contraception). The blending of fundamental science, technology development, and translational research is highly interdisciplinary and integrates knowledge from the fields of materials science and chemical synthesis, biochemical engineering, molecular and cellular biology, and immunology. Her laboratory bridges the Department of Global Health in the School of Public Health, where she is developing joint activities between Bioengineering and the Center for Women's and Children's Health, and the Department of Obstetrics and Gynecology in SOM, where the Woodrow Laboratory has collaborations to translate their drug delivery technology into clinical applications.

Research Assistant Professor Barry Lutz has a new research program with a primary focus on novel diagnostics for global health applications. His work contributes to an emerging critical mass in Global Health, representing an important growth opportunity for UW BIOE and provides exceptional research and educational experiences for students. Specifically, the unique challenges of the developing world often require creative technologies and require students to assimilate engineering with an understanding of medical, economic, and cultural issues. His work by nature requires collaborations with clinical and translational partners, including investigators from PATH and UW Medicine. Currently, Dr. Lutz is co-Investigator with Dr. Paul Yager on an NIH ARRA Challenge Grant to develop high performance diagnostics using inexpensive paper materials. Another project uses the audio properties of fluidic circuits to create diagnostics controlled by cell phone audio signals, in which audio tones control fluidic assay steps and the returning tones quantitatively report the assay result. A second area of research is a translational collaboration with UW Neurosurgery to develop an implanted fluid drainage system for treatment of hydrocephalus ("water on the brain"). This work began when a Pediatric Neurosurgeon, Dr. Sam Browd, approached Paul Yager with a challenge to the department to design new devices to reduce the high failure rates of existing drains. Yager introduced Lutz and Browd, and they developed a proposal for a failure-resistant drain that was funded by the UW Coulter Translational Research Partnership. In the 8 months since the project began, it has created opportunities for commercialization, student research, and educational material for BIOE and Business courses. Lutz and Browd work closely with a commercialization team established by UW C4C, and they have founded a company to carry out commercialization. The team received commercialization funding from UW C4C (Commercialization Gap Fund) and the Washington Research Foundation. The project has been highlighted in UW external relations presentations at the UW C4C Economic Impact Day attended by Washington State officials and the AdvaMed conference attended by biomedical device investors.

Undergraduate and graduate student awards and fellowships

Awards granted via such programs as the NASA Undergraduate Student Research Program, the Mary Gates Endowment, the Levinson Emerging scholars Program, the Goldwater Foundation

and the Washington Research Foundation help mark undergraduate student achievements in the program and make a positive impact on the department.

Graduate student fellowships awarded via the National Science Foundation, National Institutes of Health, American Heart Association, Department of Defense, and other prestigious programs have had a similar effect on the department and students' experience within their program.

For further details on student awards, please see Part B (Unit defined questions), Question 8, as well as Appendices G (Undergraduate Awards) and H (Graduate Student Fellowships).

External changes that have affected BIOE

Many factors have influenced the changes in the department over the last 10 years. As the science of biology and the technologies available through engineering change, the research topics move with them, sometimes following trends, and sometime leading them. Changes in funding also have an enormous impact. The NSF funding for the UWEB Engineering Research Center (ERC) ended in early 2009, which reduced the impact of our highly-prestigious biomaterials program, and forced it into a post-ERC mode of relying exclusively on NIH and corporate funding. The rise of the Bill & Melinda Gates Foundation and its focus on global health created new power bases in Seattle, adding the Department of Global Health and Institute for Health Metrics Evaluation at UW to the existing PATH and Seattle Biomedical Research Institute (now Seattle Biomed). This influx of interest and funding has caused many in the department, including the Chair and Buddy Ratner, to compete (successfully) for funding to work on projects that will have their primary benefit in the developing world. The impact of the 5-year $15.4M DxBox project funded by the Grand Challenges in Global Health initiative of the Gates Foundation had a substantial and positive impact on Yager's group, attracted many bright students to the department, and launched the careers of Assistant Professors Lutz and Fu. We have also hired new faculty (e.g., Kim Woodward) in part because of their interest in global health issues and their potential for interaction with the new Department of Global Health.

We cannot overemphasize the impact that primary funding from the Gates Foundation had on allowing the construction of the new William H. Foege Building in which the department is now housed. This state-of-the-art building in a spectacular site is very attractive to faculty, staff, and both undergraduates and graduate students!

We have also been fortunate that the state of Washington decided to take $350M from the tobacco company settlement with the tobacco companies, and use it to establish the Life Sciences Discover Fund. This fund is directed by our former department Chair, Lee Huntsman. Several core and adjunct faculty have had funding from this agency, most prominently a project for Prof. Giachelli, and a program grant on drug delivery to Prof. Stayton, and one shared by BIOE, Radiology and the Advanced Physics Laboratory on molecular ultrasound imaging. The department has benefitted substantially from these funds, and, as long as the state can continue to fund the program, bioengineering research initiatives will continue to meet the criteria for grant funding.

For the last five years we have had the benefit of a generous grant from the Wallace H. Coulter Foundation under their Translational Research Partnership program. This program provided nearly $1M per year to support teams of bioengineers and clinicians to perform translational projects. This has had a catalytic role in changing the culture in our department and across the campus, particularly with UW C4C and SOM. We are in a far better position now to implement translational research programs than we were five years ago.

When Dean O'Donnell was hired, the University committed to create a new building and interdisciplinary program in molecular engineering. The Molecular Engineering Building is nearing completion, and will soon provide extensive new facilities for collaborative funded research at the boundaries between Engineering, Chemistry and Physics. The fact that Prof. Stayton was just named director of this center has substantial positive long-term implications

for BIOE. This is a new facility near the Foege Building that will provide us room to grow for new and existing faculty with interest in engineering biomolecules; this will help to support growth in our biomaterials, drug delivery and biosensors programs in the next decade.

Continuing education through professional degrees like MME, and now with PharmBE, are becoming a new paradigm for teaching. We continue to adapt to "outsourcing" some of our educational efforts through partnerships with the UW Educational Outreach Professional and Continuing Education program.

BIOE collaborative and/or interdisciplinary efforts

BIOE faculty have a long history of collaboration with faculty in many UW departments and with faculty from other US and international institutions. Faculty recruitment, joint appointments and recent joint hires provide excellent opportunities to expand collaborative and interdisciplinary efforts. Such opportunities include the recent recruitment of Dr. Ruikang Wang in BIOE, which stands to benefit not only Bioengineering but also its collaborative efforts with APL and Radiology, as well as recent joint hires of Dr. Paul Wiggins (33% BIOE, 67% Physics) and Dr Rong Tian (joint with Anesthesiology). An offer is currently pending for another joint appointment in Bioengineering and Pediatrics (Division of Neonatology)

Future interdisciplinary efforts include the upcoming appointment of Dr. Deok Ho Kim, who will stand to benefit Bioengineering with South Lake Union/Pathology/ISCRM connections, and the planned imaging/LSDF cluster recruitment in 2011. A recent significant effort was the relocation of Bioengineering faculty, Dr. Michael Regnier and Dr. Marta Scatena, to join Drs. Charles Murry and Rong Tian at UW's South Lake Union campus to foster productive collaborations and interdisciplinary research efforts with other campus partners.

More examples of interdisciplinary efforts are demonstrated by Bioengineering faculty's collaborations with clinicians in SOM, which are discussed in depth in Part B (unit-defined questions), Question 6, and Appendix I (Collaborations Between BIOE Faculty and Clinicians).

Lastly, interdisciplinary collaborations are actively pursued by undergraduate and graduate students through their work with adjunct faculty. Please see Appendix J (Student Collaborations with Non-Core Faculty) for more details. Some of these collaborations are facilitated by our NIH training grant (PI – Dr. Regnier) and Center resources (see Appendix K, Center and Training Grants in BIOE).

Development of junior faculty

Our excellent junior faculty has seen major success and has gained national stature, all while being fairly self-sufficient and productive. Departmental effort to assist our junior faculty is still important, however, particularly to provide the proper resources to foster their success. Such efforts include annual meetings between junior faculty members and the Chair, frequent meetings with the Chair for lunch, and formal assignment of senior faculty to mentor junior faculty.

New BIOE faculty participate in various training activities offered at UW and by the SOM and COE. Examples include the Faculty Fellows Program, New Faculty Orientation offered by Office of Sponsored Programs), and Provost's Workshops on Teaching and Learning.

Bioengineering believes the ongoing success and productivity of junior faculty to be vital going forth into the future, especially given the many strides yet to be made in their careers and the inevitable aging of senior faculty. We discuss this concern further in Section IV (Future Directions), Question 2 (Challenges), and have some suggestions on how to accomplish this in Part B (Unit Defined Questions), Question 2.

Strategy to recruit, and support the career success of, faculty members from under-represented groups; success in diversifying faculty ranks

In BIOE, 30% of our core faculty members are female; among core faculty under age 50, half are women. This balance is reflective of our student body, which is about 50% female. It is important that the department provide resources to our junior faculty so that they can succeed in developing their careers particularly during the challenging transition to building independent research labs with stable funding. Women faculty members often face difficult choices in achieving work and life balance. Achieving a balanced faculty creates a community where junior, female faculty can consult with other women faculty members who have achieved tenure and built successful labs.

The department supports the use of family and parental leave to accommodate the birth or adoption of children and our faculty, male and female, have benefited from these university benefits. The option for assistant professors to "postpone" the tenure clock while on leave has proven to be a valuable benefit.

Development of female leaders in bioengineering is the next challenge as the junior cohort matures to become tomorrow's leaders, in our department and in the field. Examples of current and emerging female leaders with national/international recognition include:

- Wendy Thomas (Associate Professor), who serves on the board of the Biomedical Engineering Society (BMES).
- Suzie Pun (Associate Professor), who is the Robert F. Rushmer Associate Professor of Bioengineering.
- Cecilia Giachelli (Professor), who is a fellow of the American Institute for Medical and Biological Engineering (AIMBE). Recipients of this honor are recognized for their outstanding achievements in medical and biological engineering.

While bioengineering as a discipline has achieved success in bringing women into the field, significant barriers exist to the recruitment of under-represented minorities, first as students and later as faculty members. BIOE is no exception: according to EEO data from academic HR, 66% of our core faculty are white, 25% Asian, 2% Hispanic and 7% not reported. This lack of diversity is a threat to funding from federal sources. We would like to increase the racial diversity of our faculty so it is more representative of the regional and global community in which we work and live and we seek support and training from UW to attract and retain under-represented faculty.

In October, the University Diversity Council released a report titled "Diversity at UW: A Blueprint for the Future 2010-2014." This important initiative sets specific targets for recruitment of under-represented minorities. We are eager to participate in workshops and training sessions to bring in a more diverse candidate pool when recruiting and also to create a climate that supports and promotes a diverse faculty. Realistically, meeting this goal will require assistance from the upper level administration.

Section IV. Future Directions

Where is Bioengineering Headed?

In the last 10-year review, under the leadership of Yongmin Kim, the Department set itself the following 4 specific targets:

1. To develop outstanding undergraduate and graduate educational programs to prepare our students for careers in industry, academia and government.

2. To enhance our place as one of the best bioengineering departments in the world.

3. To develop integrated research and education programs in five Bioengineering thrust areas: Distributed Diagnosis and Home Healthcare (D2H2), Engineered Biomaterials, Molecular Bioengineering and Nanotechnology, Medical Imaging and Image-Guided Therapy, and Computational Bioengineering.

4. To construct a building in which the expanded role of Bioengineering can flourish.

It can be argued that all four goals were largely accomplished during the Kim administration ending in June of 2007. Both the graduate and the new undergraduate programs are very highly ranked by US News and World Report (fifth and sixth, respectively). The high graduate ranking has been maintained despite great increases in the number of BME undergraduate and graduate programs at other schools in the last decade, and the high undergraduate ranking for such a new program represents a great achievement. The significant accomplishment of the accreditation by ABET of our undergraduate program was, no doubt, the single largest factor in the last two years' increases in rankings of our undergraduate program. Our truly excellent new building has been occupied for 4 years now, and will be, for the first time, completely full with the arrival of our latest hires. Whether we have developed truly integrated research and educational programs is debatable, but an attempt to do this continues as we speak.

Where do we go next?

In a highly competitive field that continually reinvents itself, resting on one's laurels is not an option. The secret of the department's success in the past has been to remain light on its feet and recruit the brightest faculty, usually in areas that have both academic depth and commercial potential in areas related to both engineering and medicine. What has changed since the founding of the Center for Bioengineering is the establishment of bioengineering as a "conventional" discipline within engineering with teaching expectations for its faculty, its own ABET standards, and alumni who want the fact that they graduated from UW BIOE to be a highlight of their CVs.

The senior faculty in the department are adjusting to the concept that we are no longer just the "mavericks" of the engineering world, but citizens of a larger community of bioengineers; the more junior faculty are more comfortable with our new place in the global community. In this regard, we are increasing our presence at the Biomedical Engineering Society meetings. One of our faculty (Dr. Wendy Thomas) serves on the Society board, and at the annual meeting we are aggressively promoting the department at a display booth and hosting a reception to raise our visibility in the community and to coalesce our alumni.

Goal Setting Process

Bioengineering faculty, staff and students meet periodically in committees and group meetings to assess the state of our Department and to plan for the future. This includes our annual retreat and special, dedicated faculty meetings. At these meetings we discuss our current areas of expertise and how/whether to strengthen them, the changes in the field of Bioengineering, and ways to improve/move our teaching and research programs towards new areas that we think will be significant in the future. This process is most focused around determinations of faculty search directions, which, for many reasons, are really decided by the Chair, although every effort is made to consult as many faculty as possible on these decisions.

Our Current State

Our department now has strong teaching and research components. The revision of our undergraduate curriculum (beginning implementation this year) was designed to more closely match our research strengths and other areas we and our colleagues consider important in the field of bioengineering.

Our faculty have a wide range of research interests--perhaps a broader range of interests than might be found in many other leading BME departments. While this can be confusing for potential students, donors, and senior administrators, who prefer a simpler message, we have historically considered this "academic diversity" to be a major strength of the department. Diversity has been an advantage both for our students' educational experience and for development of novel areas of multi-disciplinary bioengineering research. This is reflected in our departmental website, which currently lists eight research themes that include all or our core faculty (see Chart L-2 of Appendix L, Bioengineering Research Themes). These themes include: 1) Bioinstrumentation, 2) Biomaterials & Tissue Engineering, 3) Global Health & D2H2[1], 4) Imaging & Image Guided Therapy, 5) Integrative Physiology, Systems Biology & Synthetic Biology, 6) Molecular Bioengineering, 7) Neural Engineering, Rehabilitation & Augmentation, and 8) Understanding Nature through Engineering. This complex grouping was an attempt on the part of a new Acting Chair three years ago to include every one of the faculty in such a way that the central work they did would fit into at least one category.

We have found that some of our colleagues in BME departments that have one or two very strong research themes express frustration that we have not adequately pigeonholed ourselves; there is clearly an element of sour grapes in this complaint, as we have maintained high rankings despite (and perhaps because of) this diversity[2]. However, as we have been assembling a comprehensive communications plan for the department, it has been clear that some better way of categorizing what we do is necessary. We have condensed our eightfold categorization into four main research areas that cover most of our faculty research interests; these are areas where we have a history of leadership and where we should continue to recruit students and faculty in the immediate future. These areas are titled as follows:

1. Regenerative Medicine & Biomaterials
2. Molecular & Cellular Engineering
3. Imaging & Image-Guided Therapy
4. Reducing the Cost of Healthcare

Most of our faculty conduct multi-disciplinary, applied and translational-based research, and thus fall under two or more of these categories. More detail on faculty research interests within this new model is given in Chart L-3 of Appendix L (Bioengineering Research Themes). We also have a long, strong, and extensive history of collaborative, clinically based research with physicians and physician-scientists and many of these interactions are provided in Appendices I (Collaborations Between BIOE Faculty and Clinicians), J (Student Collaborations with Adjuncts), and K (Center and Training Grants in BIOE).

The completion of Foege Hall in 2006 allowed us to bring our entire faculty together into one building; this has been beneficial for many aspects of our teaching, training and research programs. Currently the Bioengineering space in Foege is completely occupied, and there are already three faculty (Regnier, Scatena and Deok-Ho Kim) with their primary laboratories in South Lake Union (SLU) and one (Daggett) in the Benjamin Hall Building. New nuclei of faculty are located at these two remote sites, and within a year we anticipate that one or two of our senior faculty will move their laboratories to the new MolE building. These new locations are

[1] While Yongmin Kim and Paul Yager were very fond of the D2H2 acronym for Distributed Diagnosis and Home Healthcare, the name did not catch on. Since we always considered D2H2 to be the domestic side of a global health initiative, we will abandon both for the simpler "Reducing the Cost of Healthcare" in our future publicity.

[2] One should note that CalTech, whose new Bioengineering Department, claims 9 different research areas (http://www.be.caltech.edu/research/index.html), did very well in the recent NRC rankings.

occupied on a programmatic themes, and offer opportunities to provide leadership in these research areas

Challenges and Goals for the next 5-10 years

Challenges

There are significant challenges to education at state institutions nationally because of the poor economy at this time. These challenges are particularly acute at UW at this time because of the way in which the budget for the State of Washington works. Because the state must balance its budget, recent and current serious budget imbalances result in cuts to state spending. Because of direct cuts to higher education (the highest in the US two years ago), there were 10% cuts to all departmental budgets in the last biennium, further cuts in the second half of the biennium, and plans for 6% cuts this coming year, and possibly larger ones after the defeat of tax measures in the October elections. These budget cuts will constrain the department in almost every way except in our ability to carry out research. In addition, there is a cumulative effect of the absence of raises for staff or faculty for over two years. Furthermore, we are vulnerable to cuts in state funds for research; for example, while we have had excellent support from the Life Sciences Discovery Fund, those funds are subject to recapture by the state at any time, putting current and future LSDF-supported activities at risk.

While we did a good deal of hiring in the 2009-20010 year, and benefitted greatly for largesse from the offices of the Dean of Engineering and the Provost, most of these funds are now gone. Future hiring is dependent on refilling depleted reserves at almost every level of the university, including at this department. In addition to this simple fiscal challenge, there are others of concern:

Teaching resources for expanding our undergraduate and graduate educational and training programs. The equipment and supplies budget for our teaching laboratories has been historically inadequate. With shrinking state support, these funds are now nonexistent. We do not have adequate funds to maintain existing equipment in several of the labs, and little or no replacement monies. This problem will be compounded if we increase our student population to meet increasing demand for Bioengineering and/or bring new courses/labs into our curriculum. In addition, providing adequate TA coverage for courses with labs, etc. will require additional funding.

The 'graying' of our faculty. We may lose much of our current senior leadership in the next 5-10 years. Of the 38 Tenure- and Research-track faculty with primary or joint appointments in Bioengineering, 19 are full Professors, 8 are Associate Professors and 11 are Assistant Professors. Several of our full Professors are nearing or are at retirement age. Additionally, of these ranks 18 of 19 full Professors are tenured, 5 of 8 Associate Professors are tenured or tenure-eligible and 5 of 11 Associate Professors are tenure-track. As such, the possessors of a disproportionate number of our tenure lines are currently (very) senior.

Nine tenured professors will be age 55 or older in 2011, and of this group, three will be age 70 or older. Faculty members age 55+ hold leadership positions in the department and university. Looking at grant productivity, faculty in the age bracket 50-59 are the most productive, collectively their grant expenditures comprised 67% of total direct costs in FY2010.

Research funding portfolio/distribution of our faculty. While we continue to be successful in obtaining research funding, as shown in Appendix M (Grant and Contract Awards). (~$2.6 of ~ $4 million for 2010), almost two-thirds of our research funding for 2010 has been awarded to our senior (full) professors. Much of this research funding comes from large grants, such as NIH BRP, P01 and Center awards, and more recently form LSDF, etc.

Mentoring our junior/mid-level faculty into leadership roles. As our most senior faculty retire, we face the challenge of more junior faculty taking on leadership roles in our Department, the UW and the national/international research community.

Reduction and end of Coulter funding. As previously mentioned, for the last 5 years we have had the benefit of a generous grant from the Wallace H. Coulter Foundation under their Translational Research Partnership program. This program has given us nearly $1M per year to support teams of bioengineers and clinicians to perform translational projects. This has had a catalytic role in changing the culture in our department and across the campus. That grant will come to an end in January of 2011; for the next 5 years we will be operating at a reduced level with $300K per year from the Coulter Foundation, and a match of $250K per year from the Washington Research Foundation. After that period, we are on our own. This year we funded 8 projects, but next year the number will drop to just 4. Given the importance of this type of work to our department and to the campus and to the region, we need to find a new and stable source of funding to support translational research.

Goals

To continue to strive for greater diversity in the student population. Bioengineering as a discipline has a much more balanced ratio of male to female students than engineering disciplines as a whole, and UW BIOE is no exception. However, the University of Washington has, for historical and geographical reasons, had relatively few underrepresented minority students compared to major universities in other regions. Attracting qualified minority students represents an ongoing challenge. We need to become more active in our recruitment efforts, utilizing COE and UW resources, and partner with other departments in *recruiting at national science and engineering conferences such as BMES, Biomaterials, and the Biophysical Society meeting, and minority career development conferences such as SACNAS and AISES* (see next section).

To continue to improve and expand our undergraduate and graduate and post-doctoral educational programs to prepare our students for careers in industry, academia and government. We will continue to evaluate and adjust our undergraduate and graduate course curriculum to provide the best possible education and training experience, including emerging new areas. One area of immediate interest is creating a new track in the Ph.D. program in Biomedical imaging. We desire to increase both undergraduate and graduate programs, but this will require additional resources including faculty, staff, teaching lab space, equipment and supplies.

To continue to enhance our standing as one of the best Bioengineering research departments in the world. We will focus our research and graduate educational programs in the four research areas identified above and plan how to capitalize on promising emerging areas of Bioengineering. This will require that we replace retiring (or leaving) faculty as well as recruiting new faculty, especially in promising, emerging areas of Bioengineering research. It will also require space and facilities located strategically in UW campus buildings that will facilitate multi-investigator research efforts between our Bioengineering faculty and with faculty from other departments and programs. We seek to have major research programs not only in our Bioengineering building (North Foege Hall), but also increasingly at the new SLU Medical Campus (phase III), the Hall building and the future MolE building.

To develop a Corporate Affiliates Program (CAP). To date the department has had no formal program that builds relationships with industry. This is all the more remarkable considering that UW Bioengineering faculty have, for decades, had a hand in producing many new technologies of great commercial value, and many have had a hand in starting up companies here in Seattle. The one coordinated approach to industry centered in the department was UWEB's industrial affiliate group, the creation of which a dozen years ago was mandated by the charter of that NSF Engineering Research Center. With the termination of the NSF funding, that biomaterials-oriented industrial affiliates group lapsed, although efforts are ongoing to

reconstitute it. This fall a confluence of interest on the part of the Chair, the COE Advancement Office and the UW Center for Commercialization (UWC4C) has resulted in a series of meetings aimed at creating a CAP and having an inaugural CAP meeting on campus in the fall of 2011.

The potential benefits of this CAP are broad, and extend beyond BIOE itself:

- Build strong, sustainable relationships between companies and UW BIOE researchers
- Increase employment opportunities for students and postdocs (through internships, co-ops, and a job fair)
- Enhance visibility of the of UW and the region with large companies
- Strengthen the region as an international hub for bioengineering research and development
- Create new opportunities for sponsored research for BIOE faculty
- Create networking opportunities for corporate personnel, faculty and students
- Attract investment funds to strengthen the corporate sector in the region
- Provide funds to support UW BIOE activities

Opportunities and Plans to Achieve our Goals

Education

The development of new research programs in MolE, synthetic biology, imaging, etc. provides an opportunity to apply for training grant funds from the NIH and NSF to support graduate students. Our one current departmental training grant (PI-Regnier) provides support for eight graduate student trainees with a broad-based theme of cardiovascular bioengineering.

For recruitment and retention of under-represented minority students we can work closely with the COE's Minority Scholars Engineering Program (MSEP) office. They directly recruit at targeted institutions with high numbers of talented under-represented minority students and jointly recruit at national student conferences such as American Indian Science and Engineering Society (AISES) and Society for Advancement of Chicanos and Native Americans in Science (SACNAS). The MSEP office is very familiar with our program and communicates Bioengineering opportunities to prospective undergraduate and graduate students.

For improving our teaching resources we can partner more with faculty from other departments whom have joint or adjunct appointments with Bioengineering. This includes faculty Radiology, Physics, Pathology, Biology, Genome Sciences and several Engineering departments.

Revitalized and New Programs

UW BIOE Ph.D. applications continue to be very strong, with over 400 applications this past year, but nationwide PhD student enrollments are dropping. We plan to maintain a leading Ph.D. program but need to find ways to fund our students if NIH and training funds continue to decrease. Offering new and revitalized programs is part of the solution. In addition we are exploring how increasing our Masters student program can benefit our research programs.

Biomedical Imaging

For years the number of faculty working on imaging applications within the core faculty has been declining, and as a consequence, we have had very few class offerings in this central area of biomedical engineering. The staffing trend has been reversed with recent hires into the department, and as a consequence we are now able to initiate a long-anticipated new track within the BIOE graduate curriculum. Beginning in the fall of 2011 we will offer the first of a series of three highly technical classes that will constitute the core of a new Biomedical Imaging

concentration. It is anticipated that these three classes will ultimately form the core of a certificate program offered by BIOE, but jointly taught by faculty from BIOE and Radiology. We anticipate that this new feature of graduate education will be very attractive to potential graduate students. A critical and as-yet-unresolved issue will be paying for the teaching hours of the clinical faculty.

Reducing the Cost of Healthcare

Faculty, staff and students are here because we believe in innovation, collaboration, and social responsibility; a new goal that we may be uniquely well suited to bring to the discipline as a whole is awareness of the need for cost-effective medical solutions in the developed and developing worlds. Initial discussions are underway to combine our exiting departmental efforts in global health to produce low-cost technologies with colleagues on and off campus concerned with health economics to bring an engineering approach to the art of developing new technologies for medicine in the developed world.

Program on Technology Commercialization 2.0

A decade ago, BIOE initiated a class sequence entitled the Program in Technology Commercialization with support from a generous donor to UW. This class was aimed to train engineers to bring technical ideas from the university or industrial laboratory through a start-up company; for various reasons, it was done without connections to the UW School of Business. The three-class was organized by a combination of BIOE faculty and outside entrepreneurs, and the classes were taught by an all-star cast of local entrepreneurs, investors and lawyers, and received phenomenally high student ratings. That class was cancelled when Professor Yongmin Kim went on sabbatical, and has never regained its former student numbers. In discussions with the Dean of Engineering and others, including representatives from the Foster School or Business, it has been decided to revive the program as PTC 2.0. The new aims are to generalize the program so that it is not so BIOE-centric, bur covers a range of technologies, and to incorporate assistance of and participation by students from the business and law schools. However, BIOE is still taking a strong role in coordinating the program, with two of our Professors (Buddy Ratner and Matt O'Donnell) co-teaching the first course, and plans for major curriculum input from Professors Kim and Ratner. The PTC sequence will begin with PTC I, a first "business boot camp" class for all engineers in Spring of 2011; ultimately this could support 600 or more students. While this would nominally be a graduate course sequence, it is anticipated that senior undergraduates would allowed to take PTC I as well. In fall of 2011, there would be sequence of parallel PTC II business-sector-specific classes, one of which would be taught and run by BIOE and entitled Biomedical Instrumentation. Another PTC II section would be on Computer Software and taught by CS&E. Other PTC II sections would be created in subsequent years for other industrial sectors. It would be expected that students from business and law would join the engineers in PTC II classes. PTC III would for teams to begin to discuss forming business plans around UW IP from UW, with assistance by inventors and tech managers from UWC4C. PTC IV, first taught in Spring 2011, would be the Foster School's business competitions themselves. We are in the initial stages of working out the details of PTC I at this time.

Faculty positions

As mentioned above, we face a 'graying' of our distinguished faculty. To help mitigate the effect of faculty retirements over the next 10 years, we request that at least a portion of these positions be retained at full salary rather than returning them to the Dean's office.

Opportunities for tenure-line faculty expansion in the current economic climate are limited, but opportunities include one position through the UWAMIT program and another MolE position, funded in part by LSDF awards. Additional opportunities to expand our faculty in expanding our educational and research efforts include more research track and joint appointments with

other departments. Research areas for faculty searches are discussed in the next section (Self-study Qu. 1).

Part B. Self Study Questions

I. What research areas should be strengthened and/or contracted by targeted hiring in the next 10 years? How do we achieve high research productivity while maintaining excellence in teaching.

Research Areas and Targeted Hiring

The current economic situation at the UW and the State of Washington presents a challenge to planning for targeted hiring in the coming years. We are dedicated to maintaining a leadership in our areas of strength (Regenerative Medicine & Biomaterials, Imaging & Image-Guided Therapy, Distributed Diagnostics and Home Healthcare (D2H2), Molecular and Cellular Bioengineering) as faculty retire or are lost through unsuccessful retention cases? Additionally are asking what directions should UW Bioengineering take in the next decade? This is always based on a combination of careful prognostication, watching what our sister departments are betting on, finding sources of funding for research, and the luck of who shows up for faculty searches. However, if we are guided by the idea that Bioengineering at UW is linked to both technology generation and the practice of medicine, some medical trends are clear and can help to guide our search:

- Increasingly personalized approaches to disease prevention and therapy
- Decentralization of diagnostic and therapeutic capabilities
- Increasing ability to create replacement tissue and organs for the ill
- Synthetic biology creates tailored microorganisms to carry out short-term and long-term therapies
- Enhanced tissue-specific targeting of macromolecular therapeutics
- Convergence of healthcare technologies in the developed and developing worlds to reduce cost in the developed world
- Integration of healthcare cost analysis with translational research
- Increased access by healthcare providers to all relevant information to aid in diagnosis and therapy

These trends map well into our four research themes and our translational research efforts clinicians and institutions such as the Coulter Foundation, the Washington Research Foundation and the Program for Technology Commercialization. We are pleased with the changes that have been brought about by the Dean of Engineering, Dr. Yongmin Kim (during his tenure as Chair of Bioengineering) and Paul Yager, and will work with the UW C4C administration to continue to move these efforts forward.

This year BIOE will join the Department of Radiology and Applied Physics Lab to recruit new faculty to the LSDF-funded Center for Ultrasound-based Washington Molecular Imaging and Therapy (uWAMIT). The goal of the recruitment is to bring in a cluster of three professors at the level of associate or full professor. BIOE has committed our single vacant faculty line (tenure track) for this commitment. Depending on the candidates, the appointments may be joint between multiple participating departments. The LSDF grant will provide a portion of the start-up costs and some portion of the faculty salary for the initial three years.

How do we achieve high research productivity while maintaining excellence in teaching?

The department has been successful thus far in balancing research and teaching excellence. There was concern as we were developing our undergraduate program, about a decade ago, that teaching and research training of undergraduates would compromise our research efforts.

However, we have been pleasantly surprised to find that participation of undergraduates in faculty laboratories has helped our research move forward more effectively than was possible with graduate students alone. Our balance of research and teaching excellence has been accomplished through a department-wide effort for managing our teaching and mentoring load, which includes:

Teaching Plan. The department Chair and the Curriculum Committee have worked to manage the impact of the undergraduate and graduate curriculum on faculty time and effort. The Curriculum Committee implement a revised graduate curriculum in Autumn 2006 with a reduced number of didactic credits (from 48 to 32). This has allowed increased research effort by both faculty and graduate students. In addition, two instructor positions have been added to our faculty to assist with the undergraduate curriculum. These positions have been filled by Dr. Chris Neils (9/16/2009) and Dr. Alyssa Taylor (9/16/2010). These instructors play major role in undergraduate core courses and labs, providing a high quality of teaching, and will take a leading role in our newly developed capstone team projects that will be an alternative to individual research design projects in PI laboratories. To maintain high research productivity and excellence in teaching we have also recently revised our undergraduate curriculum to more closely match our research strengths. As part of this revision, faculty are encouraged to develop and teach elective courses in their areas of research interests, which will help recruit interested students into their labs. Our new undergraduate curriculum is beginning implementation this year and next, and our curriculum committee will work to make implementation as efficient as possible.

Grant support staff. The department provides excellent support for the development, submission and management of grants and contracts. This is particularly helpful for large multi-investigator and center applications that require coordination with, and documentation from, other departments.

Trainees. Our department recruits top quality graduate students and post-doctoral fellows that greatly aid in maintaining high quality research.

Faculty composition. Bioengineering has had a strong tradition of balancing our faculty with Research- and Tenure track faculty positions. With recent hires we currently have 25 tenure-track appointments and 10 research-track appointments (Appendix N, Hires, Resignations, Retirements and Promotions in BIOE).This model has been quite successful for us with research-track Professors contributing greatly to innovative and cutting edge research, as well as contributing to teaching, mentoring and departmental committees. In addition, we have more than 40 adjunct faculty appointments (Appendix O, Adjunct Faculty in BIOE). Many of these professors from other departments have long, strong collaborations with our core faculty (often via co-mentoring or mentoring graduates students or post-doctoral fellows) and who also contribute to teaching.

Undergraduate research requirement. A unique aspect of our Department is the required research component for senior undergraduates in our program. This aspect of our program has been very successful and has helped attract excellent undergraduate candidates. The research component provides hand-on teaching, greater interaction with faculty, post-docs and graduate students and contributes to research efforts in laboratories. Many undergraduate projects result in authorship on a manuscript that can be invaluable for helping them achieve the next stage of their career.

II. Bioengineering is by necessity a diverse department with interests overlapping other basic science and engineering departments. Recognizing this, how can BIOE advertise and facilitate better interactions with other departments and faculty in terms of mutual research and instructional interests?

BIOE is made up of a diverse set of faculty with widely varying interests. The diversity is reflected in the broad range of collaborations that exist as part of center and training grants. For example, there are significant collaborations with SOM departments (Radiology, Pathology, Pediatrics, etc.) and various departments in College of Arts and Sciences such as Biology, Chemistry and Microbiology. Within COE there are strong links with Electrical Engineering, Materials Science & Engineering, and Mechanical Engineering. Many of these collaborative ties (particularly funded centers) were forged by senior faculty over a long period of time. However, our junior and mid-level faculty have fewer substantive links. As such, we need to explore mechanisms to help these faculty build a portfolio of collaborations across departments that will, in time, lead to the creation of center and graduate training programs.

As described previously, new opportunities for collaboration are emerging with an emphasis on biomedical imaging. In partnership with the Department of Radiology and the Applied Physics Lab, BIOE will develop new curricula and is considering introducing a new MS degree track. Further, our three units are participating in recruitment for a three-person "cluster" in medical imaging. By working together on the recruitment and curriculum initiatives, we will increase the impact of UW on the field and provide high demand education and training in medical imaging.

Another potential pathway to new collaborations is to hold joint seminars between departments, particularly basic sciences and engineering. Such seminars could include junior and mid-level faculty, post doctoral fellows and even graduate students. These seminars could be organized under the umbrella, 'Research in Progress', a mechanism used in other schools, most notably MIT. A further mechanism that can encourage collaboration involves holding multi-departmental research retreats. Although more difficult to organize, they can be quite effective. In relation to center grants or other high level funding mechanisms, another way to bring together departments is to organize core facilities across departments that support particular research themes or programs such as the Cardiovascular Research Center, the Neurobiology program and the new Molecular Engineering program. Finally, where common interests emerge, some effort could be spent in developing cross-departmental curricula, particularly for graduate education. This has already been achieved between Bioengineering and EE in the development of a synthetic biology course series for undergraduates and graduate students.

III. Are our curricula (UG and Grad) in line with the needs of our students given their career aspirations and goals? How can the department improve time to degree within the program?

A 2007 survey of BIOE BS alumni reported that undergraduate destinations following graduation were: 43% to graduates school, 30% to medical school, 15% to industry and 9% unknown. The vast majority of our undergraduate students continue on to professional (medical, dental or veterinary) or graduate school and only a small proportion go immediately to industry. The question is whether our curriculum is in line with this preference. An analysis of our undergraduate courses indicates that 34% of courses are of interest to the pre-med students; this is close to the 34% of students that are expected to go to medical school. The other 64% of courses are likely to be of interest to engineers only. This is close to the 58% of our students pursuing advanced degrees and entering industry careers. These data provide evidence that the curriculum is in line with our students interests. To further strengthen the undergraduate experience we could:

- Strengthen interactions between students, faculty and academic advisors
- Increase promotion of the MD/PhD program as an option for students
- Increase faculty involvement in assisting students with career choices.

The table below shows the average time taken for doctoral students to complete their degrees. The four-year average time to PhD degree is 5.6 years. This is not an unreasonable time period to complete a PhD but is slightly above the norm in the field. However the average is dominated by a small number of outliers who took over 7 years to complete their degrees. If the outliers are removed the average drops to 5.24 years. The remaining 0.24 is due to graduates who took between 5 and 7 years to complete, particularly in years 2006 and 2007 where 66 and 47 percent of all graduates, respectively, took 5 - 7 years to graduate.

	2006	2007	2008	2009
% Above 7 years	5.56	26.32	7.69	18.18
% Between 5 and 7 years	66.67	47.37	38.46	27.27
% Below 5 years	27.78	26.32	53.85	54.55

It is noteworthy that since 2008 the number of graduates completing their degrees between 5 and 7 years has dropped considerably and in the most recent year now only accounts for 27 percent. To further reduce our time to degree, the department could implement an oversight process for monitoring students who cross the 5 year threshold. There are a small number of students that take over 7 years complete with one at over 9 years. A mechanism could be put in place to assist these students to complete their degrees in a more reasonable time. This will be discussed with the full faculty.

IV. Should the department continue to expand or contract offered Masters programs? Should existing masters degree programs be expedited such that they can be completed in 3 yrs instead of 4 yrs?

Our department has historically had a small Masters program compared with our Ph.D. program, but this pattern is changing. With the changing economic environment and potential growth in need for bioengineers in industry, our department is considering how to expand and develop our MS programs. A recommendation in the report from our Bioengineering External Advisory Board following a recent (August 9, 2010) meeting was that we should form "a more research oriented Masters program attractive to faculty". We will explore this in the coming year and evaluate the need and issues involved in implementing more expansive BS/MS and/or MS degree programs.

Our four currently-offered Masters degree programs have different targeted populations.

The BS/MS degree option, available to undergraduates in their senior year, allows them to continue their education and research for an additional year to obtain a Masters degree. Students take the graduate core courses and have an additional year to devote to research projects, which are normally an extension of their senior capstone research project. Students are usually interested in this program as a means to strengthen their record prior to looking for employment in industry or application to graduate or medical schools. This program has been successful and has usually had 2-4 students per year, though we have not promoted this option with any vigor.

Our second Bioengineering Master's Degree option is for students who have already obtained a BS degree. We have historically admitted few of these students, and generally they have been directly admitted into an identified professor's laboratory, and they are not supported by the department with rotations like the Ph.D. students. While this program requires significant coursework, it is designed to be a research-intensive degree taking ~3 years and culminating in a research thesis and publication in a peer-reviewed journal. In the past, faculty have greatly preferred admitting students to the Ph.D. program over this program, even though Masters students are not guaranteed financial support from the Department or faculty advisors, because of a belief that the short period these students spend in the laboratory is not worth the time it takes to train them.

The third Masters degree that has been offered for almost 15 years is through the Masters of Medical Engineering (MME) program co-administered with UWEO. This program was designed for individuals in industry, usually with an engineering degree, who are seeking post-graduate education and professional development. The degree program is part-time and designed to be completed in four years, with courses offered in UW's Seattle or Bellevue classroom facilities, and via videoconference, and usually in the evenings. Students are also welcome to complete four certificate programs individually without applying for degree status. Initially this program had a research/thesis component, but because of problems with IP between UW and employers, this was revised to be completely didactic. The first graduates from this program were in 2000. Since then participation in the program has resulted in graduation of 7-16 students per year. Admissions for this program were down in 2009, but have rebounded; 8 students have been accepted into the program in 2010. We are currently discussing if the program should be reduced to a three year curriculum, to make it more tractable for working individuals, and reconsidering an optional research project component. We are also working with administrators to allow our MME students access to financial aid, which will help make the program more accessible to our working-professional students.

The fourth program is our newly-instituted Masters of Pharmaceutical Bioengineering (PharmBE) program, an evening degree program designed to enable working local engineers, scientists, researchers, and professionals in the biotechnology, pharmaceutical, and related industries to explore advanced education in the areas of molecular and cellular biology, drug

discovery and design, pharmaceutics, and translational pharmaceutics. Professionals may also complete three certificate programs without applying for degree status. In 2009, the first year of the program, 13 students were accepted, and in 2010 29 students applied, 26 were offered admission and 2 more were conditionally admitted (pending receipt of official test scores). We expect this program to be popular and grow in the coming years.

More information about all these programs is available on our departmental website.

A new option under consideration would be to create an on-campus non-thesis Masters degree. Students would be primary targeted toward employment in industry, would pay their own way, but could apply for the Ph.D. track after completing a large fraction of their MS degree requirements. Such programs are substantial "moneymakers" at peer institutions and, given new incentives with activity based budgeting we will consider if this is a viable option for our department. First, however, one or more specific graduate "tracks" (augmented by 400-level senior electives) would have to be created to attract students . Given the strong local ultrasound industry, the planned graduate Imaging track may be the prototype program to attract such MSE students; other tracks could follow, as well.

V. Bioengineering is strongly associated with translational activities and entrepreneurship. Given that translation is an important function of an engineer, and also considering that there are many entrepreneurship programs on campus, how should Bioengineering best structure our educational and research programs to address translation and entrepreneurship?

Bioengineering at the University of Washington has a history of entrepreneurship going back to the invention of Doppler ultrasound and ultrasound imaging. In the past, entrepreneurship training was largely handled through the business school. However, recently there has been a realization on the part of donors and engineers that technology entrepreneurship was not being well addressed on campus; this led to the establishment of the BIOE-run Program in Technology Commercialization (PTC). PTC was (and still is) a successful educational experience that garnered much praise from students and from the local entrepreneurial community. However, the "technopreneurship" environment on campus has changed in the last two years. For example, the COE has seen the value of the PTC program and wishes to offer this program college-wide. The University of Washington Center for Commercialization (C4C) is open to having a role in PTC. The business school now views a partnership in teaching technology commercialization as desirable. Thus, we are now restructuring the PTC program to be college-wide, and to do this in partnership with C4C and business school. BIOE will continue to have a key role in the program but the scope and magnitude of PTC will increase. The first course (of four) in the restructured PTC program will be offered in Spring, 2011. This first course will introduce general principles of entrepreneurship and business. A second course in the sequence will focus on issues specific to the bioengineering and medical device industry.

VI. Strong collaborations with practicing clinicians have been growing within Bioengineering. This is good for our students, good for grant funding, and good for our translational activities. How can we nurture and encourage these collaborations?

Bioengineering, more than any other engineering or science department on campus, has had numerous strong and long-term collaborations with medical school clinical faculty. These ties have been beneficial to the department at many levels and deserve to be fostered and nurtured. Beyond the partnerships that have always formed spontaneously and continue to do so, the Coulter Foundation's Translational Research Partnership program has, in the last 5 years, worked to foster new connections between bioengineers and clinicians by a few different mechanisms, and using the potential for funding as a carrot. With the (regrettable) ramp-down of the Coulter program over the next 5 years, we will propose a few mechanisms to continue these collaborations and build new ones. A successful mechanism for making first contact has been "roundtable" meetings between bioengineering and clinical faculty. We have had two such Coulter-sponsored roundtables – with the OB/GYN and with Radiology. These roundtables bring interested faculty into a room with short, informal presentations by BIOE faculty who describe their capabilities, and then short, informal presentations by clinical faculty who describe their clinical problems. Discussion then ensues to look for possible solutions and collaborations, followed by lunch or coffee. Two more roundtables are now planned with Urology and Otolaryngology. In the future, roundtables with Orthopedics and Sports Medicine, Ophthalmology and Cardiovascular Surgery have significant potential for catalyzing collaboration. Other BIOE efforts that foster collaborations with clinical faculty include undergraduate capstone design projects (many of which involve clinical faculty) and Coulter translational grants. For additional information see Appendix I (Collaborations Between BIOE Faculty and Clinicians).

VII. Given the high cost of bioengineering education and declining state funds, what is a sustainable financial model to effectively educate bioengineering students and maintain the ability to provide leadership in our field?

Diminishing support from the State of Washington legislature to the UW threatens the department's educational mission. As described previously, budget cuts have resulted in lost funds for instructional faculty, research fellowships, advising and operational staff, and instructional supplies. Deeper cuts are planned for the next biennium. These budget reductions necessitate changes to our financial model to support our educational mission.

Long term

Increase Alumni base and giving – endowments. Our undergraduate BIOE program is fairly new, so we do not enjoy a large alumni population available to other engineering departments who are in a position to give back to their *alma mater* in the form of donations and endowments. While we plan to focus considerable effort into establishing a strong alumni bond in the coming years, any revenues from this source must be considered as part of a more long-term solution. We rely on gift officers from COE and SOM for fund raising and our individual impact in this area is limited.

Short term

Industrial Affiliates. We are aggressively pursuing new revenue sources from our industrial colleagues. In the near term we intend to establish and grow a Corporate Affiliates Program (CAP) that will help support undergraduate and graduate research in the form of fellowships and internships, as well as providing monetary, equipment and/or supplies donations for teaching laboratories.

Lab fees. Our current funding from the state of Washington for instruction covers ~15% of the cost of materials and supplies necessary to run our undergraduate laboratory courses, with the difference being made up from RCR. We will institute lab fees to cover more (or all) of these costs. As revenues from Industrial Affiliates become available we can adjust these fees.

Continued strong research funding. One major source of financial resources for our educational programs has been the indirect costs recovered from government grants (primarily NIH). We plan to continue our success in achieving high funding levels from these agencies.

VIII. What criteria should we consider in evaluating our program relative to our peers?

We believe there are several metrics that should be used in evaluating our program relative to our peers. These include:

Faculty awards and impact in the literature.

Bioengineering faculty have continued to receive numerous awards and honors over the past 10 years. Our faculty publish books and papers in high impact journals, and most serve on editorial boards of journals. Selected publications can be found on the department's website pages for each faculty. Comparison with peer departments can be made with such tools as the recently-popularized Google Scholar and h-index, where the h-index is equal to the number papers published (n) that have at least n citations. See Appendix P (BIOE Faculty – H-Index (grouped by rank)).

Awards and fellowships to students.

Our trainees have had considerable success in competing for national and international honors and fellowships. For 2010-2011 alone they have been awarded 7 NSF fellowships, 2 AHA fellowships, 1 Boeing fellowship, 1 Strauss, Bruno Endowed Fellowship, and 2 MSTP fellowships for graduate studies. Our undergraduates have also been quite successful in obtaining research scholarships and fellowships from the NASA Undergraduate Student Research Program, the Mary Gates Endowment, the Levinson Emerging scholars Program, the Goldwater Foundation and the Washington Research Foundation. Detailed information on student awards may be found in Appendices G (Undergraduate Awards in BIOE, 2007-2011) and H (Graduate Student Fellowships in BIOE, 2005-2011).

Rankings (NRC and U.S. News and World Report)

While we realize that national ranking organizations and criterion are often quite subjective and must be taken with a 'grain of salt', these metrics are useful for recruitment and exposure of our department. Our #5 ranking in US News and World Report for graduate programs this year is consistent with a history of top 4 and 5 rankings for the past 20 years. We are excited by the #6 ranking of our undergraduate program for 2011, up from #11 in 2010. There has been a great deal of confusion over the NRC rankings just released. UW BIOE was ranked as 3rd back in 2005, and our ranking is essentially unchanged (tied for 3rd) in the recent rankings, despite the fact that the number of BME departments has more than doubled in the interim. We would be very satisfied, were it not for the fact that the NRC rankings are demonstrably flawed. We believe we might have done even better, but considering that there are so many flaws, we prefer to ignore the rankings to the extent that it is practical.

Research Funding

Bioengineering faculty have been extraordinarily productive in obtaining external research funding for the past 10 years, as shown in Appendix M (Grant and Contract Awards). For example, for fiscal year 2010, faculty were awarded over $32 million, and for the past 6 years this amount has averaged approximately $23.5 million. Research accounts for 68% of BIOE's annual budget and supports tenure- and research-track faculty, staff and the vast majority of students. Support for 7 graduate students is provided by a departmental training grant (from NIBIB) that was just renewed July 1, 2010 for an additional 5 years. This training program providing interdisciplinary training and fosters collaborations with multiple science and clinical departments, (see Appendix K, Center and Training Grants in BIOE).

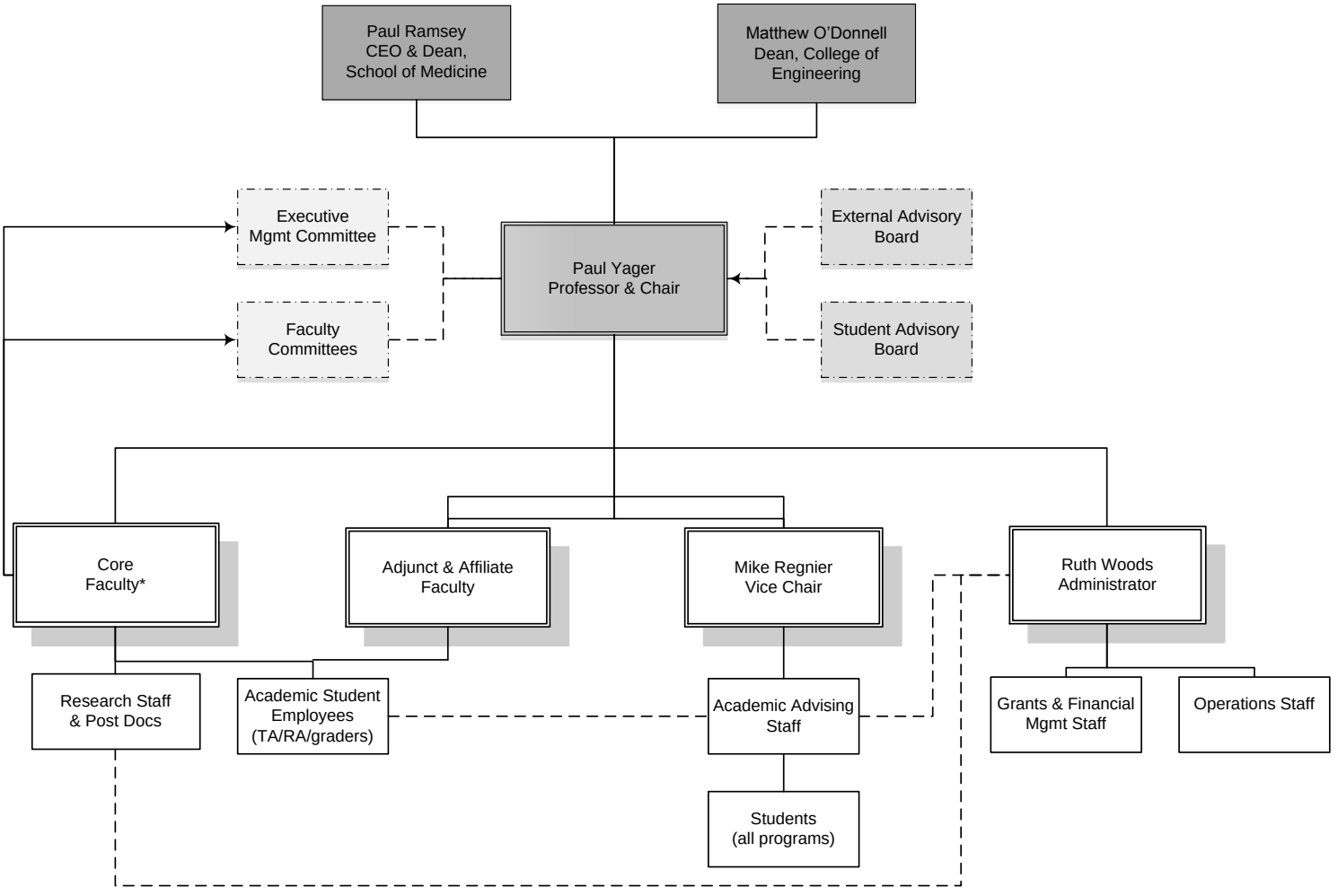
Disclosures, Patents & Licenses

BIOE has creative and productive faculty, post-docs and students. Since the establishment of our program this has resulted in 514 invention disclosures, 132 issued patents, 128 patents

pending, 28 current licenses and 12 cases of copyrighted software. Eleven existing startup companies have benefited from the intellectual properties generated by our department and we continue to generate substantial ideas, processes, inventions, patents and devices that benefit industry.

Department of Bioengineering

Overall Organizational Structure

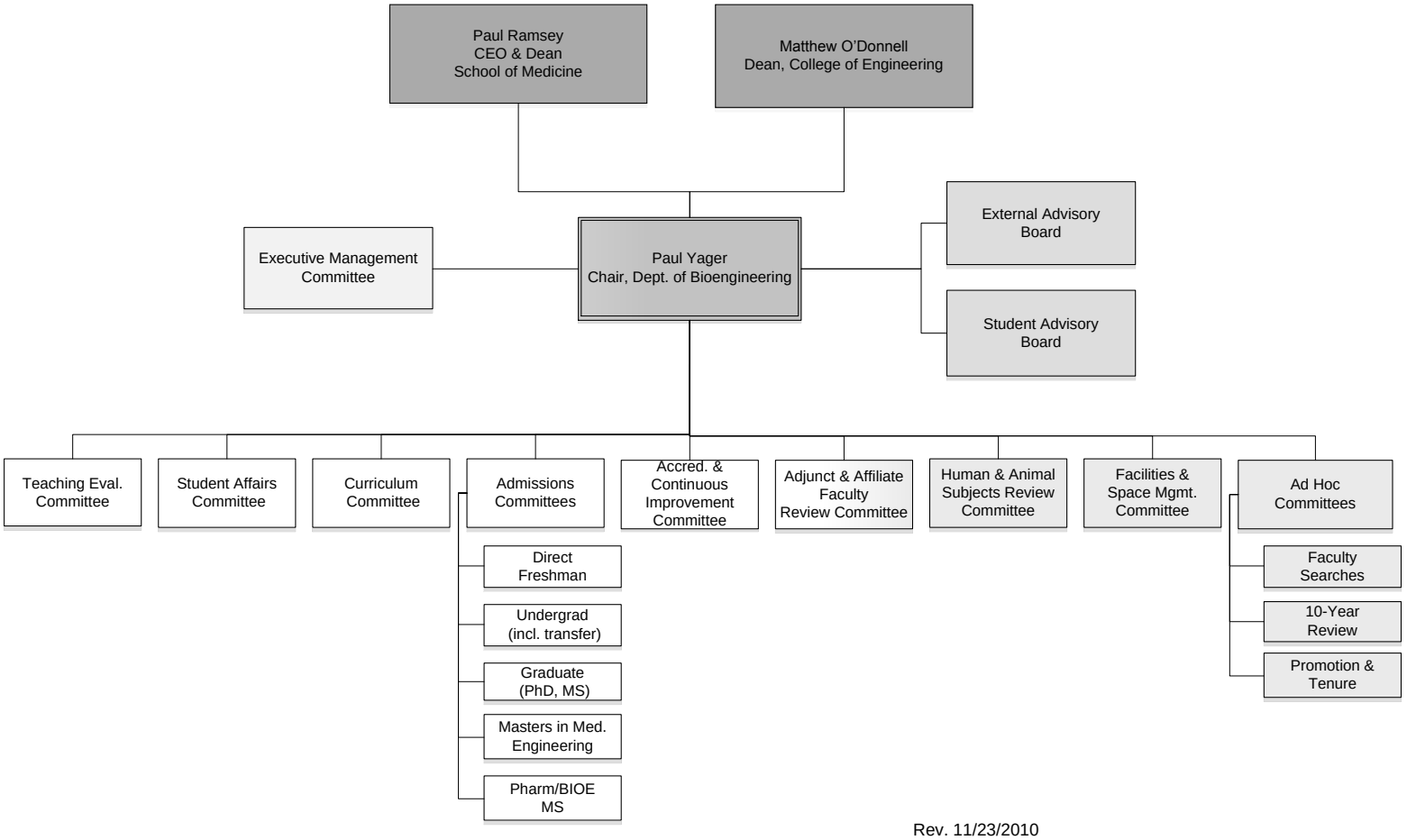


* Core faculty include: Tenured and tenure track, research track and full-time lecturers

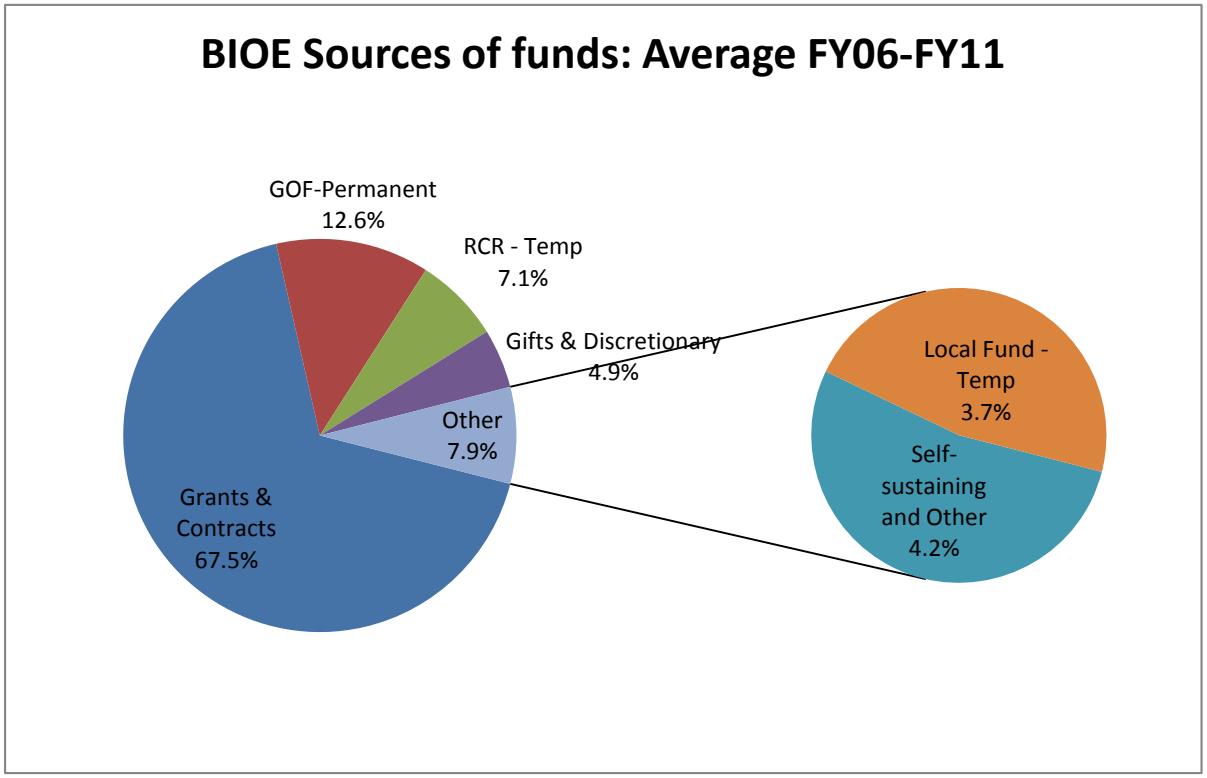
Rev. 11/23/2010

Department of Bioengineering

Governance Structure

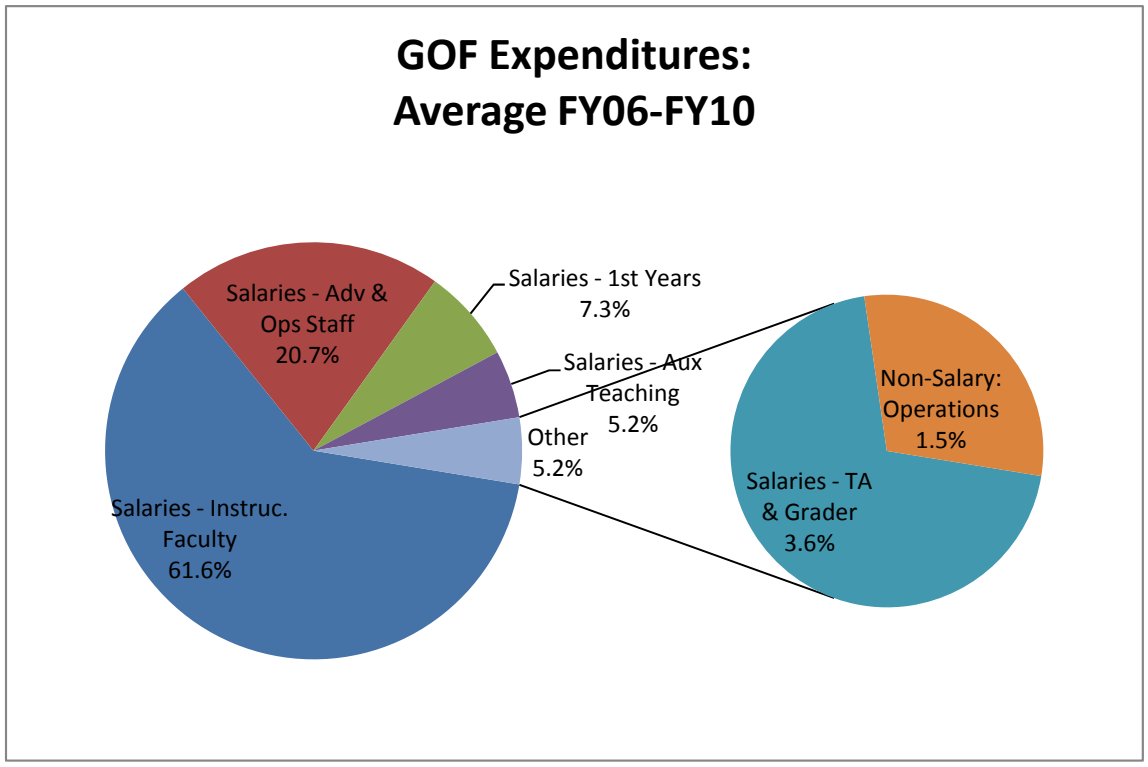


Rev. 11/23/2010



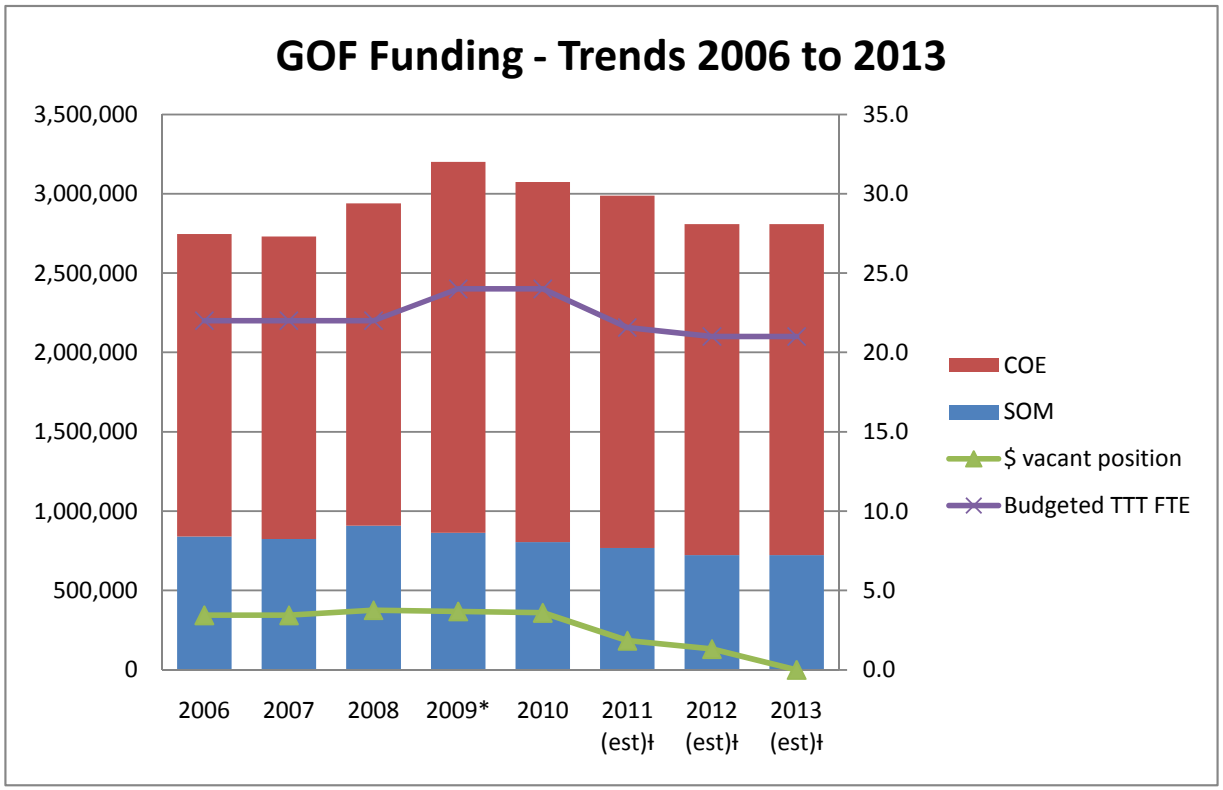
Total Awards/Revenue by Fiscal Year

Award/Revenue Type	FY11 (proj)	FY10	FY09	FY08	FY07	FY06	Average FY06 - FY11
GOF-Permanent	2,987,333	3,021,854	3,190,790	2,909,506	2,722,571	2,615,799	2,907,976
GOF-Temporary	38,697	302,787	9,382	29,038	129,762	130,410	106,679
Local Fund - Perm	0	0	18,900	18,900	18,900	18,900	12,600
Local Fund - Temp	572,348	582,775	601,332	1,088,332	480,000	1,811,984	856,129
RCR - Permanent	148,319	148,319	148,319	148,319	148,319	290,935	172,088
RCR - Temp	1,152,250	1,510,848	1,494,732	2,172,721	1,116,340	2,356,389	1,633,880
STF	59,425	0	5,950	152	10,506	58,343	22,396
G&C D.C. (= expend)	17,242,576	17,670,094	14,052,581	15,766,647	17,390,064	11,092,141	15,535,684
Gifts & Discretionary	59,904	2,080,138	316,316	2,051,893	507,273	1,719,721	1,122,541
Self-sust. and Other	158,667	887,495	359,869	1,223,822	281,312	1,038,046	658,202
Sum of Awards/Rev:	22,419,519	26,204,310	20,198,171	25,409,330	22,805,047	21,132,669	23,028,174



Total Direct Cost Expenditures - FY2006 to FY2010

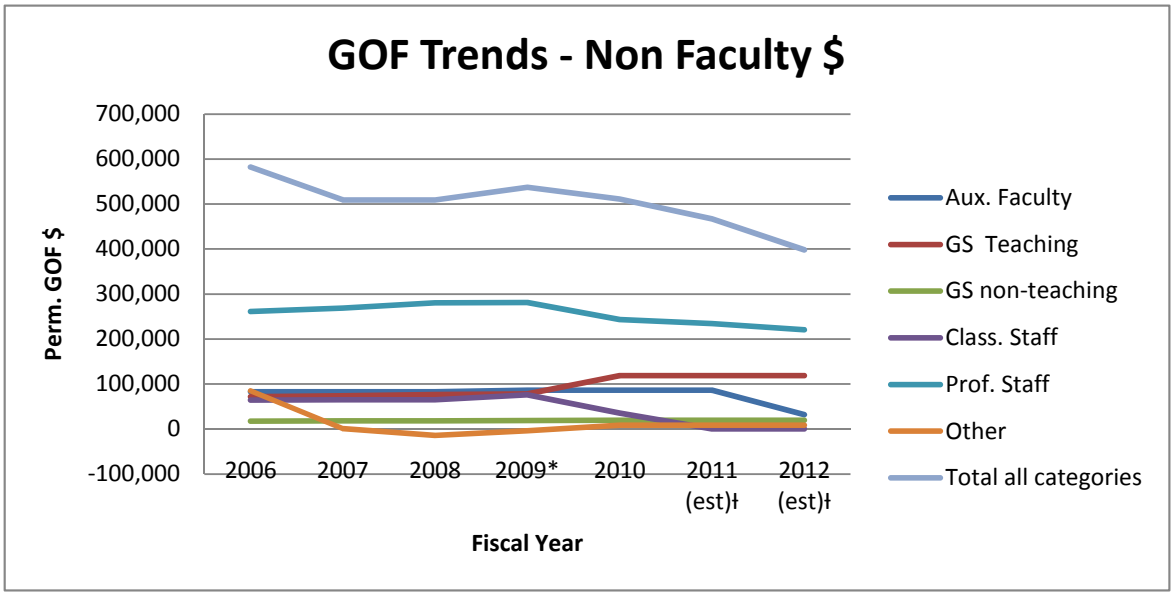
Expenditure Type	FY11	FY10	FY09	FY08	FY07	FY06	Average
GOF SAL - Instructional Faculty	Data not available	1,881,222	2,013,790	1,939,232	1,609,616	1,540,388	1,796,850
GOF SAL - Aux Teaching		78,421	62,806	108,665	94,773	182,785	105,490
GOF SAL - TA & Grader		141,886	159,670	130,936	157,835	174,809	153,027
GOF SAL - RA (1st Year Rotation)		180,155	197,484	251,524	162,795	269,421	212,276
GOF SAL - Staff		572,884	655,618	598,203	621,961	566,782	603,090
GOF - Operations		3,440	387	7,634	206,189	7,531	45,036
GOF - Total Direct Costs		2,858,008	3,089,755	3,036,194	2,853,169	2,741,715	2,915,768



Year	SOM	COE	$ vacant position	Budgeted TTT FTE	Total	change
2006	841,063	1,905,146	343,695	22.0	2,746,209	
2007	825,157	1,904,923	343,695	22.0	2,730,080	-16,129
2008	908,818	2,029,726	375,383	22.0	2,938,544	208,464
2009*	864,184	2,335,988	367,413	24.0	3,200,172	261,628
2010	804,744	2,269,897	359,442	24.0	3,074,641	-125,531
2011 (est)ł	768,282	2,219,047	183,995	21.6	2,987,329	-87,312
2012 (est)ł	722,189	2,085,662	131,411	21.0	2,807,851	-179,478
2013 (est)ł	722,189	2,085,662	0	21.0	2,807,851	0

* 2009 new commitments for Yager/Chair start-up

ł 2011 - budget after October 2010 cuts. Est. 6% cut for 2012 and 2013.



Summary of GOF $ by Type: FYE 2006 to (est) FYE 2012

Category	2006	2007	2008	2009*	2010	2011 (est)ł	2012 (est)ł
Aux. Faculty	82,719	82,719	82,719	86,445	86,445	86,445	31,874
GS Teaching	72,135	74,007	76,375	78,283	118,685	118,685	118,685
GS non-teaching	17,370	17,820	18,388	18,848	19,316	19,316	19,316
Class. Staff	64,056	64,764	65,076	76,126	35,208	0	0
Prof. Staff	261,354	268,884	280,572	281,310	243,048	234,600	220,314
Other	84,656	978	-14,322	-3,678	8,180	8,222	8,222
Total all categories	**582,290**	**509,172**	**508,808**	**537,334**	**510,882**	**467,268**	**398,411**
change		*(73,118)*	*-364*	*28,526*	*-26,452*	*-43,614*	*-68,857*

* 2009 new commitments for Yager/Chair start-up

ł 2011 - budget after October 2010 cuts. Est. 6% cut for 2012 and 2013.

Faculty in Bioengineering

Professors

James B. Bassingthwaighte

Professor
Adjunct with Biomathematics and Radiology
PhD (physiology), Mayo Graduate School of Medicine, 1964
MD, University of Toronto, 1955

Research: Cardiovascular mass transport; cardiac metabolism; PET imaging; fractal physiology; physiome project; large scale systems modeling and analysis

James D. Bryers

Professor
Adjunct with Chemical Engineering
PhD (chemical engineering), Rice University, 1980

Research: Bacterial adhesion; bacterial biofilm; biomaterials that heal while preventing bacterial infection; plasmid retention, expression, and transfer within biofilm communities; gene delivery

David G. Castner

Professor & Associate Dean of Infrastructure, College of Engineering
Joint with Chemical Engineering
Director, National ESCA & Surface Analysis Center
PhD (physical chemistry), University of California Berkeley, 1979

Research: Surface analysis; surface modification; biomaterials

Lawrence Crum

Research Professor
PhD (physics), University of Ohio, 1967

Research: Acoustic hemostasis; HIFU therapy; ultrasound-enhanced drug delivery; extracorporeal shock wave lithotripsy; sonoluminescence

Valerie Daggett

Professor
Adjunct with Biochemistry, Biomedical and Health Informatics
PhD (pharmaceutical chemistry), University of California, San Francisco, 1990

Research: Protein folding; dynameomics/bioinformatics; extremophile proteins; protein modulators; protein design; unfolding diseases; protein complexes; single nucleotide polymorphisms

Cecilia Giachelli

Professor
PhD (pharmacology), University of Washington, 1987

Research: Tissue engineering; calcification; cell-material interactions; foreign body response; ectopic calcification

Lee Huntsman

Professor and UW President Emeritus
PhD (biomedical engineering), University of Pennsylvania, 1968

Research: Mechanics of heart and heart muscle; cardiovascular system assessment; new measurement techniques (research program currently inactive)

Yongmin Kim

Professor
Joint with Electrical Engineering; Adjunct with Radiology, Computer Science & Engineering
PhD (electrical engineering), University of Wisconsin-Madison, 1982

Research: Medical devices, medical imaging and computing, ultrasound imaging, electronic medicine, and distributed diagnosis and home healthcare (D2H2)

Henry C. Lai

Research Professor
PhD (psychology), University of Washington, 1978

Research: Biological effects of electromagnetic fields; cancer treatment using artemisinin and synthetic compounds

Charles E. Murry

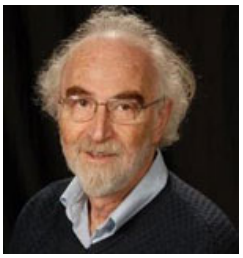
Professor
Joint with Pathology
Director, Center for Cardiovascular Biology
PhD (pathology) Duke University, 1988
MD, Duke University, 1989

Research: Regenerative medicine; stem cells; tissue repair and regeneration; tissue engineering; angiogenesis

Matthew O'Donnell

Professor & Frank & Julie Jungers Dean of Engineering
PhD (solid state physics), University of Notre Dame, 1976

Research: Exploring new imaging modalities in biomedicine, including elasticity imaging, in vivo microscopy, optoacoustic arrays, optoacoustic contrast agents for molecular imaging and therapy, thermal strain imaging, and catheter based devices.



Gerald H. Pollack

Professor
PhD (bioengineering), University of Pennsylvania, 1968

Research: Unexpectedly profound ordering of water at interfaces; role of water and light in natural processes; molecular basis of biological motion; engineering of water-based technologies for solving societal problems.

Buddy D. Ratner

Professor & Michael L. & Myrna Darland Endowed Chair in Technology Commercialization
Joint with Chemical Engineering
Director, University of Washington Engineered Biomaterials (UWEB-21)
PhD (polymer chemistry), Polytechnic Institute of Brooklyn, 1972

Research: Synthesis and characterization of polymeric biomaterials; surface analysis by ESCA, SIMS, STM, FTIR-ATR, AFM; plasma deposition of thin films

Michael Regnier

Professor and Vice Chair
Adjunct with Physiology & Biophysics, Affiliate with Benaroya Research Institute
PhD (biology-neurobiology), University of Southern California, 1991

Research: Molecular mechanisms regulating cardiac and skeletal muscle contraction; computational biophysical models; gene and cell based therapeutics for cardiac and skeletal muscle disease

Jay Rubinstein

Professor; Director, Virginia Merrill Bloedel Hearing Research Center
Joint with Otolaryngology
PhD (bioengineering), University of Washington, 1988; MD University of Washington, 1987
Research: Computational biophysics; clinical and basic electrophysiology; human psychophysics; clinical trials of new cochlear implant technology

Patrick S. Stayton

Washington Research Foundation Endowed Professor in Bioengineering
PhD (biochemistry), University of Illinois-Champaign, 1989

Research: Protein engineering; biomaterials; drug delivery; biomineralization

Rong Tian

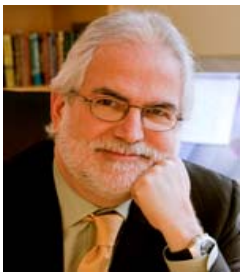
Professor
Joint with Anesthesiology
MD, West China University of Medical Sciences, (1986)
PhD (pharmacology), Institute of Pharmacology (Denmark), 1992

Research: Energy metabolism in cardiovascular diseases Mitochondrial dysfunction and metabolic signaling NMR spectroscopy and Imaging-guided spectroscopy

Ruikang K. Wang

Professor
PhD (optical engineering), University of Glasgow, 1995

Research: Biomedical Optics/Biophotonics; Functional optical imaging using coherence gating (OCT) and confocal gating techniques; Photoacoustic imaging; Laser Doppler, speckle and intrinsic optical signal imaging; Optical biopsy and functional imaging in tissue engineering; Light propagation in biological tissue



Paul Yager

Professor & Hunter & Dorothy Simpson Endowed Chair in Bioengineering
Adjunct with Chemical Engineering, Chemistry, Oral Biology, and Global Health
PhD (chemistry), University of Oregon, 1980

Research: Microfluidic devices for chemical and biochemical measurement and analysis; point-of-care diagnostic instruments; global health

Associate Professors

Eric H. Chudler

Research Associate Professor

PhD (psychology), University of Washington, 1985

Research: Parkinson's disease, pain, science education and outreach

Albert Folch

Associate Professor

Adjunct with Mechanical Engineering

PhD (surface science and nanotechnology), University of Barcelona, Spain, 1994

Research: Miniature cell culture tools for quantitative neurobiology studies, with a focus on axon guidance and synaptogenesis; BioMEMS

Suzie Pun

Robert F. Rushmer Associate Professor in Bioengineering

PhD (chemical engineering), California Institute of Technology, 2000

Research: Non-viral gene delivery; Delivery of drugs & molecular contrast agents; Intracellular trafficking

Joan E. Sanders

Associate Professor

Adjunct with Rehabilitation Medicine, Mechanical Engineering

PhD (bioengineering), University of Washington, 1991

Research: Tissue engineering for cardiac applications; design of novel fiber-porous biomaterials; skin adaptation to mechanical stress; prosthetic engineering

Herbert Sauro

Associate Professor

PhD (computational biochemistry), Oxford Brooks University, UK,1986

Research: Metabolic and signal transduction networks, synthetic biology, simulation, non-linear dynamics, control analysis, software development.

Marta Scatena
Research Associate Professor
PhD (cell biology), University of Padova, Italy, 1992

Research: Biomaterials; inflammation; cardiovascular disease; tissue engineering

Narendra P. Singh
Research Associate Professor
MS (surgery), King George's Medical College, India, 1976
MBBS (medicine & surgery),
King George's Medical College, India, 1972

Research: DNA damage/repair; apoptosis; aging and cancer

Wendy E. Thomas
Associate Professor
PhD (bioengineering), University of Washington, 2003

Research: Mechanics of biological adhesion

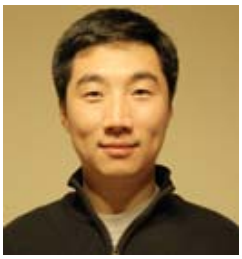
Assistant Professors

Lara Gamble

Research Assistant Professor

PhD (physical chemistry), University of Washington, 1996

Research: Surface analysis; surface modification; biomaterials; microarray chemistry



Xiaohu Gao

Assistant Professor

PhD (chemistry) Indiana University, Bloomington, 2004

Research: Engineered nanostructures for detection; analysis and treatment of human diseases; cardiovascular diseases; infectious diseases; neurological diseases

James J. Lai

Research Assistant Professor

PhD (chemical engineering), Polytechnic University, 2005

Barry R. Lutz

Research Assistant Professor

PhD (chemical engineering), University of Washington, 2003

Research: Biosensor chemical transport & kinetics; sound-based microfluidic systems; single-cell manipulation; multiplex optical detection; point-of-care diagnostics

Daniel M. Ratner

Assistant Professor

PhD (chemistry), Massachusetts Institute of Technology, 2004

Research: Glycotechnology; modification of surfaces with glycans; carbohydrate mediated host-pathogen interactions; glycoproteomics

Yanfeng (Mei) Speer

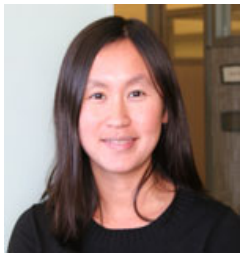
Research Assistant Professor
PhD (biochemistry), University of Helsinki, Finland, 1999
Master of Medicine, Tongji Medical University, China, 1990

Research: Ectopic calcification; cell differentiation and phenotype modulation; gene targeting; tissue engineering

Paul Wiggins

Assistant Professor
PhD (physics), California Institute of Technology, 2005

Research: Bacterial Ultrastructure, Bioimaging, Chromosome structure, DNA and membrane mechanics, DNA binding proteins



Kim Woodrow

Assistant Professor
PhD (chemical engineering), Stanford University, 2006

Research: Mucosal pathogen transport and drug delivery; protein engineered viral mimics for mucosal immunity; topical microbicides & contraception; catalytic nucleic acids for diagnostics

Lecturers

Christopher Neils

Lecturer

PhD (biomedical engineering), The University of Texas at Austin, 2000

Teaching Focus: Medical electronic devices, feedback control systems, fluid & structural dynamics, signal & image processing, senior capstone design projects

Alyssa Taylor

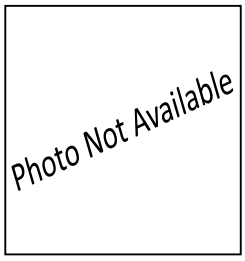
Lecturer

PhD (biomedical engineering),University of Virginia, 2010

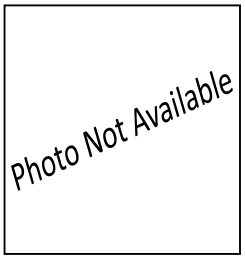
Teaching Focus:
senior capstone design projects
bioengineering design principles
ethics and decision making in bioengineering
tissue/vascular engineering
optimizing student learning outcomes through educational research

Emeritus/Retired Faculty

Kirk W. Beach
Research Professor Emeritus
PhD (chemical engineering), UC Berkeley, 1971
MD, University of Washington, 1976



David M. Foster
Research Professor Emeritus
PhD (Mathematics), University of British Columbia, 1969



Arthur Guy
Professor Emeritus

Allan S. Hoffman
Professor Emeritus
Adjunct with Chemical Engineering
ScD (chemical engineering), MIT, 1957

Thomas A. Horbett
Professor Emeritus
Joint with Chemical Engineering
PhD (biochemistry), University of Washington, 1970

Martin J. Kushmerick
Professor Emeritus
Joint with Radiology, Physiology & Biophysics
PhD (molecular biology), University of Pennsylvania, 1966
MD University of Pennsylvania, 1963

Photo Not Available

Roy Martin
Professor Emeritus

Photo Not Available

Donald Martyn
Research Professor Emeritus

Photo Not Available

Francis A. Spelman
Professor Emeritus

Pedro Verdugo
Professor Emeritus
Adjunct with Internal Medicine
MD State University of Chile, 1965

Existing Program Review: HEC Board Summary

Name of unit	Department of Bioengineering
Name of School/College	Medicine and Engineering
Degree Titles	BS BIOE, BS/MS BIOE, MS BIOE, PhD BIOE, MS Medical Engineering, and MS PHARBX
Year of last review	2000
Current Date	December 1, 2010

A. Documentation of continuing need, including reference to the statewide and regional needs assessment

Statement of Need:

The field of bioengineering has grown tremendously in the past 20 years and the UW Department of Bioengineering remains a recognized leader in research and education in this competitive field. As described in the table below, we offer six degree tracks and serve a population of about 308 students through tuition and fee-based programs. Our graduate program is consistently ranked in the top 4-5 programs nationwide by the US News & World Report. The undergraduate program, established in 2000, is now ranked 6th by the US News and World Report. Further, the department received high rankings (3rd place in 5% R rankings) in the recent National Resource Council Assessment of Research Doctorate Program Rankings, released in September 2010.

The 2005 State and Regional Needs Assessment describes the ongoing need for engineering and medical/health sciences training. BIOE is at the intersection of these two disciplines and our program faces high demand among students, with high quality applications exceeding available openings. Further, our program meets industry workforce demand by producing graduates with strong technical training and skills. Feedback from employers is positive; they recognize the BIOE graduates as strong leaders with the ability to lead project teams and demonstrate innovation in addressing problems.

The 2005 State and Regional Needs Assessment identified the need to increase enrollment and degrees granted in Engineering and Health Science programs (pages 8, 18, 28, 29 and 31). The emergence of biotech as a regional industry further heightens the demand for our graduates.

B. Assessment information related to expected student learning outcomes and the achievement of the program's objectives

Evaluation of student learning

BS The BS Bioengineering degree is now accredited by the Accreditation Board of Engineering Teaching (ABET). The accreditation process requires an extensive evaluation of how each student and the program as a whole is meeting each of ABET's defined outcomes. We are also required to document continuous improvement.

Outcomes are assigned to various courses, and course assignments provide specific measures of each outcome. Each student is evaluated for competency on each outcome. Competency means that a student meets or exceeds a grade of 2.5 on all outcomes. Each student is expected to pass all outcomes by time of graduation. The BIOE Accreditation and Continuous

Improvement (ACI) committee looks at both individual and program data and suggests changes to assignments, courses, and the program as a whole.

BS/MS and MS Students are expected to complete courses with a minimum 2.7 GPA (each quarter) and maintain a cumulative GPAs above 3.0. MS students meet regularly with their advisor to monitor academic progress related to research and lab notebooks are frequently checked and reviewed. By the fourth quarter a supervisory committee is established and a student plan is approved. Master's students may begin taking BIOEN 700 after their student plan is approved, and the student must successfully complete at least 9 credits of BIOEN 700 in order to defend.

The final outcome of the BS/MS and MS track is a thesis. The thesis is defended orally and if the student passes the oral exam, the committee signs both the paper thesis and the student's exam warrant. By signing the exam warrant, the committee certifies that the student has met all departmental requirements.

MME Students are evaluated using graded homework exercises, self-evaluations, and periodic exams tied to course learning goals and program objectives. Advanced courses are assessed using individual and team projects, presentations, literature/regulatory document reviews, and project presentations that judge assimilation and integration of basic concepts.

PharBE Students will continually demonstrate learning through examinations, course assignments, papers and projects that are tied to course learning objectives and overall program outcomes.

PhD Course and research progress as for BS/MS and MS, above. The academic counselor helps the faculty monitor student progress to degree. PhD students have three exams they must successfully pass in order to be granted their degree: the Qualifying Exam (QE), General, and Final exams.

The QE is completed over a 5-week period by the end of the second year. The student is evaluated in four specific areas: 1) scientific merit of the written and oral presentations of the proposal, 2) general knowledge and reasoning ability as demonstrated in the question/answer session, 3) presentation (quality of oral and written presentation, style, organization, clarity), and 4) knowledge and understanding of expected prerequisites. The student will be scored as either "Excellent," "Good," "Fair," or "Poor," and each ranking is clearly defined on the student's evaluation paper and in the student handbook. Based on the committee's final scores, the student will either "pass," "conditionally pass," "resubmit" or "fail." Students cannot take the QE more than 2 times.

The General Exam is used to assesses the following features: Scientific and scholarly quality, oral presentation (approximately 2 hours), NIH "Guiding principles for research involving animals and human beings," and ethics, as well as the written presentation (writing, references, data, tables, figures, titles, abstracts, units of measure). The outcomes include, "pass," "conditional pass," "fail and retake," "fail." This is the committee's opportunity to correct deficiencies in the student's overall educational program.

The final assessment is a public oral defense of the thesis, after it has been reviewed by the Reading Committee. The Supervisory Committee judges whether the oral exam has been successful and approves the written thesis.

C. Plans to improve the quality and productivity of the program

Opportunities and Plans to Achieve our Goals

Revitalized and New Programs: UW BioE Ph.D. applications continue to be very strong, with over 400 applications this past year, despite the fact that, nationwide, PhD student enrollments are dropping. We plan to maintain a leading Ph.D. program but need to find ways to fund our

students if NIH and training funds continue to decrease. Offering new and revitalized training grants is part of the solution. Continued strong funding to the faculty can allow earlier support by faculty but at the expense of a less competitive shortened rotation period. In addition we are exploring how increasing enrollment in our MS program can benefit the department and meet regional workforce needs.

Education: The development of new research programs in Molecular Engineering (MolE), synthetic biology, imaging, etc. provides an opportunity to apply for training grant funds from the NIH and NSF to support graduate students. Our one current departmental training grant (PI-Regnier) provides support for eight graduate student trainees with a broad-based theme of cardiovascular bioengineering.

Recruitment of URM Students: We will continue to present the department at URM recruiting events and professional society meetings. We will partner with UW Office of Minority Affairs and the COE Minority Scholars Engineering Program (MSEP) office. In October, the UW released a report that committed to provide training and new resources to departments and colleges to improve our ability to attract and retain URM students.

Expand teaching faculty in target areas: We are exploring opportunities to partner with faculty from other department to provide teaching in core and elective courses. This will allow us to expand course offerings without new tenured faculty positions. This includes faculty Radiology, Physics, Pathology, Biology, Genome Sciences and several Engineering departments.

Biomedical Imaging: The number of BIOE faculty working on imaging applications within the core faculty has been declining, and as a consequence, we have had few class offerings in this central area of biomedical engineering. The staffing trend has been reversed with recent hires into the department, and as a consequence we are now able to initiate a long-anticipated new track within the BIOE graduate curriculum. Beginning in the fall of 2011 we will offer the first of a series of three highly technical classes that will constitute the core of a new Biomedical Imaging concentration. It is anticipated that these three classes will ultimately form the core of a certificate program offered by BIOE, but jointly taught by faculty from BIOE and Radiology. We anticipate that this new feature of graduate education will be very attractive to potential graduate students. A critical and as-yet-unresolved issue will be paying for the teaching hours of the clinical faculty.

Reducing the Cost of Healthcare: As stated in the BIOE self study executive summary (2010), faculty, staff and students work in BIOE because we believe in innovation, collaboration, and social responsibility; a new goal that we may be uniquely well suited to bring to the discipline is awareness of the need for cost-effective medical solutions in the developed and developing worlds. Initial discussions are underway to combine our existing departmental efforts in global health (producing low-cost technologies with colleagues on and off campus concerned with health economics) to bring an engineering approach to the art of developing new technologies for medicine in the developed world.

PTC 2.0: A decade ago, BIOE initiated a class sequence entitled the Program in Technology Commercialization with support from a generous donor to UW. We are currently working with the Dean of Engineering, representatives from the Foster School or Business and the Law School to offer a revised program, referred to as PTC 2.0. The first courses will be offered during winter 2011. The goal of PTC 2.0 is to train engineers to bring technical ideas from the university or industrial laboratory through a start-up company

Faculty positions: BIOE faces a 'graying' of our distinguished faculty and we anticipate several retirements over the next decade. To help mitigate the effect of faculty retirements over the next 10 years, we request that at least a portion of these positions be retained at full salary rather than returning them to the Dean's office.

Number of instructional faculty, students enrolled, and degrees granted over last three years:

	AUT 2007 - SUM 2008	AUT 2008-SUM 2009	AUT 2009-SUM 2010	TOTAL
FTE Instructional Faculty[1]	20.25	21.325	20.325	61.9
FTE Graduate Teaching Assistants[2]	4	4	6	14
Degree Program: **BS**				
Headcount of enrolled students	134	142	159	435
Number of degrees granted	38	38	40	116
Degree Program: **BS/MS**				
Headcount of enrolled students	0	3	1	4
Number of degrees granted	0	3	1	4
Degree Program: **MS**				
Headcount of enrolled students	3	2	3	8
Number of degrees granted	2	2	3	7
Degree Program: **PhD**				
Headcount of enrolled students	68	81	91	240
Number of degrees granted	18	14	11	43
Degree Program: **MME**				
Headcount of enrolled students	29	28	19	76
Number of degrees granted	10	11	10	31
Degree Program: **M-PHARBX**				
Headcount of enrolled students	0	0	35	35
Number of degrees granted	0	0	0	0
TOTAL - Headcount of enrolled students	234	256	308	798
TOTAL - Number of degrees granted	68	68	65	201

[1] Faculty FTE reported are actual FTE and do not include vacant tenured positions or non-BIOE appointed instructors.

[2] TA FTE reported are budgeted, 9-month TA appointments; we use recapture $ to fund an additional 3-4 TAs slots/year and also hourly graders.

DEPARTMENT OF BIOENGINEERING
UNIVERSITY of WASHINGTON

Daniel M. Ratner, Ph.D.
Assistant Professor of Bioengineering
8 July 2010

Dear Sir or Madam:

Please accept the following project summary, **"Facilitating Student-Inspired Innovation: The Bioengineering Student Design Fund and Bioengineers without Borders,**" as a part of my application to participate in the 2010 Frontiers of Engineering Education Symposium. The pedagogical topic for my FOEE 2010 application is, *"Engaging students in self-directed learning: Encouraging students to take initiative and responsibility for their own learning."*

1) The objective/education outcome of the Innovation

The objective of my education project is to facilitate student-inspired and student-led innovation beyond the classroom. I will achieve this outcome through the creation of a fund to seed student design projects. This fund, titled the Bioengineering Student Design Fund (BSDF), will provide monetary support and lab space for undergrads to form interdisciplinary teams engaged in design projects outside the classroom setting. The BSDF will allow groups of students to compete for funds to support their design projects and form lasting relationships with Bioengineering faculty mentors on topics of mutual interest.

2) The developmental history

Inspiration—Before joining the faculty of UW Bioengineering, I served as a graduate resident tutor in the dorms of MIT while pursuing my Ph.D. Living with MIT undergrads, I learned first-hand the importance of student-directed learning that extends beyond classroom prescribed activities. Whether the students were designing and competing autonomous robots or building working (!) roller coasters in the dorm courtyard, the sense of self-responsibility and ownership engaged students in these activities in a way that could not be easily replicated by a classroom assignment. As we have seen, innovative and valuable ideas often grow out of pet projects that are developed by students in their free time (e.g. the creation of Facebook). Based on this experience with the MIT undergrads, I am determined to incorporate student-inspired learning into my pedagogical approach to teaching Bioengineering.

With the support of the BSDF, Bioengineers Without Borders won the Student Design Competition at Seattle's 2010 NAE Grand Challenges Summit with their entry titled, "Transcutaneous Bilirubinometer and Mobile EKG Diagnostics: Students engineering solutions to global health challenges." They have now advanced to the 2010 NAE National Summit on Grand Challenges Student Design Competition.

History—The concept for the Bioengineering Student Design Fund dates back to January '08, when I was asked by a student to serve as her BioE advisor during her study abroad program with Child Family Health International's Urban Rural Comparative Health Internship in Ecuador. During the summer, my student interviewed rural and urban Ecuadorian doctors to identify opportunities to improve the quality of healthcare that they could deliver to their patients. Upon her return, she gave a presentation on how Bioengineering students could contribute to the affordable delivery of healthcare to patients in resource-limited settings. The positive response from our undergrad bioengineers was overwhelming, and I recognized the need for departmental support to help students realize their ambitions of addressing challenges in global

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health. This served as a catalyst for the creation of the BSDF. As a member of the Bioengineering Student Affairs Committee (SAC), I approached our chair (Prof. Paul Yager) with my proposal to create the BSDF. With the Chair's approval, the BSDF was established and the first competition resulted in the creation of the student organization "Bioengineers Without Borders."

3) The learning activities and materials that you have developed or would develop

No formal didactic materials are planned for this education innovation. Instead, learning activities are developed organically through the discovery and design process as students engage in their team design projects. As opposed to classroom assignments, Faculty mentors assist the student design teams through regular consultation and by hosting meetings/presentations with local companies, business schools and organizations that share common goals and interests with the students.

4) How you would execute/operate in your class or course

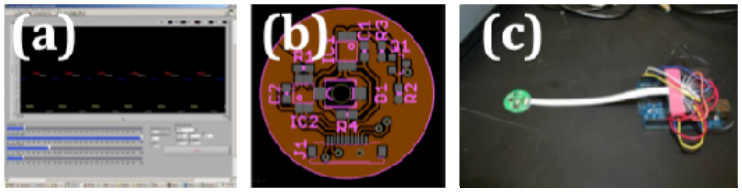
Funds—Bioengineering has committed $800-$1,000 annually to support the BSDF competition and UW's Biomedical Engineering Society (BMES) has pledged matching funds on an ad hoc basis. As the program grows, we will solicit support from other sources (College, University, Gates, PATH).

Request for Proposals—The call for BSDF proposals is issued annually by the Student Affairs Committee, which reviews and selects proposals during the Winter Quarter. To apply, students are required to submit a formal 'grant' that describes their organization, design plan, milestones/timeline, and budget. They must also include a faculty mentor's letter of support. Applications for renewal require an additional section describing the outcomes from prior funding.

Space—While the BSDF only supports non-classroom activities, I recognized the importance of dedicated lab space for students to stage and develop their design projects. Through negotiations with the department, I have secured dedicated laboratory space in the Bioengineering building to facilitate these student activities (~600 square feet, including benches, tools, and project lockers).

5) If you have done this, examples of what has worked or not worked.

The BSDF has held two rounds of competition. In the first year, Bioengineers Without Borders (BWB) won BSDF support to design a cost-effective bilirubinometer for neonatal care in resource-limited hospitals (see Figure on right). In the most recent round of funding (March, 2010), BWB expanded their focus to build and validate the bilirubinometer design and a second group of BWB students are developing an inexpensive mobile EKG for use with a smart phone. As the faculty mentor to BWB, I have facilitated meetings between our students the UW Center for Commercialization and PATH (a Seattle-based NGO focused on global health) to discuss how our students could expand BWB's mission, including protection of intellectual property, and focus their efforts on clinically relevant challenges in the developing world.



BWB design for an inexpensive LED-based transcutaneous bilirubinometer. (a) LabVIEW-based software acquisition package; (b) Optics board design; (c) prototype device.

The BSDF and BWB have been wildly successful, as indicated by their popularity and student participation. BWB meetings routinely attract 3-4 dozen students of varying backgrounds, all interested in contributing their time to engineering solutions for global health challenges. **Recently, BWB entered and won Seattle's regional NAE Grand Challenge Summit Student Design Competition and will compete this fall at the national NAE Grand Challenges Summit.**

Sincerely,

Daniel M. Ratner
Assistant Professor of Bioengineering

Bioengineering Student Design Fund

09-10 – Design Project Seed Grant

Purpose: Bioengineering wishes to recognize the extraordinary talent of our undergraduates by making available the funds to support extracurricular design projects that are of interest to our students. These can include, but are not limited to, projects focused on Global Health, do-it-yourself (DIY) bioengineering, as well as outreach and education. To support these out of the box design projects, the department has created the Bioengineering Student Design Fund (BSDF), a grant to support extracurricular undergraduate design projects. Pending availability of funds, BSDF will hold annual competitions to award money to support new and existing student organizations that have specific design projects they wish to conduct.

Funds available and anticipated number of awards: Bioengineering intends to commit $$800 to the BSDF in '09-'10 to support two or three design project seed grants. We anticipate increased availability of funds in future years to support more design projects with larger grants.

Budget period: Awarded funds will be available 4/1/2010 through 12/31/2010.

Eligible student groups and organizations: Any group of 3 or more BioE majors with a BioE faculty member serving as an advisor. Students from other departments, as well as pre-BioE students, are invited to participate. Group organizers must be BioE majors. NOTE: BSDF does not support design projects conducted for credit towards graduation, but will gladly support the extension of projects developed in a BioE course, once that course has ended.

Application requirements: A complete application for the 10-01 Design Project Seed Grant Competition should be no longer than 3 pages (including tables, figures, charts and references) and should include the following elements:

- **Student Organization Details (~1/2 page):** Name of student organization, name of student organizer(s), partial list of student participants (name, major, year), name of BioE Faculty Advisor, short mission statement for the organization.
- **Project summary (~1 to 1 ½ pages):** Brief introduction/background to the problem being addressed, description of design goals, anticipated outcomes, and a summary of methods to achieve the stated goals.
- **Milestones (~1/2 page):** List of specific milestones for the proposed activity
- **Budget (~1/2 page):** Prepare a budget and short justification of anticipated expenses (allowable expenses include equipment, reagents, instrumentation fees, fabrication costs, hardware, tools). The Budget does not need to be itemized, but should be listed by category. Food, beverage, software and travel are not allowable expenses without specific justification (awards amounts and budget can be adjusted by the BSDF).

- **Renewals (1/2 page):** If your application is a renewal for a previous BSDF-funded project, you should include a ½ page summary of your accomplishments for the previous period of support.
- **Faculty letter of support (not included in page limit)**: A brief letter/email by a BioE faculty member expressing commitment to mentor students in the proposed activity. The letter should include details of how often the faculty will meet with the students and in what capacity they will mentor the group

Dates: Submissions should be completed electronically and submitted as a pdf to Kelli Jayn Nichols no later than March 1, 2010. Awards will be announced after the subsequent SAC meeting.

Selection Criteria: Projects will be evaluated by the Student Affairs Committee. The selection panel will include faculty, a student representative, and BioE advising staff. BSDF awards will be made on the basis of the merit of the problem to be addressed, the quality of the design proposal, and the perceived ability of the student group to achieve the stated outcomes.

Undergraduate Awards in BIOE, 2007-2011

Goldwater Scholarships		
Name		**Award**
Wei	Kathy	Goldwater Scholarship, 2008
Hiremath	Pranoti	Goldwater Scholarship, 2009
Mount	Christopher	Goldwater Scholarship, 2010

Levinson Emerging Scholar Awards		
Name		**Award**
Linders	David	Levinson Emerging Scholar, 2007-08
Peterson	Teresa	Levinson Emerging Scholar, 2007-08
Buckley	Kate	Levinson Emerging Scholar, 2008-09
Shieh	Alyssa	Levinson Emerging Scholar, 2009-10
Mount	Christopher	Levinson Emerging Scholar, 2010-11

Luce Scholars Award		
Name		**Award**
Burk-Rafel	Jesse	Luce Scholar 2010-11

Mary Gates Awards		
Name		**Award**
Chu	Jian	Mary Gates Honors Scholars, 2007-08
Hiremath	Pranonoti	Mary Gates Honors Scholars, 2007-08
Ng	Bennett	Mary Gates Honors Scholars, 2007-08
Cezar	Christine	Mary Gates Research Scholars, 2007-08
Chang	Andy	Mary Gates Research Scholars, 2007-08
Chen	Yung-Chun	Mary Gates Research Scholars, 2007-08
Donnet	Verne	Mary Gates Research Scholars, 2007-08
Eng	Diana	Mary Gates Research Scholars, 2007-08
Goh	Zhi	Mary Gates Research Scholars, 2007-08
Hui	Benedict	Mary Gates Research Scholars, 2007-08
Jia	Carol	Mary Gates Research Scholars, 2007-08
Kim	Arnold	Mary Gates Research Scholars, 2007-08
Kuester	Jordan	Mary Gates Research Scholars, 2007-08
Mahadevan	Reena	Mary Gates Research Scholars, 2007-08
Mandt	Tyler	Mary Gates Research Scholars, 2007-08
Padvorac	Jason	Mary Gates Research Scholars, 2007-08
Peterson	Teresa	Mary Gates Research Scholars, 2007-08
Tran	Kimberly	Mary Gates Research Scholars, 2007-08
Ward	Alice	Mary Gates Research Scholars, 2007-08
Wei	Kathy	Mary Gates Research Scholars, 2007-08
Wong	James	Mary Gates Research Scholars, 2007-08
Hiremath	Prano	Mary Gates Research Scholars, 2007-08, 2008-09
Hua	Jeremy	Mary Gates Research Scholars, 2007-08, 2008-09
Linders	David	Mary Gates Research Scholars, 2007-08, 2008-09

Amiad	Daria	Mary Gates Research Scholars, 2008-09
Buckley	Kate	Mary Gates Research Scholars, 2008-09
Burk-Rafel	Jesse	Mary Gates Research Scholars, 2008-09
Calhoun	Sara	Mary Gates Research Scholars, 2008-09
Coult	Jason	Mary Gates Research Scholars, 2008-09
Donaldson	Melvin	Mary Gates Research Scholars, 2008-09
Feng	Shu	Mary Gates Research Scholars, 2008-09
Gu	Stanley	Mary Gates Research Scholars, 2008-09
Guan	Phillip	Mary Gates Research Scholars, 2008-09
Liong	Sylvie	Mary Gates Research Scholars, 2008-09
Mount	Chris	Mary Gates Research Scholars, 2008-09
Nielsen	Alec	Mary Gates Research Scholars, 2008-09
Sena	Mark	Mary Gates Research Scholars, 2008-09
Shubin	Andrew	Mary Gates Research Scholars, 2008-09
Zhou	Andy	Mary Gates Research Scholars, 2008-09
Asplund	Karin	Mary Gates Research Scholars, 2009-10
Cole	Devon	Mary Gates Research Scholars, 2009-10
Dulken	Benjamin	Mary Gates Research Scholars, 2009-10
Estrada	Carlos Alamo	Mary Gates Research Scholars, 2009-10
Hackett	Marissa	Mary Gates Research Scholars, 2009-10
Jang	Jee Hoon	Mary Gates Research Scholars, 2009-10
Kirkpatrick	Robin	Mary Gates Research Scholars, 2009-10
Luo	Jonathan	Mary Gates Research Scholars, 2009-10
Mar	Eric	Mary Gates Research Scholars, 2009-10
Mount	Christopher	Mary Gates Research Scholars, 2009-10
Phillips	Reid	Mary Gates Research Scholars, 2009-10
Robinson	Bree	Mary Gates Research Scholars, 2009-10
Tantakitti	Faifan	Mary Gates Research Scholars, 2009-10
Turtle	Cameron	Mary Gates Research Scholars, 2009-10
Twaddle	Kate	Mary Gates Research Scholars, 2009-10

NASA Space Grant		
Name		**Award**
Hiremath	Pranoti	NASA Space Grant, 2007-08
Miteva	Martina	NASA Space Grant, 2007-08
Kirkpatrick	Robin	NASA Space Grant, 2007-08
McKenzie	Brittney	NASA Space Grant, 2008-09

National Science Foundation Awards		
Name		**Award**
Gualu	Miliyard	NSF/CSEM scholarship AUT 2007
Hui	Benedict	NSF/CSEM scholarship AUT 2007

Washington Research Foundation Fellowship		
Name		**Award**
Lee	Fan	WRF Fellowship 2008-09

Nivala	Jeff	WRF Fellowship 2009-10
Martin	Alicia	WRF Fellowship 2009-10
Calhoun	Sara	WRF Fellowship 2009-10
Buckley	Kate	WRF Fellowship 2009-10
Phillips	Reid	WRF/Washington Space Grant Fellowship 2009-10

Graduate Student Fellowships in BIOE, 2005-2011

2010-2011	
Name	**Sponsor**
Ausk, Brandon	NIH
Berguig, Geoffrey	NSF
Bradshaw, Brittany	NSF
Chamberlain, Jeff	NSF
Cheng, Connie	NDSEG
Cheng,Connie	NSF
Coe, Ryan	NSF
Copeland, Wilbert	NSF
Day, Austin	NSF
Feest, Erik	NSF
Fridley,Gina	NSF
Hillenmeyer, Elaine	NSF
Keller, Salka	NSF
Lin, Ralph	NDSEG
Lund, Susan "Mandy"	AHA Pre-Doctoral
Lundy, Scott	NIH
McCully, Michelle (BMSD)	NDSEG
McUsic, Andrew	NSF
Nash, Michael	NSF
Nowakowski, Sarah	NSF
Osborn, Jennifer	NSF
Phan, Joseph	NSF
Shah, Rachana	NSF
Shi, Julie	NSF
Thompson, Kassandra	AHA Pre-Doctoral
Thomson, Kassandra	NSF
Zrazhevskiy, Pavel	NSF
Holstein, Carly	NSF
Ted Chen	NSF
Total	29
NSF	22
AHA	2
NDSEG	3
NIH	2
Other	0

2009-2010	
Name	**Sponsor**
Balasubramanian, Gayathri	NSF
Berguig, Geoffrey	NSF
Bradshaw, Brittany	NSF
Callihan, Jackie	NSF
Chamberlain, Jeff	NSF
Cheng, Connie	NDSEG
Dave, Shivang	NSF
Day, Austin	NSF
Dewaraja, Asanka	NSF
Feest, Erik	NSF
Hillenmeyer, Elaine	NSF
Keller, Salka	NSF
Katzenmeyer, Kristy	NSF

Lin, Ralph	NDSEG
Lundy, Scott	NIH
McCully, Michelle (BMSD)	NDSEG
McUsic, Andrew	NSF
Nash, Michael	NSF
Nowakowski, Sarah	NSF
Osborn, Jennifer	NSF
Park, Kyung	NSF
Penkala, Becky	NSF
Shaffer, Justin	NSF
Shah, Rachana	NSF
Shepherd, Lauren	NSF
Shi, Julie	NSF
Thomson, Kassandra	NSF
Zrazhevskiy, Pavel	NSF
Total	28
NSF	24
AHA	0
NDSEG	3
NIH	1
Other	0

2008-2009	
Name	**Sponsor**
Balasubramanian, Gayathri	NSF
Bradshaw, Brittany	NSF
Callihan, Jackie	NSF
Chamberlain, Jeff	NSF
Dave, Shivang	NSF
Dewaraja, Asanka	NSF
Hillenmeyer, Elaine	NSF
Katzenmeyer, Kristy	NSF
Lin, Ralph	NDSEG
McUsic, Andrew	NSF
Nash, Michael	NSF
Osborn, Jennifer	NSF
Park, Kyung	NSF
Penkala, Becky	NSF
Shaffer, Justin	NSF
Shepherd, Lauren	NSF
Thomson, Kassandra	NSF
Total	18
NSF	16
AHA	0
NDSEG	1
NIH	0
Other	0

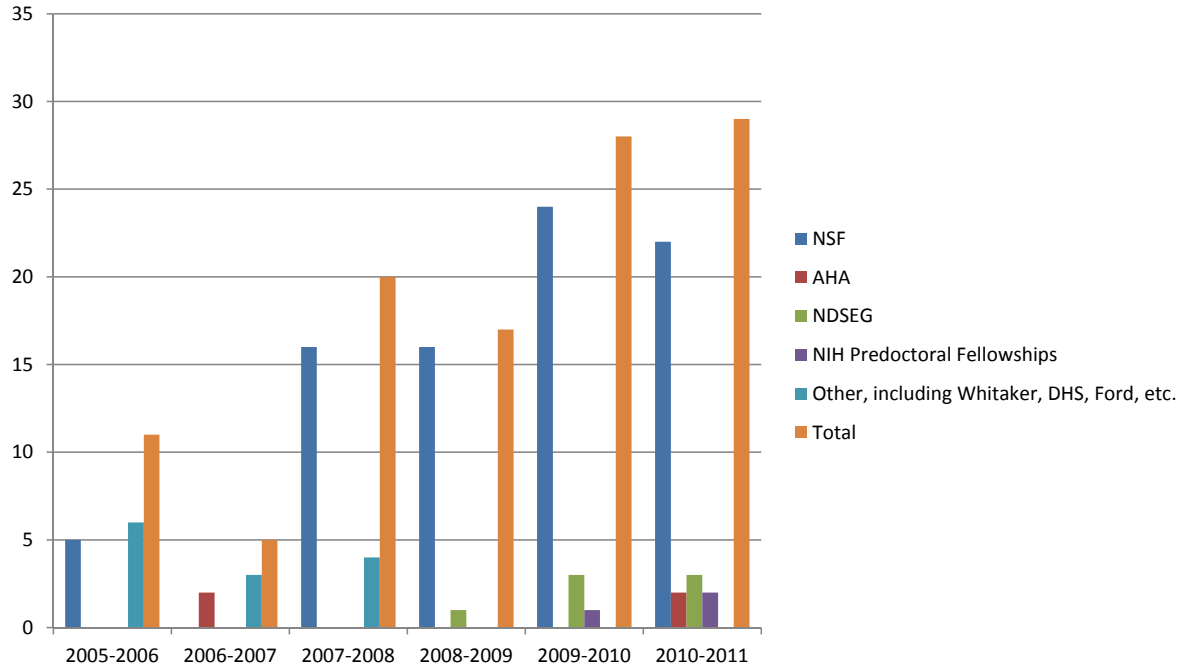
2007-2008	
Name	**Sponsor**
Balasubramanian, Gayathri	NSF
Baluyot, Florence	Gates Foundation
Bradshaw, Brittany	NSF
Burke, Rob	NSF
Callihan, Jackie	NSF
Crownover, Emily	NSF

Dave, Shivang	NSF
Dewaraja, Asanka	NSF
Flexman, Jennifer	NSERC
Goodman, Thomas	NSF
Helton, Kristin	NSF
Katzenmeyer, Kristy	NSF
McUsic, Andrew	NSF
Nash, Mike	DHS
Park, Kyung	NSF
Penkala, Becky	NSF
Rodriguez, Victoria	Ford Fellowship
Shaffer, Justin	NSF
Shepherd, Lauren	NSF
Thomson, Kassandra	NSF
Total	20
NSF	16
AHA	0
NDSEG	0
NIH	0
Other	4

2006-2007	
Name	**Sponsor**
Baek, Daehyun	Samsung
Joseph, Jeremy	Ford Fellowship
Moreno-Gonzalez, Alicia	AHA
Seng, Kok-Yong	DSTA of Singapore
Vinnakota, Kalyan	AHA
Total	5
NSF	0
AHA	2
NDSEG	0
NIH	0
Other	3

2005-2006	
Name	**Sponsor**
Bergen, Jamie	Whitaker Foundation
Flanary, Suzanne	Whitaker Foundation
Foley, Jessica	Seattle Foundation
Hwang, Jason	Whitaker Foundation
Johns, Rachel	Whitaker Foundation
Kreutziger, Kareen	Whitaker Foundation
Nilsson, Lina	NSF
Patterson, Jennifer	NSF
Stein, Maria (Jeanette)	NSF
Stevens, Kelly	NSF
Sylvester, Marisa	NSF
Total	11
NSF	5
AHA	0
NDSEG	0
NIH	0
Other	6

Graduate Student Fellowships in BIOE, 2005-2011



Collaborations Between BIOE Faculty and Clinicians

Name	Collaborator	Department
Bryers, James	Chan, C. Daniel	Restorative Dentistry
	Chung, Kwok-Hung	Restorative Dentistry
	Olerud, John	Dermatology
	Shen, Tueng	Ophthalmology
Beach, Kirk	Starns, Ben	Vascular Division
	Zierler, R. Eugene	Vascular Division
Chudler, Eric	Minoshima, Satoshi	Radiology
	Terman, Gregory	Anesthesiology
Castner, Dave	Bomsztyk, Karol	Medicine
Folch, Albert	Monnat, Ray	Pathology, Genome Sciences
Gamble, Lara	Mankoff, David	Radiology
Gao, Xiaohu	True, Larry	Pathology
	Vessella, Bob	Urology
O'Donnell, Matt	Beauchamp, Norm	Radiology
	Eary, Janet	Radiology
Pun, Suzie	Horner, Phillip (Research)	Neurological Surgery
	Raines, Elaine (Research)	Pathology
	Rubel, Edwin(Research)	Otolaryngology
	Blau, C. Anthony (clinical)	Hematology
	Hwang, Joo Ha (clinical)	Gastroenterology
	Ou, Henry	Otolaryngology
Ratner, Buddy	Fialkow, Michael	OB/GYN
	Manner, Paul	Orthopedics
	Moe, Kris	Otolaryngology
	Murry, Chuck	Pathology
	Ramakrishna, Rohan	Neurological Surgery
	Shen, Tueng	Ophthalmology
	Wessels, Hunter	Urology
Ratner, Dan	Johnsen, Jill	PSBC, Medicine
	Martin, Michael	Oral Medicine
	Schnapp, Lynn	Pulmonary Medicine
Regnier, Michael		Surgery (affiliate). Primary appt at Virginia Mason, Benaroya
	Allen, Margaret	Research Institute
	Bamshad, Mike	Pediatrics
	Beck, Anita	Pediatrics
	Minami, Elina	Medicine, Cardiology
	Murry, Chuck	Pathology
Sanders, Joan	Abrahamson, Danny	Rehabilitory Medicine
	Ciol, Marcia	Rehabilitory Medicine
	Hafner, Brian	Rehabilitory Medicine
	Tsai, Elaine	VA, Endocrinology

Spelman, Francis (Emeritus)	Gates, George (01-06)	Otolaryngology
	Goldenberg, Robert	Otolaryngology
	Rubinstein, Jay	Otolaryngology
Stayton, Patrick	Bulger, Eileen	Surgery (Harborview)
	Maier, Ron	Surgery (Harborview)
	Press, Oliver	Fred Hutchinson
	Schnapp, Lynn	Pulmonary Medicine
Taylor, Alyssa	Neitz, Jay	Ophthalmology
	Shen, Tueng	Ophthalmology
Thomas, Wendy	Chandler, Wayne	Laboratory Medicine
	Josephson, Neil	Hematology
	Konkle, Barbara	Hematology
	Linker, David	Cardiology
	Lopez, Jose (WT asks if he sho	Hematology
	Olerud, John	Dermatology
	Weissman, Scott	Pediatrics
	White, Nathan	Emergency Medicine

2010 Undergraduate Students and Interdisciplinary Collaborations

Student Name	Faculty	Affiliation
Aulck, Lavi	Ching, Randal	Mechanical Engineering
Castelli, Anthony	Allan, Chris	Orthopedics and Sports Medicine
Chen, Daniel F	Lee, Donghoon (w/ Gao, Xiaohu)	Radiology
Cheung, Douglas	Zhang, Miqin (w/ Ratner, Dan)	Materials Science and Engineering
Huynh, Kristina	Matsuoka, Yoky	Computer Science and Engineering
Kindle, Lance	Moehring, Mark (w/ Chris Neils)	Spencer Technologies, Inc.
Lee, Elliot	Cavanagh, Peter	Orthopedics and Sports Medicine
Liu, Vicki	Zhang, Miqin (w/ Ratner, Buddy)	Materials Science and Engineering
McConnell, Mark	Seibel, Eric	Mechanical Engineering
Nguyen, Kristina	Rao, Rajesh	Computer Science and Engineering
McNamara, Michael	Laflamme, Michael (w/Regnier, Michael)	Pathology
Meister, Melissa	Cavanagh, Peter	Orthopedics and Sports Medicine
Park, James (Jun)	Sarikaya, Mehmet (w/ Ratner, Dan)	Materials Science and Engineering
Pauley, Vivian	Washington, Ida (w/ Chudler, Eric)	Comparative Medicine
Postlewait, Steven	Ching, Randal	Mechanical Engineering
Steucke, Kerianne	Lopez, Jose (w/ Thomas, Wendy)	Puget Sound Blood Center
Zhang, Ada	Matsuoka, Yoky	Computer Science and Engineering
	TOTAL	**17**

Note: This includes our senior undergraduates who are working on a capstone project with adjunct faculty.

2010 Graduate Students and Interdisciplinary Collaborations

Name	Faculty	Affiliation
Ausk, Brandon	Gross, Ted	Orthopedics and Sports Med
Baluyot, Florence	Yuan, Chun	Radiology
Blakely, Tim	Rao, Rajesh	Computer Science & Engineering
Chen, Hong	Matula, Tom (w/Crum, Larry)	APL
Coe, Ryan L.	Seibel, Eric	Mechanical Engineering
Day, Austin	Baker, David (w/Thomas,Wendy)	Biochemistry
Farr, Navid	Hwang, Joo Ha	Gastroenterology
Gantz, Jay	Laflamme, Michael (w/Regnier, Michael)	Pathology
Kabilan, Senthil	Hlastala, Michael	Pbio
Li, Tong	Curra, Franco (w/Crum, Larry)	APL
Lin, Ralph	Matsuoka, Yoky	Computer Science & Engineering
Lu, Wei	Bailey, Michael (w/Crum, Larry)	APL
Lundy, Scott	Laflamme, Michael (w/Regnier, Michael)	Pathology
McUsic, Drew	Reh, Tom	Biological Structure
Miao, Qin	Seibel, Eric	Mechanical Engineering
Rodriguez, Anthony	Sniadecki, Nathan	Mechanical Engineering
Ruan, Jia-Ling	Matula, Tom (w/Crum, Larry)	APL
Siegel, Michael	Marcinek, David	Radiology
Simon, Julianna	Bailey, Michael	APL
Sun, Sijie	Gao, Dayong	Mechanical Engineering
White, Lee	Hannaford, Blake	Electrical Engineering
Xia, Ting	Kinahan, Paul	Radiology
Yang, Chenying	Dager, Stephen	Radiology
Yu, Shawn	Baker, David	Biochemistry
	TOTAL	**24**

Note: This includes students whose a) primary advisor or b) coadvisor are adjuct faculty.

Center and Training Grants in BIOE

Current:

1) Bioengineering Cardiovascular Training Grant

    a. PI: Mike Regnier
    b. Department involved:
        i. Bioengineering
        ii. Physiology & Biophysics
        iii. Department of Medicine
        iv. Radiology
        v. Pathology
        vi. Pediatrics
        vii. Applied Physics Lab
        viii. Biology
        ix. Anesthesiology
        x. Mechanical Engineering
        xi. Anesthesiology & Pain Med

2) Center for Intracellular Delivery of Biologics

    a. PI: Pat Stayton
    b. Department involved:
        i. Bioengineering
        ii. Medicinal Chemistry
        iii. Department of Medicine
        iv. Chemical Engineering

3) REU Site: University of Washington Engineered Biomaterials

    a. PI: Eric Chudler
    b. Department involved:
        i. Bioengineering

4) Building Bioengineering Bridges

    a. PI: Eric Chudler.
    Department involved:
        i. Bioengineering

5) Initiative for Maximizing Student Diversity (IMSD)

   a. PI: Pat Stayton
      Department involved:
      i. Bioengineering
      ii. Microbiology
      iii. Office of Minority Affairs

Past:

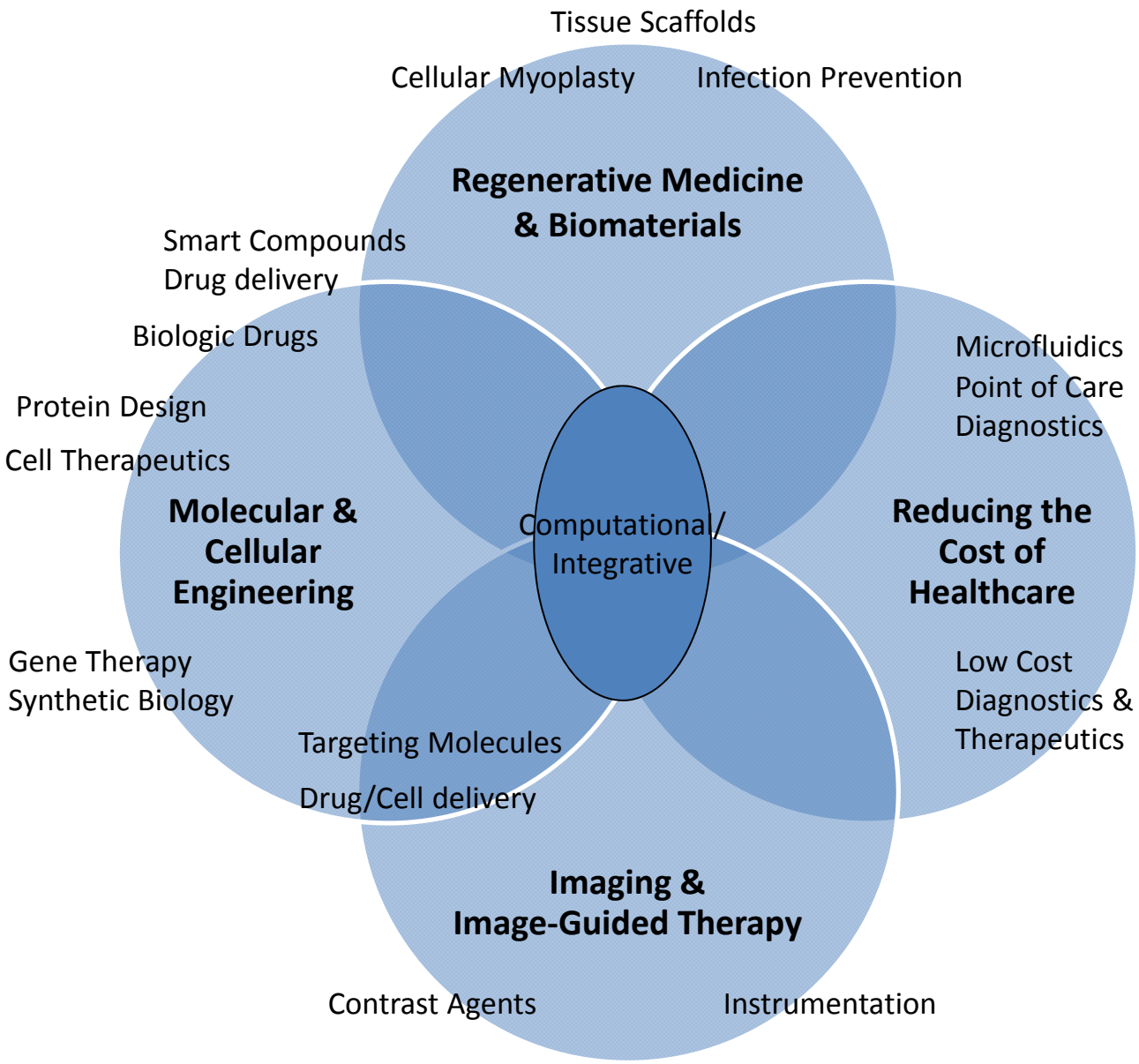
6) Training in Engineered Biomaterials. This grant ended in 2006.

   a. PI: Buddy Ratner
      Department involved:
      i. Bioengineering
      ii. Electrical Engineering
      iii. Chemistry
      iv. Material Science & Engineering

7) University of Washington Engineered Biomaterials (UWEB) Engineering Research Center (ERC). This grant ended in 2008.

   a. PI: Buddy Ratner
   b. Department involved:
      i. Bioengineering
      ii. Biochemistry
      iii. Material Science & Engineering
      iv. Department of Medicine
      v. Orthopedics

Bioengineering Research Themes - Multi-Disciplinary Approach



Bioengineering Research Themes - Current

Bioinstrumentation

PROFESSORS
David Castner
Yongmin Kim
Gerald Pollack
Buddy Ratner
Paul Yager

ASSOCIATE PROFESSORS
Albert Folch
Joan Sanders

ASSISTANT PROFESSORS
Lara Gamble r
Xiaohu Gao
Barry Lutz r
Daniel Ratner

Biomaterials & Tissue Engineering

PROFESSORS
James Bryers
David Castner
Valerie Daggett
Cecilia Giachelli
Allan Hoffman *
Thomas Horbett *
Charles Murry
Gerald Pollack
Buddy Ratner
Michael Regnier

ASSOCIATE PROFESSORS
Suzie Pun
Marta Scatena
Joan Sanders
Wendy Thomas

ASSISTANT PROFESSORS
Mei Speer r

Global Health, D2H2

PROFESSORS
Kirk Beach *
Yongmin Kim
Patrick Stayton
Paul Yager

ASSOCIATE PROFESSORS
Narendra Singh r

ASSISTANT PROFESSORS
Barry Lutz r
Daniel Ratner

Imaging & Image Guided Therapy

PROFESSORS
James Bassingthwaighte
Kirk Beach *
Lawrence Crum r
Yongmin Kim
Martin Kushmerick *
Matthew O'Donnell
Rong Tian

ASSOCIATE PROFESSORS
Suzie Pun

ASSISTANT PROFESSORS
Xiaohu Gao

Integrative Physiology, Systems Biology & Synthetic Biology

PROFESSORS
James Bassingthwaighte
Martin Kushmerick *
Henry Lai r
Donald Martyn*
Michael Regnier
Rong Tian

ASSOCIATE PROFESSORS
Eric Chudler r
Herbert Sauro
Narendra Singh r
Wendy Thomas

Molecular Bioengineering

PROFESSORS
James Bryers
David Castner
Valerie Daggett
Cecilia Giachelli
Allan Hoffman *
Thomas Horbett *
Henry Lai r
Matthew O'Donnell
Gerald Pollack
Buddy Ratner
Michael Regnier
Patrick Stayton
Pedro Verdugo *
Paul Yager

ASSOCIATE PROFESSORS
Suzie Pun
Joan Sanders
Wendy Thomas

ASSISTANT PROFESSORS
Lara Gamble r
Xiaohu Gao
Daniel Ratner

Neural Engineering, Rehabilitation & Augmentation

PROFESSORS
Buddy Ratner
Jay Rubinstein

ASSOCIATE PROFESSORS
Eric Chudler r
Albert Folch
Suzie Pun
Joan Sanders

Understanding Nature Through Engineering

PROFESSORS
Valerie Daggett
Martin Kushmerick *
Gerald Pollack
Michael Regnier
Rong Tian
Pedro Verdugo

ASSOCIATE PROFESSORS
Joan Sanders
Wendy Thomas

Key:
*** emeritus faculty**
r research faculty

Bioengineering Research Themes - Proposed

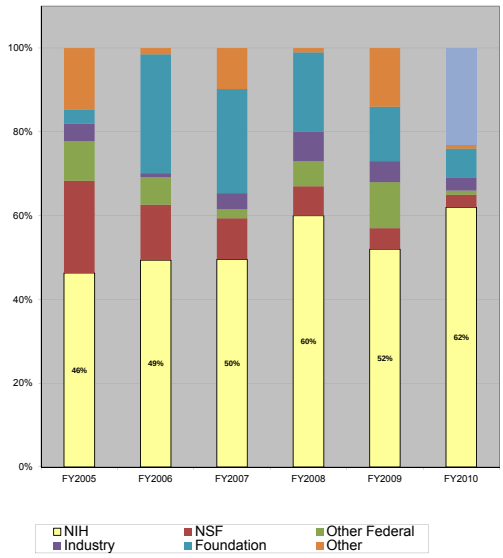
Regenerative Medicine & Biomaterials	Molecular/Cellular Engineering	Imaging & Image-Guided Therapy	Reducing the Cost of Healthcare
PROFESSORS	PROFESSORS	PROFESSORS	PROFESSORS
James Bryers	James Bryers	Jim Bassingthwaighte	Kirk Beach *
David Castner	David Castner	Kirk Beach *	Yongmin Kim
Valerie Daggett	Valerie Daggett	Larry Crum	Patrick Stayton
Cecilia Giachelli	Cecilia Giachelli	Yongmin Kim	Paul Yager
Allan Hoffman *	Allan Hoffman *	Martin Kushmerick *	
Thomas Horbett *	Thomas Horbett*	Matthew O'Donnell	
Donald Martyn *	Henry Lai	Rong Tian	
Charles Murry	Charles Murry	Ruikang Wang	
Buddy Ratner	Gerald Pollack		
Daniel Ratner	Buddy Ratner		
Michael Regnier	Michael Regnier		
Jay Rubinstein	Patrick Stayton		
Patrick Stayton	Paul Yager		
ASSOC. PROFESSORS	ASSOC. PROFESSORS	ASSOC. PROFESSORS	ASSOC. PROFESSORS
Albert Folch	Lara Gamble	Suzie Pun	Narendra Singh
Lara Gamble	Suzie Pun		Eric Chudler
Suzie Pun	Joan Sanders		
Joan Sanders	Herbert Sauro		
Marta Scatena	Narendra Singh		
Wendy Thomas	Wendy Thomas		
ASST. PROFESSORS	ASST. PROFESSORS	ASST. PROFESSORS	ASST. PROFESSORS
Deok-Ho Kim#	Xiaohu Gao	Xiaohu Gao	James Lai
Yanfeng (Mei) Speer	Deok-Ho Kim	Barry Lutz	Barry Lutz
Kim Woodrow	Daniel Ratner	Paul Wiggins	Daniel Ratner
	Kim Woodrow		Kim Woodrow
	James Lai		

Key:
*** emeritus faculty**
 # appointment begins 2011

GRANT & CONTRACT AWARDS

Prepared by Lina Nguyen

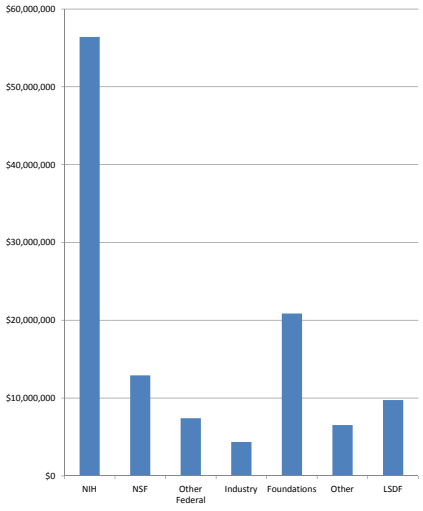
History of Awards: FY05 – FY10

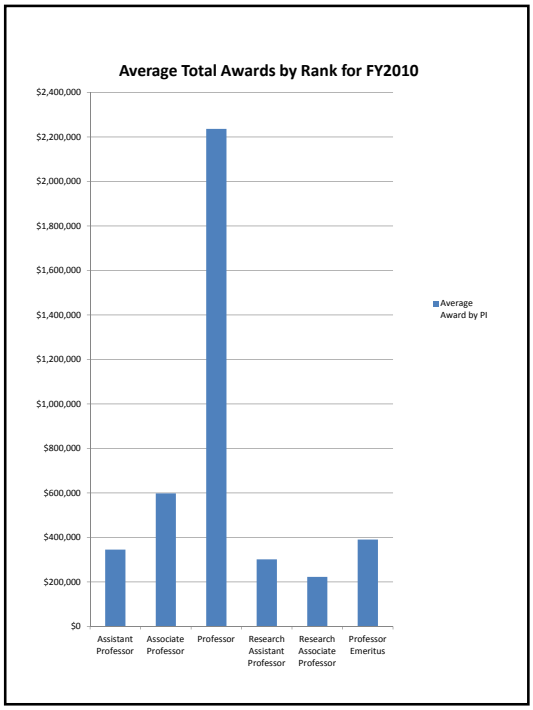


History of Awards: FY2005-FY2010

	FY05	FY06	FY07	FY08	FY09	FY10
Funds Awarded	$24,450,078	$23,090,884	$29,987,468	$16,556,612	$18,637,795	$32,267,133
# of NEW grants awarded	26 New	37 New	32 New/ 87 total	23 New/ 63 total	29 New/ 69 total	28 New/ 80 total
Avg Award Amount			$344,684	$262,803	$270,113	$403,339

Cumulative Awards:FY2005-FY2010





Average Awards per Faculty FTE

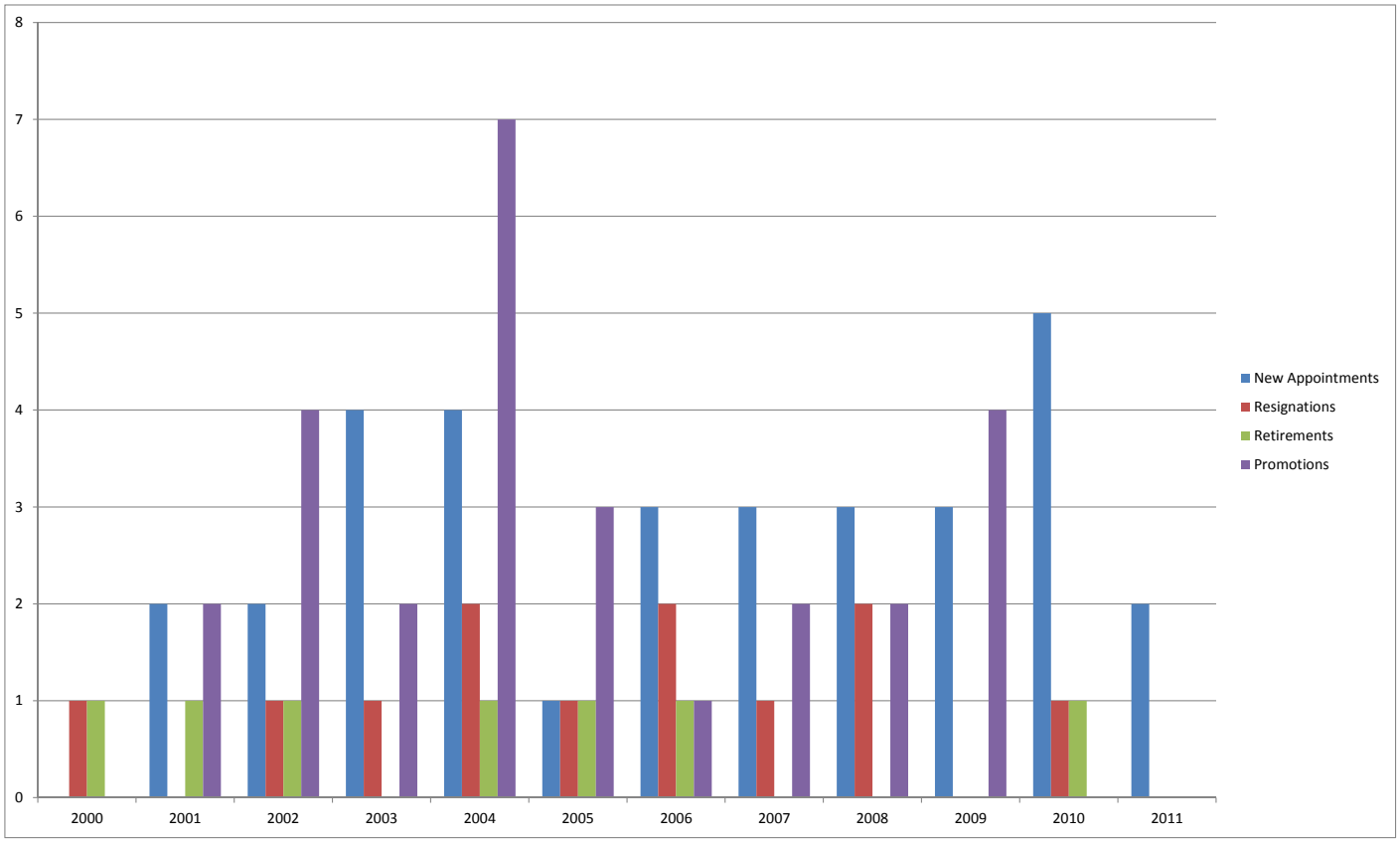
Award Year	Faculty FTE	Total Funding	*Avg Funding per PI*
FY 2007	30	$29,987,468	***$999,582***
FY2008	28	$16,556,612	***$591,308***
FY2009	26.5	$18,637,795	***$703,313***
FY2010	30	$32,267,133	***$1,075,571***

Hires, Resignations, Retirements, and Promotions in BIOE, 2001-2011

Name	Rank (as of Jan 2000 or when first appointed)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Anderson, Joe	Research Assistant Professor					new		resigned					
Bassingthwaighte, James	Professor												
Beach, Kirk	Emeritus Research Professor (joint w/Surgery)									new			
Beard, Daniel	Research Assistant Professor					new							
Bonadio, Jeffrey	Associate Professor				new								
Bryers, James	Professor w/o tenure					new					to Professor w/ Tenure		
Castner, David	Research Associate Professor					to Research Professor	to Professor						
Crum, Lawrence	Research Professor												
Daggett, Valerie	Professor									new			
Folch, Albert	Assistant Professor							to Associate Professor					
Foster, David	Research Professor Emeritus	retired											
Franza, B. Robert	Research Professor							resigned					
Fu, Elain	Research Assistant Professor											new	
Gamble, Lara	Research Assistant Professor												
Gao, Xiaohu	Assistant Professor						new						
Giachelli, Cecilia	Associate Professor					to Professor							
Harris, Samantha	Research Assistant Professor				new				resigned				
Hess, Henry	Research Assistant Professor			new			resigned						
Hoffman, Allan	Professor						retired						
Horbett, Thomas	Professor											retired	
Huntsman, Lee	Professor and Provost			to Interim President	to President	to President Emeritus							
Kim, Deok-Ho	Assistant Professor												new
Kim, Yongmin	Professor/Chair												
Kushmerick, Martin	Professor												
Lai, Henry	Research Professor												
Lai, James	Research Assistant Professor										new		
Lybrand, Terry	Associate Professor	resigned											
Li, Xingde	Assistant Professor		new				to Associate Professor			resigned			
Li, Zheng	Research Assistant Professor			resigned									
Lutz, Barry	Research Assistant Professor										new		
Managuli, Ravi	Research Assistant Professor				new								
Martin, Roy	Research Professor					retired							
Martyn, Don	Research Associate Professor					to Research Professor		retired					
Murry, Charles	Professor (joint w/ Pathology)							new					
Neils, Christopher	Lecturer, Full-Time								new				
Neumann, Thomas	Research Assistant Professor			new		resigned							
O'Donnell, Matthew	Professor and Dean, COE							new					
Pollack, Gerald	Professor												
Pun, Suzie	Assistant Professor				new				to Associate Professor				
Ratner, Buddy	Professor												
Ratner, Daniel	Assistant Professor									new			
Regnier, Michael	Research Assistant Professor			to Associate Professor without Tenure		to Associate Professor with Tenure				to Vice Chair	to Professor		
Rubinstein, Jay	Professor (joint w/ Otolaryngology)								new				
Sanders, Joan	Associate Professor												
Sauro, Herbert	Associate Professor								new				
Scatena, Marta	Research Assistant Professor		new								to Research Associate Professor		
Singh, Narendra	Research Assistant Professor					to Research Associate Professor							
Speer, Yanfeng (Mei)	Research Assistant							new					
Spelman, Francis	Professor and Vice Chair		retired										
Stayton, Patrick	Associate Professor		to Professor										
Taylor, Alyssa	Lecturer, Full-Time											new	
Thomas, Wendy	Assistant Professor					new					to Associate Professor		

Tian, Rong	Professor (joint w/ Anesthesiology)										new		
Vaezy, Shahram	Research Assistant Professor			to Assistant Professor without Tenure	to Associate Professor without Tenure		to Associate Professor with Tenure					resigned	
Verdugo, Pedro	Professor			retired									
Vicini, Paolo	Assistant Professor					to Associate Professor with Tenure				resigned			
Vogel, Viola	Associate Professor			to Professor		resigned							
Wang, Ruikang	Acting Professor											new	
Wiggins, Paul	Assistant Professor (joint w/ Physics)											new	
Woodrow, Kim	Assistant Professor (joint w/ Physics)											new	
Yager, Paul	Professor		to Vice Chair						to Acting Chair	to Chair			
Zachariah, Santosh	Research Assistant Professor				resigned								
Zheng, Ying	Research Assistant Professor												new
Totals		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
New Appointments		0	2	2	4	4	1	3	3	3	3	5	2
Resignations		1	0	1	1	2	1	2	1	2	0	1	0
Retirements		1	1	1	0	1	1	1	0	0	0	1	0
Promotions		0	2	4	2	7	3	1	2	2	4	0	0

Hires, Resignations, Retirements, and Promotions in BIOE, 2001-2011



Adjunct Faculty in BIOE

Christopher Allan, Associate Professor, Orthopaedics and Sports Medicine
MD, Northwestern University, 1992
Wound repair and regeneration; tissue engineering

David Baker, Professor, Biochemistry
PhD, Biochemistry, University of California - Berkeley, 1989
Protein folding

Francois Baneyx, Professor, Chemical Engineering
PhD, Chemical Engineering, University of Texas - Austin 1991
Biotechnology; protein technology; biochemical engineering

James V Burke, Professor, Mathematics
PhD, Mathematics, University of Illinois at Urbana-Champaign, 1983
Optimization; nonsmooth analysis

James H Caldwell, Professor, Medicine/Cardiology and Adjunct Professor, Radiology
MD, University of Missouri, 1970
Positron emission tomography; myocardial ischemia; myocardial metabolism; cardiac sympathetic nervous system

Peter Cavanagh, Professor, Orthopaedics & Sports Medicine
Endowed Chair in Women's Sports Medicine and Lifetime Fitness
DSc, Faculty of Medicine, University of London, 2004
PhD, Royal Free Medical School, University of London, 1972
Osteoporosis, lower extremity biomechanics, bone health, diabetes

Randal P. Ching, Research Associate Professor, Mechanical Engineering
PhD, Mechanical Engineering, University of Washington, 1992
Musculoskeletal biomechanics for injury research and improved clinical outcomes

Howard Chizeck, Professor, Electrical Engineering
ScD, Electrical Engineering and Computer Science, MIT, 1982
Control engineering theory and the application of control engineering to biomedical problems and biologically inspired engineered systems; closed loop drug delivery; neural prostheses, functional electrical stimulation; robotic surgery; multi-scale modelling.

Kevin E. Conley, Professor, Radiology
PhD, Zoology, University of Wisconsin - Madison, 1983
In vivo muscle metabolism and energetics; magnetic resonance spectroscopy; muscle structure and function; muscle physiology; exercise physiology

Stephen R Dager, Professor, Radiology; Director, Neuroimaging Research Grant; Adjunct Professor, Psychiatry
MD, Psychiatry, University of Nebraska, 1978
Metabolism of the central nervous system; imaging

Thomas Daniel, Professor, Biology
PhD, Biology, Duke University, 1982
MacArthur Fellow, 1996
Implantable microelectronics, dynamics of muscle contraction

Eberhard Fetz, Professor, Physiology and Biophysics
PhD, Physics, Massachusetts Institute of Technology, 1967
Critical Control of Movement, Neural modeling

Dayong Gao, Professor, Mechanical Engineering
PhD, Mechanical Engineering and Biomedical Engineering, Concordia University, 1992
Cryopreservation and fundamental cryobiology; bio-heat-mass transfer and thermal stress; artificial kidney; nano-technology/nano-fluid/membrane science; development of optimal technology and equipment; tissue engineering; cardiovascular and blood research

Philip P. Green, Professor, Genome Sciences
PhD, Mathematics, University of California - Berkeley, 1976
Mathematical, statistical, and computer methods for analyzing the genomes of humans and other organisms

Ted S. Gross, Professor, Orthopaedics and Sports Medicine
PhD, Mechanical Engineering, State University of New York at Stony Brook, 1993
Mechanotransduction signalling pathways; novel loading strategies to build bone mass; cell and tissue response to hypoxia; tissue engineering

Blake Hannaford, Professor, Electrical Engineering
PhD, Electrical Engineering and Computer Science, University of California - Berkeley, 1985
Neural control of movement; robotics; human-machine interaction; telerobotics

Stephen Hauschka, Professor, Biochemistry; Adjunct Professor, Zoology
PhD, Biology, Johns Hopkins University
Skeletal and cardiac muscle biology

David Haynor, Professor, Radiology
PhD, Mathematics, University of California - Berkeley, 1971
MD, Harvard Medical School, 1979
Medical image processing for morphometrics; anatomic imaging

Michael Hlastala, Professor, Physiology and Biophysics/Pulmonary and Critical Care Medicine
PhD, Physiology, State University of New York at Buffalo, 1969
Respiratory physiology; inert gas analysis of respiratory function

Joo Ha Hwang, Md, PhD, Assistant Professor, Gastroenterology
MD, University of Chicago, 2005
Treatment of pancreatic cancer with high-intensity focused ultrasound

Shaoyi Jiang, Professor, Chemical Engineering
PhD, Cornell University, 1993
Interfacial phenomena and nanotechnology

Paul Kinahan, Professor, Radiology
PhD, Bioengineering, University of Pennsylvania, 1994
Clinical oncology imaging with 3DPET; 3D imaging reconstruction using planograms; PET/CT tomography

Michael Laflamme, Assistant Professor, Pathology
PhD, Emory Univeristy, Molecular Therapeutics & Toxicology, 1998
MD, Emory University, 1999
Cardiac application for human embryonic stem cells to achieve cardiac repair

David Linker, Associate Professor, Internal Medicine, Cardiology
MD, Stanford University, 1976
Ultrasound; vascular; cardiology; signal processing; ventricular function; diastole

David A. Mankoff, Professor, Radiology and Medicine
MD, University of Pennsylvania, 1988
PhD in Bioengineering, University of Pennsylvania
Application of PET and molecular imaging to cancer, especially breast cancer; quantitative image analysis and tracer kinetic modeling for medical images; use of molecular imaging in cancer clinical trials

David J. Marcinek, Research Assistant Professor, Radiology
PhD, Physiology, Staford University, 2000
mitochondrial dysfunction in aging and disease, optical and magnetic resonance spectroscopy

Yoky Matsuoka, Associate Professor, Computer Science and Engineering
PhD, Massachusetts Institute of Technology, 1998
MacArthur Fellow, 2007
Robotics; brain-machine interface

Satoshi Minoshima, Professor and Vice Chair, Radiology
MD, Chiba University, 1987
PhD, Radiological Science, Chiba University, 1994
High resolution PET imaging; imaging of neurogenesis; brain mapping

Pierre Mourad, Associate Professor, Neurological Surgery; Senior Scientist, Applied Physics Laboratory
PhD, Applied Mathematics, University of Washington
Diagnostic and therapeutic ultrasound

Deborah Nickerson, Professor, Genome Sciences
PhD, Immunology, University of Tennessee, 1978
Automating the identification and typing of human DNA variations

Hong Qian, Associate Professor, Applied Math
PhD, Biochemistry and Biophysics, Washington University, 1989
Computational systems biology; macromolecular biophysics; mathematical modeling

Rajesh Rao, Associate Professor, Computer Science & Engineering
PhD, University of Rochester, 1998
Computational neuroscience and brain-computer interfaces

Tom Reh, Professor, Biological Structure
PhD, Neuroscience, University of Wisconsin-Madison, 1981
Developing stem cell technology for the treatment of blindness, retinal regeneration

Kenneth A. Schenkman, Associate Professor, Pediatrics
MD, Indiana University School of Medicine, 1986
PhD in Bioengineering, University of Washington, 1996
Optical spectroscopy; tissue oxygenation; mitochondrial function; myocardial energetics

Stephen M. Schwartz, Professor, Pathology
MD, Boston University, 1967
PhD, Experimental Pathology, University of Washington, 1973
Mechanisms controlling growth of cells in the vessel wall; abnormal growth control role atherosclerosis and hypertension; image analysis

Georg Seelig, Assistant Professor of Computer Science and Engineering and Electrical Engineering
PHD, Physics, University of Geneva
Quantitative Biology and DNA Nanotechnology

Eric J. Seibel, Research Associate Professor, Mechanical Engineering
PhD, Bioengineering, University of Washington, 1996
3D interface technology; biomedical instrumentation; optical disease diagnosis and laser therapy; and vision assistive devices

Florence H. Sheehan, Professor, Cardiology; Director, Cardiovascular Research and Training Center
MD, University of Chicago, 1975
Cardiac imaging and image analysis for patient care; clinical investigation and clinical trials; three-dimensional echocardiography and MRI; the right ventricle in congenital heart disease and other conditions

Tueng Shen, Assistant Professor, Ophthalmology; Director, Refractive Surgery Center
MD, Harvard Medical School, 1997
PhD, Medical Engineering, Massachusetts Institute of Technology
Corneal tissue engineering, refractive surgery, medical and surgical management of corneal disorders

Nathan Sniadecki, Assistant Professor, Mechanical Engineering
PhD, University of Maryland at College Park, 2003
Cell mechanics, mechanotransduction, and bioMEMS

Alexander Veress, Research Assistant Professor, Mechanical Engineering
PhD, Biomedical Engineering, Ohio State University, 2000
Soft tissue and cardiac mechanics

Hubert Vesselle, Associate Professor, Radiology
MD, Case Western Reserve University , 1991

PhD, Biomedical Engineering, Case Western Reserve University,
Positron emission tomography applied to oncology; cross-sectional imaging

Chun Yuan, Professor, Radiology
PhD, Medical Biophysics, University of Utah, 1988
Magnetic resonance imaging

BIOE Faculty - H-Index (grouped by rank)

Last	*First*	*H-Factor*	*Title*	*Track*
Ratner	Daniel	13	Assist. Professor	T/TT
Gamble	Lara	14	Assist. Professor	Research
Gao	Xiaohu	26	Assist. Professor	T/TT
Speer	Yanfeng Mei	26	Assist. Professor	T/TT
Thomas	Wendy	14	Assoc Professor	T/TT
Pun	Suzie	15	Assoc Professor	T/TT
Chudler	Eric	17	Assoc Professor	Research
Scatena	Marta	17	Assoc Professor	Research
Folch	Albert	20	Assoc Professor	T/TT
Sanders	Joan	21	Assoc Professor	T/TT
Sauro	Herbert	31	Assoc Professor	T/TT
Singh	Narendra	41	Assoc Professor	Research
Huntsman	Lee	13	Professor	T/TT
Bryers	James	22	Professor	T/TT
Regnier	Michael	22	Professor	T/TT
Rubinstein	Jay	22	Professor	T/TT
Wang	Ruikang	24	Professor	T/TT
Pollack	Gerald	25	Professor	T/TT
Tian	Rong	27	Professor	T/TT
Lai	Henry	28	Professor	Research
Kim	Yongmin	32	Professor	T/TT
O'Donnell	Matthew	34	Professor	T/TT
Bassingthwaighte	James	37	Professor	T/TT
Crum	Lawrence	39	Professor	Research
Castner	Dave	41	Professor	T/TT
Yager	Paul	42	Professor	T/TT
Stayton	Patrick	43	Professor	T/TT
Daggett	Valerie	**47**	Professor	T/TT
Murry	Charles	**49**	Professor	T/TT
Ratner	Buddy	**49**	Professor	T/TT
Giachelli	Cecilia	**52**	Professor	T/TT
Martyn	Don	15	Professor	Emeritus
Verdugo	Pedro	16	Professor	Emeritus
Foster	David	21	Professor	Emeritus
Horbett	Thomas	43	Professor	Emeritus
Hoffman	Allan	**54**	Professor	Emeritus
< 3 years Assistant Professor				
Fu	Elaine	8	Assist. Professor	Research
Lai	James	undefined *	Assist. Professor	Research
Lutz	Barry	4 *	Assist. Professor	Research
Wiggins	Paul	5 *	Assist. Professor	Research
Woodrow	Kim	undefined *	Assist. Professor	T/TT

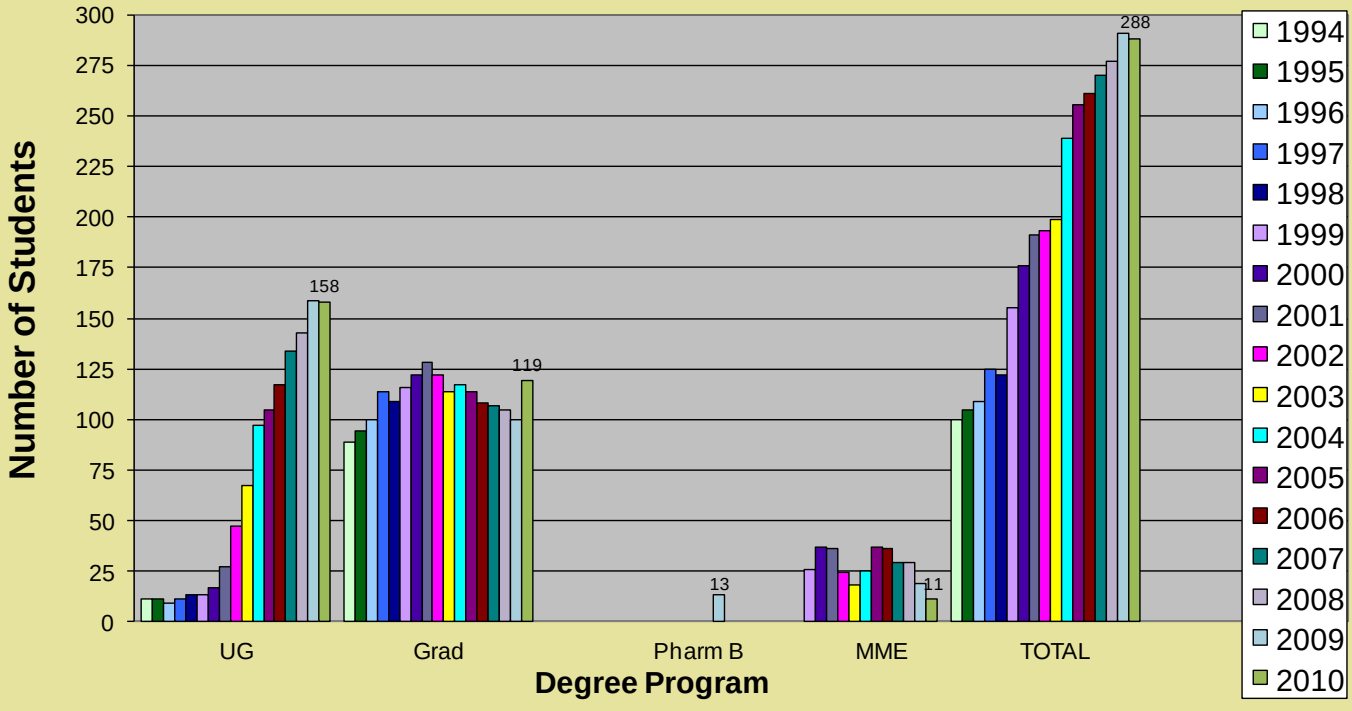
* indicates asst prof with 0-3 years at rank.

Summary of BIOE Faculty H-Index

Rank	Low	High	Median	Average
Assistant (3-6 yrs)	13	26	20	20
Associate	14	41	19	22
Professor	13	52	34	34
Emeritus	15	54	21	30
Overall	13	54	26	29

DATA OBTAINED WITH GOOGLE SCHOLAR "citations-gadget" http://code.google.com/p/citations-gadget/

Student population



Missing: the new PharmBioE UWEO program