

Annual Report
Department of Mechanical Engineering
Academic Year 2007-08

1) Introduction and Highlights for 2007-08

The Mechanical Engineering program is the largest in the College of Engineering and Applied Science (CEAS) and the 7th most popular major at UW as measured by undergraduate enrollment. Despite the burden of having the highest student/faculty ratio of any department in the CEAS (see OIA data in Appendix), faculty in the department continue to maintain one of most rigorous academic standards of any unit on campus which is reflected by our students having the lowest GPA of any discipline in the CEAS, but at the same time having the highest performance on the Fundamentals of Engineering Exam (FE), a nationwide exam that is the first hurdle to becoming a licensed professional engineer. Seniors in Mechanical Engineering have passed the exam at a rate of 96% over the last decade, which is 11 percentage points higher than the national average (85%) for mechanical engineers and 17 percentage points higher than the average pass rate (79%) for all other disciplines in the CEAS. For the last two FE exams (given spring and fall of 2007), 36 of 37 (97%) ME students passed the exam.

Our undergraduates have also distinguished themselves this year with two noteworthy senior design projects. One team finished 4th place among 23 entries in NASA's "Great Moon Buggy Race", also earning the "Most Improved Team Award". A second design team composed of 11 ME students and 10 students from other engineering disciplines won the "Disappearing Road Competition", a national competition sponsored by Halliburton that examines minimization of environmental impact on oil drilling operations. The award carried a \$20,000 honorarium for the students.

Following Dean Rob Ettema's suggestion that the ME Department was in the best position of any CEAS program to develop a new energy-intensive curriculum that would mesh well with the School of Energy Resources (SER) mission, the ME Department developed two new academic programs. The first is an "Energy Conversion Option", which is a variation of the standard ME degree that broadens the scope of existing energy-related elective courses. The second initiative is a proposed degree program in "Energy Systems Engineering", which would have 80% of its course work in common with the conventional ME degree while taking the other 20% of the coursework from the departments of ENR, POLS, GEOL, CE, PETE, LIFE, and ATSC. This program will be a fully-accredited engineering degree intended to appeal to a diverse audience of students. The Energy Systems Engineering degree has been proposed as a cornerstone academic program for the SER as the Department works to extend its collaboration on issues central to the SER mission. Both curricular initiatives have been flushed out and shared with various administrators, but further



progress toward implementing them is pending allotment of additional faculty resources.

The Department's research effort continues to grow in both quantity and quality. Demetris Kouris' contributions to the profession were recognized in two substantial ways this year – first by his election to Fellow grade of the American Society of Mechanical Engineers, and second, by his appointment as an NSF Program Director in the Nano and Bio Mechanics program. In recognition of his founding effort and funding record, Jonathon Naughton was appointed as the Director of the Wind Energy Research Center. Perhaps the single most impressive research contribution in the department continues to be that led by Dimitri Mavriplis in the area of computational fluid dynamics, in which he presently supports 5 PhD students 3 post-doctoral researchers. One of Dimitri's new PhD students was just awarded a very competitive and prestigious DOE Computational Science Graduate Fellowship that carries a \$32k/yr stipend in addition to tuition and fees.

Experience has justified our decision to concentrate on the strengths of each one of our faculty and not to force a single template upon all. Across our faculty ranks, morale is high as each member contributes to the overall departmental mission in their own unique way. This successful model has resulted in little-to-no competition among ourselves, and this attitude also carries over to the CEAS such that we are looking forward to supporting Dean Ettema in his efforts to promote the college and its goals, as opposed to engaging in a pointless competition with other UW units.

2) Academic Planning Implementation

A. Progress on Departmental-Level Action Items

- ME has contributed to the ongoing Hewlett effort, most notably by contributions of Dennis Coon and Nancy Peck to restructuring ES 1060.
- Department personnel have reviewed student surveys, time-to-graduation, and enrollment trends and discussed these issues with the Department's External Advisory Board.
- The Department has exceeded its goal of having 10% of seniors participate in research projects.
- An International Option in ME was implemented in 2005. The program has several current students and at least one graduate.
- A Plan B MS program was implemented in 2005. The program has three students currently enrolled, two new students expected for fall 2008, and one graduate.
- The Department's graduate program continues to grow slowly, with an enrollment of 31 students expected for the coming fall term. Fourteen of the 31 students are PhD students, only one shy of our 2009 goal.



Summary: The Department is making solid progress on its more important action items, but there are a few that have not yet been addressed.

B. Progress on College-Level Action Items

- The Department has implemented an International Engineering Option and documented mild student interest, and one graduate.
- The Department has approximately 15% of its graduating seniors participating in research, consistent with the CEAS goal.
- The Department has aggressively pursued enhancements to stipends for PhD students, and developed the Marino Fellowship with the goal of attracting exceptional PhD students. The fellowship carries a nationally competitive stipend of \$30k (plus tuition), which will be increased by \$5-10k next year. Our first Marino Fellowship recipient began his studies this summer.
- Recent PhD-student recruiting efforts have brought three highly qualified native students to the ME program from Georgia Tech. This past spring, the Department also used discretionary funds to support travel to UW for several PhD students we were trying to recruit.
- Efforts by particular faculty members who have secured highly qualified PhD students are recognized and documented as meritorious by the Department Head during performance reviews.
- The Department remains willing to support travel to visit with federal program managers, although this mostly occurs through PIs using their existing contract funding.
- The Department is pursuing various means for increasing energy-related research funding, most notably through Jonathon Naughton's leadership of the Wind Energy Research Center.

Summary: Many of the CEAS action items are not applicable to the ME Department, but of those that are, the Department is contributing positively to almost all.

C. Progress on University-Level Action Items

- ***(Action Item 4) Emphasize writing and oral communication in existing curricula.***

Mechanical Engineering students are required to take COJO 1010, Public Speaking. The ME Department continues to pay the English Department to reserve one section of English 2005 (Writing in Technology and the Sciences - WB) for ME students each semester. This course was originally designed by ME faculty to augment our ME 2020 (Design of Experiments) course. In addition to required University Study courses, ME students have extensive written and oral communication experiences



in ME 2020, ME 2160, ME 4060, and ME 4070 (WC), all of which are required courses in the ME program.

- **(Action Item 21)** ...streamline bachelor's-plus-master's programs.

The Department's BS/MS program continues to be a fruitful approach for exposing undergraduate students to graduate course work as they consider the merits of graduate school. The Department is pleased with the role of this program in our efforts to recruit top-notch graduate students from our own UG program. The Physics Plus/MSME program now has two students enrolled, but with only 11 UG Physics majors, prospects for significantly increased enrollments through this program are limited.

- **(Relevant to Action Item 33)** Support the proposed Science & Engineering of Materials interdisciplinary graduate program. This is a University priority, which provides a unique opportunity for our department to contribute knowledge and expertise.

Materials science is a discipline central to virtually every aspect of mechanical engineering design and as such, the department teaches one required course and three elective courses in this area. The Department has added one new faculty member for fall 2008, Carl Frick, whose expertise is in experimental mechanics and materials science. Although Professor Buttry has resigned from UW, a joint research project on corrosion that he and Demitris Kouris won continues in the Department.

- **(Relevant to Action Item 34)** Support the UW efforts in the area of Computational Science.

This remains one of the Department's highest priorities (along with development of an Energy Systems Engineering program). Dimitri Mavriplis has one of the strongest research programs at UW and was an important contributor to the effort that brought NCAR to Wyoming. At the same time, he has championed degree programs in computational science at both UG and graduate levels. He is also co-author of an EPSCoR proposal that promotes a focus in the computational sciences area. The Department tried to hire a very strong person with expertise in computational fluid dynamics for the new SER wind-position, but the individual's personal situation intruded to spoil the hiring.

- **(Action Item 85)** Discontinue unused courses that lack justification.

The Department has worked to closely police this issue and we carry no superfluous courses in the Bulletin.



3) Teaching Activities

The position of UG Program Coordinator for ME was established in 2006, and this has led to consistency and efficiency in many aspects of the UG program. More rigorous standards for Engineering Science prerequisites to ME courses were adopted to improve student retention and performance in junior-level ME classes.

The assessment process for the UG program is well coordinated as a consequence of needing to satisfy two demanding judges – our accreditation agency (ABET) and our highly-engaged External Advisory Board. The process provides logical and defensible guidance for curricular changes and improvements. We assess our program every year, review the conclusions as a faculty, and present the relevant information to our External Advisory Board for their feedback. Management of our assessment process is coordinated by a single, meticulous faculty member (Dennis Coon) whose job description is adjusted to reflect the seriousness with which we view this exercise.

4) Research Activities

The department continues to strengthen its research productivity in a variety of measurable ways. The number of archival, journal publications has increased. The research expenditures in AY 06-07 exceeded \$100K per faculty, the highest in the history of the department. More importantly, these expenditures come mainly through highly-competitive federal grants, and are the result of the involvement of many faculty and not just one or two. We now have 14 PhD students and four post-docs supporting our research effort and only 11.5 of these are supported through external grants and contracts.

The department has been a leader in supporting several of the University's research initiatives including the areas of materials science and computational sciences, and has been effective in engaging other departments to generate interdisciplinary research activities. We currently have several interdisciplinary research projects with departments outside the College of Engineering including some with the Department of Mathematics and the Department of Chemistry.

One of our faculty members, Prof. Dimitri Mavriplis was instrumental in the discussions that eventually lead to the selection of UW and Wyoming as primary partners in the NCAR Supercomputer Center. This new formal partnership between NCAR and UW will not only greatly enhance our access in Mechanical Engineering and across the UW campus to state-of-the-art computational facilities, but will foster a strong collaboration between UW, NCAR and other Front Range Institutions in the important multidisciplinary area of Computational Science and Engineering.

The department's success with DEPSCoR awards continues. After securing two such awards in 2004 and one in 2005, we recently received another from AFOSR. This is an extraordinary achievement if one considers the fact that 16 of those awards were given nationally in FY 2007 (about 25 States are eligible).



This department has received seven such awards since 2000. This must be the highest DEPSCoR success rate in the country for any department, whether in Engineering or the Sciences.

Research productivity and success in graduate education come together; this is a fact that our department understands. We will continue to mentor our new faculty and help them establish their research programs. As long as success in research is rewarded and the current positive climate is maintained, we expect that we will continue to improve. The main challenge we face is the availability of qualified graduate students. We will continue to work on improving our recruitment.

5) Service, Extension and Activities

Our faculty continue to contribute significantly in the service activities at the university and the professional community at large. In addition to committee memberships at every level, several of our faculty made seminal contributions in areas like economic development (Garnich, Hansen & Walrath through Firehole Technologies, STTR and SBIR programs, and the Laramie Economic Development Corporation). In addition, our faculty serve in national and international professional organizations, which include the American Society of Mechanical Engineers and the American Institute for Aeronautics and Astronautics, among others.

6) Student Recruitment and Retention Activities and Enrollment Trends

Over the five-year period between AY 02-03 and 07-08, OIA data suggest a 14% increase in the number of undergraduate students enrolled in Mechanical Engineering. Mechanical Engineering is the 7th most popular UG major at UW and the most popular within the CEAS.

As a result of a concerted departmental effort, even more significant growth has occurred in the number of doctoral students. The number of PhD students has increased from 2 in 2000 and 1 in 2001, to 14 expected in fall 2008 (10 are on campus now). The MS enrollments have dropped from 20 in 2000 to 15 for the fall 2008 term as departmental resources have shifted to support of PhD students. We anticipate the number of MS students rebounding as our relatively new BS/MS program and Plan B MS program gain traction. Both programs have produced students for us, with somewhere between 3 and 5 Plan B students expected for the fall 2008 term.

We are not actively recruiting UG students since we think we are near capacity with our present student/faculty ratio the highest in the CEAS. We do however make every effort to be accommodating to prospective students who visit UW of their own initiative, and we routinely spend an hour of faculty time with each visitor to explain the program and tour our facilities.



With regard to retention, all UG students in the program are assigned an ME faculty member as an academic advisor, and it is mandatory that all students visit with their advisors at least once per semester to assess their academic progress. Only ME faculty who are enthusiastic about academic and career advising participate as advisors – in recent years, 10 of our 12 faculty have done so. For 20 years, ME Department faculty have maintained an open door policy for our students as a means of fostering an attitude of personal concern for student learning and academic success – only in the last year has one faculty member chosen to enforce strict office hours.

Graduate student recruiting, particularly for strong PhD students has remained a point of emphasis within the Department. We maintain a graduate affairs committee composed of four faculty to oversee this effort. We have been disappointed by some recent recruits from China and India, despite some of these graduating first in their class in their home countries. We have had some recent success with recruiting three extraordinary PhD students from Georgia Tech – one of whom won a prestigious DOE Graduate Fellowship for the work that he will pursue under the guidance of Dimitri Mavriplis. The Department used discretionary funds to create and nationally advertise the financially-attractive “Marino PhD Fellowship” with the intent of attracting strong applicants from around the country. This fellowship has been awarded for the first time for the AY08-09. The Department has also begun funding the travel of select students to visit campus – in the last year, we funded three such student visits.

7) Development activities and public relations, including the use and maintenance of your departmental website

The development activities are coordinated through the Development Office of the College of Engineering. These include the biennial report and the College and departmental brochures. Every fall, the department sends a letter to the alumni, informing them of the latest news and events. The department mails “thank you” letters to contributors.

Our department’s External Advisory Board (current members are listed in the Appendix) has expressed an interest in assisting with alumni communications. They started in 2005 in an effort to create an event to invite alumni back to the Department. The aim is to increase Departmental visibility to reconnect alumni to the Department, build visibility and reputation of the Department, and encourage company hiring. The EAB saw only a limited response to initial contact with a selected alumni.

The Departmental web site is updated several times a year.

8) Classified and Professional Staffing

Mr. Steve Ownbey (Senior Computer Information Specialist) continues to provide excellent support for the Mechanical Engineering computer systems, including



our 96-node Linux cluster. In 2001, Mr. Ownbey's position was modified so that he also has support responsibilities to the CEAS Dean's office and to the Department of Chemical Engineering. With the subsequent addition of many new faculty and graduate students to the revived Petroleum Engineering program (which has a new cluster of their own), Mr. Ownbey is stretched very thinly and is barely able to keep up with his extensive responsibilities. This issue is likely going to require future attention.

Our two very competent office-staff members, Ms. Gale Bandsma and Ms. Debbie Stark, are both highly experienced at the University and their efforts are adequate to cover our current needs. As a measure of our satisfaction with their work, note that both were nominated for outstanding staff awards in the past year (one at the college level and one at the university level).

9) Diversity

Professor Coon, a faculty member in Mechanical Engineering, has served as the Principal Investigator and Coordinator of the NSF-funded CSEMS (Computer Science, Engineering, and Mathematics) Scholarship Program. The focus of this program is recruiting of under-represented groups.

Major effort has been directed towards increasing the enrollment of female students. Nationally, female students' enrollment in Mechanical Engineering trails the other engineering disciplines. The Department is very involved in the Engineering Science Program (ESP) of the College. This two-week summer program brings to the College 14-16 high-potential, female HS juniors. It involves engineering mini-projects aimed at exposing the students to the engineering discipline. About 50% of these students enroll in engineering.

The Hewlett CE³ is another project where Mechanical Engineering is deeply involved. In an effort to enhance the image of engineering in public schools, girls from the 6th to 8th grade are invited to participate in a science camp, modeled after ESP. last year we had eight participants.

Dr. Nancy Peck, another member of the Mechanical Engineering faculty, serves as a MSLI (Minority Student Leadership Initiative) Steering Committee member and faculty mentor and as a Selection Committee member for the Computer Science, Engineering, Mathematics Scholarship (CSEMS) program. She also serves as the College of Engineering Representative on Women's Studies Committee.

During the past two years, we had the opportunity to search for two new faculty, at the Assistant Professor level. We were fortunate to attract an excellent scholar in the area of computational mechanics and materials, Prof. Sukky Jun.

Professor Jun is the first non-Caucasian faculty member in our department.

Recently, we were also able to recruit Prof. Yong Zhu who has a solid background in experimental mechanics. Dr. Zhu's held a post-doctoral appointment at UT-Austin and will be replacing Prof. Bill Armstrong who passed away so unexpectedly last August.



10) Assessment of Student Learning

1. *What are your program goals and/or student learning outcomes? Where can they be found? Are they available to students? If so, how?*

The Mechanical Engineering Department has developed 6 Program Outcomes, which are:

ME OT 1 –Formulate engineering problems including identification of missing information and development of experimental data.

ME OT 2 –Apply the fundamentals of mathematics, science, and engineering to the design and realization of mechanical systems.

ME OT 3 –Effectively communicate including presentation and interpretation of engineering information.

ME OT 4 – Contribute to multidisciplinary teams in the development of engineering solutions.

ME OT 5 –Maintain competence in a technologically evolving profession.

ME OT 6 – Recognition of the professional, ethical, and societal responsibilities of the mechanical engineering profession.

These Program Outcomes are available to students. These Program Outcomes are given to students as part of the syllabus in 2000 and 3000 level ME courses.

2. *Provide a brief summary of your assessment activities for this past year. What did you accomplish? Please describe what data were collected or analyzed. If you analyzed data, what are you doing with the results? What changes have you made because of what you learned?*

The Mechanical Engineering Department has a comprehensive and mature assessment process aligned closely with accreditation standards. The process has been implemented by the Mechanical Engineering Department Continuous Improvement Committee. MEDCIC is comprised of the Department Head, a Coordinator, one solid mechanics faculty, and one fluid mechanics faculty. At the beginning of each semester, faculty are notified by the Coordinator of assessment activities and student materials to be collected for assessment. The Coordinator collects the assessment materials and arranges assessment of materials as appropriate. The Coordinator archives the assessment results, and provides a draft annual assessment report to MEDCIC members in late March each year. MEDCIC reviews the report, revises as necessary, and releases a summary of the report to both the department faculty and the Department's External Advisory Board in early April each year. The complete report and the summary are available on a secure Web site for examination by faculty and the External Advisory Board. Any required course, process, or program modifications are discussed and scheduled for implementation the following year.

Each year, student work is collected from select sophomore, junior, and senior level courses. This student work is assessed by a faculty other than the course instructor. Students are asked to provide a self-assessment using an exit survey, and alumni survey, preparedness surveys in select junior level courses, and



teamwork assessment in a senior level course. In addition, external entities including the Department’s External Advisory Board, external judges for the Department’s Senior Design Symposium and the national Fundamentals of Engineering Exam are used to assess demonstration of Program Outcomes. The total assessment process results in 155 separate data points distributed as follows:

	<i>(number of data points)</i>					
	ME OT 1	ME OT 2	ME OT 3	ME OT 4	ME OT 5	ME OT 6
Assessment by faculty Self	12	13	19	1	1	1
assessment by students	4	52	5	5	3	5
Assessment by external entities	3	27	3	0	0	1

The data are tracked using standard control chart methods, and the control charts are updated, analyzed, and summarized annually. A stoplight chart (attached) has been developed to graphically convey the summary information. The modifications to be implemented in calendar year 2007 are attached in a separate file.

- 3. What efforts has your program/department made to follow students once they have graduated and/or left the university? Please answer separately for undergraduate, masters, and doctoral students.*

Both the Department and College maintain a database of contact information. This information is update when new contact information is available. The information is quite accurate for recent graduates, and considerably less accurate for graduates that left UW some time ago.

Graduates are asked to respond to an online survey in the third and sixth years after graduation. Both this alumni survey and the exit survey are administered by the Dean’s Office. In addition, the Mechanical Engineering Department Head meets one-on-one with each graduating senior to discussion their experiences, future, and specific comments relative to the Department’s educational performance. Results of both the surveys and one-on-one meetings are provided to MEDCIC annually and these results are used as part of the annual assessment process.

- 4. Please respond to the feedback/suggestions provided to you from the Assessment Coordinators last year. What have you done to address these concerns?*

The Department is unaware of any specific feedback from the Assessment Coordinators last year.



5. *What problems, challenges, or issues regarding assessment does your department still have? What can be done for these issues to be resolved within the next academic year? What resources or assistance do you need?*

Last year, the Department faced two challenges: increasing the response rate for alumni surveys, and explanatory comments from the exit survey of graduating seniors. The Department and College implemented an online alumni survey to facilitate survey completion, and hopefully increase response rate. We should now see an increased response rate by Fall 2008 if this modification is successful. The Department Head implemented one-on-one meetings in Fall 2006 with each graduating senior to facilitate explanatory comments. These one-on-one meetings have been quite successful in communicating both positive and negative aspects of a student's experience.

Issues that have been identified from the Calendar Year 2006 (file attached) include poor communication of graphical and numerical engineering information in a sophomore-level course, poor discussion of teamwork issues in a senior-level report, and poor discussion of how engineering solutions integrate with problems from a broader view in a senior-level course. Each of these issues has been discussed by the Department faculty, and a modification to address each issue has been proposed. All modifications are scheduled for implementation by Fall 2007. In addition, MEDCIC has identified areas requiring careful consideration in the Calendar Year 2007 dataset.

The resources are sufficient to administer and implement the annual assessment process in the Mechanical Engineering Department.

Graduate Program: The Department has submitted a "Graduate Program Vision Statement" to the Graduate School. This document was finalized and approved by the faculty during the last academic year. It defines various methods, criteria, and metrics used for internal assessment of the graduate program in the Department of Mechanical Engineering. Reasonable, constructive assessment is vital to the continuing welfare of our graduate program, and this Vision Statement is provided to minimize any ambiguity with regard to this process. Using the verifiable benchmarks described in this document, the Department will conduct a recurring graduate program review that will be interactive, forward thinking, data based, peer-focused and consequential, with the ultimate goal being to improve the overall quality of our graduate program.

11) Accomplishments of the Department

At this point in its history, the department is enjoying a second "renaissance" after the prosperous days of the early eighties. This is due to the hard work of the faculty, the success of our students, and the excellent financial condition of the Wyoming State government. Six faculty members have joined the group since 2001. Our enrollment has been steadily increasing. The number of



archival journal publications has more than doubled since 2000. Last year we received the seventh DoD EPSCoR award since 2000; we believe that this is the highest number of awards received by any eligible department in the US. In addition, our research expenditures have recently exceeded \$100K per faculty.

External Advisory Board -- The most recent meeting of our External Advisory Board took place in Laramie, April 25-26, 2008, with 11 outside and 2 student members in attendance. In addition to numerous requests for information, recommendations, discussion, and action items, the board provided the following commendations:

1. The EAB commends the addition of new professor Dr Carl Frick in the area of experimental mechanics of materials.
2. The EAB commends Dr. Demitris Kouris for selection as an ASME Fellow, the second prestigious ASME Fellow selection in the ME Department.
3. The EAB commends Doctoral student Brian Lockwood for securing a DOE Fellowship in computational fluid mechanics.
4. The EAB commends the Department for its mentoring of junior faculty members as noted by the Dean that all of the professors since 1996 who went through the tenure process succeeded.
5. The EAB commends the Department for initiating the proposed Energy Systems degree program curriculum.
6. The EAB commends the Department's leadership role in working with BP in establishing the Wind Energy Research Center initiative in Dec 2007.
7. The EAB commends the Department and Dennis Coon specifically for using the ABET process and the Department-developed database and tools to track and make continuous improvements.
8. The EAB commends the Department for the 100 percent pass rate for the FE exam in 2007 and a ten-year average 96 percent pass rate, well above the National average.
9. The EAB commends the Department for the high degree of relevance of the Senior Projects to real world problems.
10. The EAB commends the Department for outstanding performance in the National Moon Buggy competition, finishing 4th place in the competition and recognition for the "Most Improved Team".



Appendix: ME Department External Advisory Board Members (As of 4/7/2008)

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CEAS Data by Department OIA AY 06-07 Data

<u>Dept</u>	FTE Faculty (Table #6)				<u>Table #1</u> <u>UG Studs</u>	<u>UG</u> <u>studs/fac</u>	<u>Table #2</u> <u>BS degs</u>	<u>BS</u> <u>deg/fac</u>	<u>Table #9</u> <u>Overall</u> <u>GPA</u>	<u>Table #10</u> <u>Class Size</u>
	<u>Faculty</u>	<u>APL</u>	<u>Res Sci</u>	<u>Total Fac+APs</u>						
ME	11	0.5	1	12.5	259	20.7	35	2.8	2.73	19.1
CE/ARE	16	4	1	21	405	19.3	93	4.4	3.2	17.2
CHE/PETE	13	0	0	13	152	11.7	15	1.2	3.23	13.9
EE	15	1	0	16	178	11.1	29	1.8	3.11	15.2
CS	8.5	3	0	11.5	116	10.1	19	1.7	2.94	22.1
ATM SCI	8	0	2	10	0	0.0	0	0.0	0	8.5
CEAS	71.5	8.5	4	84	1144	13.6	191	2.3	2.97	18.7

Note: The OIA 06-07 data is the most recent available that includes BS degrees awarded