STRATEGIC PLAN
(2008-2013)

DEPARTMENT OF
CIVIL AND ENVIRONMENTAL ENGINEERING

Peggy A. Johnson, Department Head
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CIVIL AND ENVIRONMENTAL ENGINEERING
DEPARTMENT PROFILE

VISION
The Department of Civil and Environmental Engineering will be internationally recognized for excellence in the preparation of undergraduate and graduate engineers through the integration of education, research, and leadership.

MISSION
The mission of the Department of Civil and Environmental Engineering is to prepare students for professional practice, graduate study, life-long learning, societal leadership and to improve the scientific and technological basis for civil and environmental engineering practice. To fulfill this mission, the Department seeks to provide a high quality undergraduate program with instruction in all the fundamental areas of civil engineering, to conduct a distinguished program of research and graduate study in selected areas of civil and environmental engineering, and to disseminate advanced technical knowledge to engineers, other professionals, and the public.

RANKINGS
In 2006, the US News and World Report ranked Penn State’s undergraduate civil and environmental engineering program at number 15 in the country while the graduate program is ranked at number 17. The undergraduate program is the 4th largest in the U.S., in terms of B.S. graduates in spring, 2006. The Chronicle of Higher Education ranked the Penn State CEE department 3rd for Faculty Scholarly Productivity based on the number of books and journal articles published, citations of journal articles, federal-grant dollars awarded, and honors and awards. The two schools ranking higher were Cal Tech and Stanford. The rankings are based on the 2005 Faculty Scholarly Productivity Index for universities with PhD programs and more than 10 faculty.

FACULTY
The current CEE faculty consists of 30 tenured or tenure-track members, 2 of whom are full-time administrators, and another who is a part-time administrator. There are 9 assistant, 8 associate, and 13 full professors. In addition, the department has 3 full-time fixed term faculty members. Diversity on the tenure track faculty is represented by 19% women and 9% minorities. This compares well with the national averages. In the top 50 CE and CEE departments in the country, there are 13% women and 6.6% minority tenure-track faculty. More than half of the CEE faculty are registered PE’s. The faculty is highly productive in terms of scholarly activity, as indicated by the high rank in the Faculty Scholarly Productivity index as well as the annual publication activity. In 2006, the faculty published, or had accepted for publication, 103 articles in peer-reviewed journals. In addition, the faculty presented 135 papers at conferences in that same year.
During the period 2005-2008, representing the prior strategic planning period, a number of faculty left the department and new faculty were hired. Drs. Miller and Krauthammer left due to retirement. Dr. Tikalsky left to pursue a department head position elsewhere. Dr. Sinha, an Assistant Professor, left for a position elsewhere. During that same period, Drs. Gooseff, Kasal, and Palomino were hired.

EDUCATION

The department offers the B.S., M.S., M.Eng., and Ph.D. degrees. According to Job Outlook 2007 (http://www.jobweb.com/joboutlook/), Civil Engineering baccalaureate graduates experienced an average salary increase of 4.8 percent over the previous year to $47,750. Civil Engineering was also listed as one of the top 10 degrees in demand in the U.S. This demand is being strongly felt in Civil and Environmental Engineering at Penn State. Table 2 shows the enrollment trends over the last 23 years. The enrollment in CEE has grown substantially, particularly in the last several years. Due to escalating enrollments, an enrollment cap was approved, and will be effective Fall, 2009. As the number of BS degrees have climbed, the number of graduate degrees, particularly PhD degrees, have decreased. The department currently awards approximately 64 undergraduate scholarships each year.

The CEE department at Penn State is currently the fourth largest in the country, in terms of BS degrees granted. Our ranking in terms of numbers of MS/MEng students graduating from the department is considerably lower, at 87th largest in the country. PhD production is currently at 26th largest. By comparison, Purdue’s Civil and Environmental Engineering department (our closest peer institution and a member of the Big 10) is currently the 3rd largest for BS degrees, 11th largest for MS/MEng, and 2nd largest for PhD. Table 2 shows the numbers of BS, MS, MEng, and PhD degrees granted over the last 23 years. The growth in the CEE program, particularly during the last few years, is evident. Table 3 provides student/faculty ratios for our department along with 6 other department for comparison. The comparison is based on the actual numbers of degrees awarded in 2006. Two of the comparative schools are in the Big 10 and the others are large, similar peer departments. In fact, all of the schools listed in Table 3 are in the top 10 largest BS granting institutions in the country. The CEE department at Penn State is second only to Iowa State in the student faculty ratio at the BS level for 2006. However, the graduate level ratios are considerably lower. The large number of BS degrees awarded per faculty is a strong factor in the ability of a program to produce significant numbers of PhD students. While it is impressive that PSU CEE has continued to produce reasonable numbers of PhD degrees, increasing these numbers is a difficult task when the BS/Faculty ratio remains so high. Overall, the total student/faculty ratio, including both undergraduate and graduate degrees, is higher than all others except for Iowa State. The trends in acceptance rates for the PhD degrees in the Civil and Environmental PhD programs are shown in Tables 4 and 5, respectively. Tables 2-5 provide important statistics to use as metrics for recruitment and retention as well as assessing the success of our research programs.
Table 2. Student enrollment in CEE.

<table>
<thead>
<tr>
<th>Year</th>
<th>Undergraduate Students</th>
<th>Undergraduate Minorities</th>
<th>Undergraduate Women</th>
<th>Graduate Students</th>
<th>B.S. Degrees</th>
<th>M.S. Degrees</th>
<th>M.Eng. Degrees</th>
<th>Ph.D. Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-86</td>
<td>339</td>
<td></td>
<td></td>
<td>103</td>
<td>115</td>
<td>22</td>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>86-87</td>
<td>334</td>
<td></td>
<td></td>
<td>103</td>
<td>122</td>
<td>14</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>87-88</td>
<td>383</td>
<td></td>
<td></td>
<td>95</td>
<td>124</td>
<td>11</td>
<td>22</td>
<td>4</td>
</tr>
<tr>
<td>88-89</td>
<td>427</td>
<td></td>
<td></td>
<td>118</td>
<td>126</td>
<td>14</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>89-90</td>
<td>465</td>
<td></td>
<td></td>
<td>126</td>
<td>161</td>
<td>19</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>90-91</td>
<td>417</td>
<td></td>
<td></td>
<td>134</td>
<td>169</td>
<td>18</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>91-92</td>
<td>469</td>
<td></td>
<td></td>
<td>144</td>
<td>173</td>
<td>25</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>92-93</td>
<td>512</td>
<td></td>
<td></td>
<td>134</td>
<td>149</td>
<td>21</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>93-94</td>
<td>507</td>
<td></td>
<td></td>
<td>145</td>
<td>196</td>
<td>18</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>94-95</td>
<td>505</td>
<td></td>
<td></td>
<td>143</td>
<td>202</td>
<td>26</td>
<td>21</td>
<td>9</td>
</tr>
<tr>
<td>95-96</td>
<td>452</td>
<td></td>
<td></td>
<td>157</td>
<td>153</td>
<td>26</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>96-97</td>
<td>450</td>
<td></td>
<td></td>
<td>161</td>
<td>154</td>
<td>27</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>97-98</td>
<td>454</td>
<td></td>
<td></td>
<td>134</td>
<td>174</td>
<td>18</td>
<td>43</td>
<td>8</td>
</tr>
<tr>
<td>98-99</td>
<td>426</td>
<td></td>
<td></td>
<td>120</td>
<td>143</td>
<td>25</td>
<td>29</td>
<td>17</td>
</tr>
<tr>
<td>99-00</td>
<td>432</td>
<td></td>
<td></td>
<td>129</td>
<td>141</td>
<td>15</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td>00-01</td>
<td>411</td>
<td>18 (4%)</td>
<td>84 (20%)</td>
<td>139</td>
<td>161</td>
<td>17</td>
<td>31</td>
<td>7</td>
</tr>
<tr>
<td>01-02</td>
<td>387</td>
<td>16 (4%)</td>
<td>74 (19%)</td>
<td>152</td>
<td>134</td>
<td>27</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>02-03</td>
<td>362</td>
<td>12 (3%)</td>
<td>70 (19%)</td>
<td>147</td>
<td>140</td>
<td>28</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>03-04</td>
<td>380</td>
<td>24 (6%)</td>
<td>63 (17%)</td>
<td>147</td>
<td>126</td>
<td>34</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>04-05</td>
<td>423</td>
<td>30 (7%)</td>
<td>63 (15%)</td>
<td>128</td>
<td>141</td>
<td>30</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>05-06</td>
<td>466</td>
<td>40 (9%)</td>
<td>63 (14%)</td>
<td>116</td>
<td>163</td>
<td>15</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>06-07</td>
<td>522</td>
<td>19 (3.6%)</td>
<td>66 (13%)</td>
<td>118</td>
<td>177</td>
<td>17</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>07-08</td>
<td>601</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* In previous years, Asian students have been included in the minority status. However, Asian students are not considered minority in Engineering. In 2006-2007, we adjusted our count to exclude Asian students.
Table 3. Student/faculty ratios at peer institutions based on number of degrees awarded in 2006.

<table>
<thead>
<tr>
<th></th>
<th>BS</th>
<th>MS</th>
<th>PhD</th>
<th>No. of Faculty</th>
<th>BS/faculty</th>
<th>MS/faculty</th>
<th>PhD/faculty</th>
<th>Total Degrees/faculty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas A&amp;M</td>
<td>196</td>
<td>37</td>
<td>15</td>
<td>75</td>
<td>2.6</td>
<td>0.5</td>
<td>0.2</td>
<td>3.3</td>
</tr>
<tr>
<td>Purdue</td>
<td>180</td>
<td>56</td>
<td>31</td>
<td>43</td>
<td>4.2</td>
<td>1.3</td>
<td>0.7</td>
<td>6.2</td>
</tr>
<tr>
<td>PSU</td>
<td>171</td>
<td>15</td>
<td>9</td>
<td>30</td>
<td>5.7</td>
<td>0.5</td>
<td>0.3</td>
<td>6.5</td>
</tr>
<tr>
<td>NC State</td>
<td>166</td>
<td>56</td>
<td>13</td>
<td>37</td>
<td>4.5</td>
<td>1.5</td>
<td>0.4</td>
<td>6.4</td>
</tr>
<tr>
<td>GA Tech</td>
<td>156</td>
<td>70</td>
<td>13</td>
<td>52</td>
<td>3.0</td>
<td>1.3</td>
<td>0.4</td>
<td>4.9</td>
</tr>
<tr>
<td>Iowa State</td>
<td>156</td>
<td>25</td>
<td>10</td>
<td>23</td>
<td>6.8</td>
<td>1.1</td>
<td>0.4</td>
<td>8.3</td>
</tr>
<tr>
<td>VA Tech</td>
<td>145</td>
<td>81</td>
<td>19</td>
<td>47</td>
<td>3.1</td>
<td>1.7</td>
<td>0.4</td>
<td>5.2</td>
</tr>
<tr>
<td>U.Illinois</td>
<td>112</td>
<td>101</td>
<td>25</td>
<td>52</td>
<td>2.2</td>
<td>1.9</td>
<td>0.5</td>
<td>4.6</td>
</tr>
</tbody>
</table>

Table 4. PhD accepts and degrees for Civil Engineering.

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Percent Accepts</th>
<th>GRE median Verbal</th>
<th>GRE median quantitative</th>
<th>Number PhD Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-2002</td>
<td>15</td>
<td>650</td>
<td>790</td>
<td>3</td>
</tr>
<tr>
<td>2002-2003</td>
<td>28</td>
<td>370</td>
<td>780</td>
<td>9</td>
</tr>
<tr>
<td>2003-2004</td>
<td>12</td>
<td>610</td>
<td>750</td>
<td>11</td>
</tr>
<tr>
<td>2004-2005</td>
<td>30</td>
<td>480</td>
<td>700</td>
<td>9</td>
</tr>
<tr>
<td>2005-2006</td>
<td>23</td>
<td>500</td>
<td>770</td>
<td>8</td>
</tr>
<tr>
<td>2006-2007</td>
<td>28</td>
<td>470</td>
<td>760</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 5. PhD accepts and degrees for Environmental Engineering.

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Percent Accepts</th>
<th>GRE median verbal</th>
<th>GRE median quantitative</th>
<th>Number PhD Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-2002</td>
<td>25</td>
<td>650</td>
<td>790</td>
<td>2</td>
</tr>
<tr>
<td>2002-2003</td>
<td>29</td>
<td>610</td>
<td>750</td>
<td>2</td>
</tr>
<tr>
<td>2003-2004</td>
<td>13</td>
<td>650</td>
<td>790</td>
<td>6</td>
</tr>
<tr>
<td>2004-2005</td>
<td>36</td>
<td>480</td>
<td>700</td>
<td>5</td>
</tr>
<tr>
<td>2005-2006</td>
<td>37</td>
<td>500</td>
<td>770</td>
<td>2</td>
</tr>
<tr>
<td>2006-2007</td>
<td>5</td>
<td>500</td>
<td>770</td>
<td>2</td>
</tr>
</tbody>
</table>
STUDENT ORGANIZATIONS

There are numerous student organizations in which our students can participate. These are briefly described below.

- **American Society of Civil Engineers (ASCE).** ASCE is the professional Civil Engineering society, with a student chapter open to freshmen and sophomores interested in the organization and all students enrolled in civil engineering. Approximately 220 of our students are involved in this organization. Chapter activities include concrete canoe races and steel bridge competitions.

- **Chi Epsilon.** Chi Epsilon is the national honor society for juniors and seniors enrolled in Civil and Environmental Engineering. Membership is by invitation and is based on scholarship, character, practicality, and sociability. The purpose of this organization is to recognize and develop the fundamental characteristics of the successful civil engineer. The students oversee and coordinate FE reviews and tours for high school students, and active encourage members to develop community service teams. There are 55 members in our department.

- **American Concrete Institute (ACI).** The ACI student chapter is open to any student interested in concrete structures or materials. Activities include competitions, guest speakers from the concrete profession, and certification opportunities.

- **National Association of Home Builders (NAHB).** The (NAHB) Student Chapter is a focus for students interested in housing, light commercial construction, and development. It provides students with the opportunity to learn more about the housing industry.

- **Environmental Engineering Society (EES).** EES organizes activities and programs that address environmental issues. Students participate in environmentally responsible projects and network with students and alumni who are involved in environmental engineering.

- **Institute of Transportation Engineers (ITE).** ITE is a professional organization of students who are interested in transportation and traffic engineering. A number of meetings are held each year, with representatives of transportation firms and agencies serving as guest speakers.

- **Intelligent Transportation Society (ITS).** ITS promotes the understanding and interest in the application of advanced technologies to transportation systems. Chapter members investigate issues ranging from user needs to the potential benefits of advanced technologies toward transportation in Central Pennsylvania.

RESEARCH

**Annual Research Expenditures**

Over the past five years, the CEE department has maintained a stable research base, as indicated by the annual research expenditures. Research expenditures are approximately $9.5 million annually. As a point of comparison, the CEE department research expenditures in FY 2005 ranked the 11th largest research expenditures of all CE and CEE departments in the country. This is an impressive ranking, given the very high student-faculty ratio compared to the 10 schools
with higher research expenditures and considering the imbalance of undergraduate and graduate student degrees.

**Research Centers**

The Department of Civil and Environmental Engineering maintains two dynamic, state-of-the-art research centers. The Pennsylvania Housing Research Center (PHRC) promotes better and more affordable housing for Pennsylvanians. The Pennsylvania Housing Research Center and the Bernard Hankin Construction Engineering and Management Research Laboratory provide a focal point for residential construction research. Dr. Bo Kasal is the current director. The Protective Technology Center (PTC) was established prior to the events of 9/11 to focus research and development activities on the goal of protecting people and infrastructure from terrorist attacks. The center encourages the use of multi-disciplinary research teams to address problems related to blast, shock, impact, and biological terrorism related concerns. The current director is Dr. Andrea Schokker.

**FACILITIES**

The Civil and Environmental Engineering department is currently housed in the Sackett Building (built in 1928) with additional offices and laboratory space at the Pennsylvania Transportation Institute (PTI) and Cato Park. The graduate student and faculty office space and the laboratories at Cato and PTI have served the department well. However, the current condition of the Sackett Building is substandard. Discussions regarding the pressing need for renovations in Sackett have begun; however, there is currently no university plan to upgrade the building. There are substantial issues with heat (or lack thereof), leaks, windows, and other unacceptable characteristics that result in a substandard working environment. More importantly, there are safety issues that are a major concern, such as multiple incidents of steam pipes bursting in staff and student offices, crumbling asbestos, etc. The building is unsafe and certainly not meeting the spirit of sustainable design and green engineering that has been embraced for all new construction on campus. An energy audit conducted in 2006 (Matson, et al., 2006) revealed that the inefficiency of the building envelope contributes to more than $30,000 in energy losses per year, primarily through air infiltration and losses through the windows. Overall, the substandard condition of the building has caused our faculty, staff, and graduate students to work at less than maximum efficiency and productivity. Our lab supervisor spends a great deal of his time on these problems, graduate students and faculty are displaced from their offices on a regular basis because of these issues, and a high risk of loss of intellectual property exists due to leaks, flooding, and pipe bursts.

In recent years, departmental upgrading efforts have been focused on improvements to the Civil Infrastructure Testing and Evaluation Lab (CITEL) at Cato Park to create a high quality research facility. This is a heavily used facility, with 30 graduate students and 10 CEE faculty members conducting research there. CITEL includes the structures lab, concrete materials lab, composites lab, wheel load simulator, corrosion lab, grouting lab, FRP lab, multiple large scale environmental chambers for evaluation of materials under extreme environments, a Mobile Model Load Simulator, nondestructive testing devices, asphalt mixer and oven, and computing lab. In 2007, a crane was purchased for use in all areas of research at the facility. The CITEL facility also houses the Protective Technology Center, Pennsylvania Housing Research Center, the Transportation Infrastructure Program, and a variety of student activities, including the solar decathlon, steel bridge, and concrete canoe.
CIVIL AND ENVIRONMENTAL ENGINEERING
STRATEGIC PLAN AND GOALS FOR 2008-2013

PLANNING PROCESS

One of the methods used to determine strategic goals for the department was a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. A SWOT analysis is a management tool that is used as the first step in formulating a strategic plan. Strength and weakness are internal factors that can be addressed by the department. Opportunities and threats are considered to be external factors over which the department has little control, but have direct impacts on the departmental success. (Williams, C. et al., 2001. Managing Organizations: BA 304. Pennsylvania State University). The SWOT analysis for the Civil and Environmental Engineering department was performed by the three guiding committees in the department: Promotion and Tenure, Undergraduate, and Graduate. This involved 18 tenure-track faculty, or 64% of the current faculty (not including the department head and Dean Mason). A faculty retreat was then held, in part, to discuss the results of the SWOT analysis and to develop a plan based on that information.

In order to understand planning needs for the staff and office management, a separate SWOT analysis was conducted by the 12 members of the CEE staff, including laboratory and IT staff. Following that exercise, a management study of the staff support functions was conducted by Management Engineering of the Penn State Office of Human Resources. Meetings were held with the staff to identify work activities and to determine improvement opportunities.

The CEE program group coordinators also provided input and worked with their respective faculty to develop future research thrusts. Finally, separate meetings were held with the Assistant and Associate Professors and one faculty meeting was focused on a review of the draft plan. Input based on the SWOT analyses, the group coordinator input, and the faculty meetings were used to develop and finalize this strategic plan. Following completion of the draft, the entire faculty was given an opportunity to provide critical reviews of the document and it was revised according to the collected comments.

As with any planning document, this strategic plan becomes a living document that should be continually updated and amended as unforeseeable events, such as faculty departures, funding opportunities, and budget cuts, occur.

GOALS AND STRATEGIES

Based on the results of the SWOT analyses, as well as discussions that followed, the following strategic goals were developed to address critical areas identified through this process:

Goal 1: Education. Be nationally and internationally recognized leaders in educating high quality engineers.
Goal 2: Research and Discovery. Further advance a nationally and internationally distinguished research program.

Goal 3: Quality Improvement. Promote continual development in quality at all levels.

Goal 4: Development. Expand alumni and corporate relations to increase support for CEE.

A five-year action plan has been developed using the following strategies to meet each of the four goals.

Strategies to meet Goal 1: Education
- Strategy 1 → Improve the recruitment of high quality graduate students.
- Strategy 2 → Improve the diversity of the student body.
- Strategy 3 → Revise the undergraduate curriculum to meet needs of the profession.
- Strategy 4 → Restructure the MEng program to a high quality, one-year degree.

Strategies to meet Goal 2: Research and Discovery
- Strategy 5 → Develop high impact research initiatives.
- Strategy 6 → Improve faculty retention efforts.
- Strategy 7 → Improve facilities to enhance support for research.
- Strategy 8 → Enhance the graduate research program.

Strategies to meet Goal 3: Quality Improvement
- Strategy 9 → Implement new department organization to support strategic plan.
- Strategy 10 → Improve departmental visibility.

Strategies to meet Goal 4: Development
- Strategy 11 → Enhance alumni relations and development activities.

**Strategy 1 → Improve the recruitment of high quality graduate students**

Each Spring, the College of Engineering hosts a graduate open house, the purpose of which is to recruit outstanding students who have already been accepted to the various Engineering programs, and to whom funding may be offered. While this has been a successful event for applicants at the acceptance stage, we have not done a good job of recruiting students who have not yet applied. In Fall, 2007, the CEE department, along with MNE and EE, conducted a competitive graduate program workshop for outstanding students from college and universities in PA as part of the Council of Graduate Schools funding for the Penn State Graduate School PhD Intervention Program.

Action Plan: Beginning in 2008 or 2009, in collaboration with COE, a fall recruiting event will be combined with the existing Graduate Research Symposium as a way to continue to recruit outstanding students into our graduate programs. Statistics that are indicative of the success of this new program will be maintained by our graduate programs office. Those statistics include attendance at the event, percent applying, percent accepted, minority and women percents, GRE scores, etc. Assessments will be ongoing to determine the success of this event in terms of how many attendees apply, are accepted, and provided funding. We will also track the success rates of minorities and women.
Measurements:
- Quantifiable assessments of admitted students including grade point averages and performance on GRE’s
- Quantifiable feedback from students and the professional community regarding the quality of students
- Number of students attending recruitment events
- Number of students applying and accepting admission
- Increase in graduate program rankings

**STRATEGY 2 → IMPROVE THE DIVERSITY OF THE STUDENT BODY**
The diversity of our undergraduate and graduate student body is critical to providing civil engineering practice with an adequate pool of well educated engineers. Diversity in the classroom and in practice is a key to providing a workforce that is capable of solving increasingly complex global and societal problems. In addition, diversity in the classroom and workplace improves the climate for learning and creative problem solving. As shown in Table 2, the diversity among the undergraduate students has been decreasing. Although this is a national trend, it signals the need for strong and immediate action. During the last strategic planning cycle, work was begun to analyze our student population data, take part in a COE Diversity Committee that is partly focused on this evolving issue, meet with Admissions Officers to determine trends in applications and admissions, and redesign our departmental website to appeal to a broad range of students.

**Action Plan:** A departmental diversity and climate committee will be established, work with the COE Diversity committee will be continued, and discussions with officials of ASCE who are involved in diversity issues will take place. We will also continue to upgrade our website to highlight the social relevance of Civil and Environmental Engineering, which has been shown to appeal to a broader range of students, including women and minorities. We will update our core curriculum to also address the social aspects of CEE, such as sustainability and global issues, as discussed below in Strategy 3. A proposal will be submitted to the Leonhard Center to obtain support for this program.

Measurements:
- Number and proportion of women and minority students

**STRATEGY 3 → REVISE THE UNDERGRADUATE CURRICULUM TO MEET NEEDS OF THE PROFESSION**
A review and possible revision of our core curriculum is needed to meet the needs of a global and rapidly changing profession and to maintain our high standards that has us annually in the top 20 Civil and Environmental Engineering departments in the country. According to a report from the National Academy of Sciences on the Engineer of 2020, by 2020 engineers will need a set of skills that include strong analytical skills, practical ingenuity, creativity, communication, business and management, leadership, professionalism, versatility, and be lifelong learners. ASCE has recently published a list of 28 “outcomes” that CE students need, which include math, physics, science, social science, humanities, mechanics, materials, CE breadth, tools, problem solving, design, experiments, contemporary issues, risk and uncertainty, sustainability, project management, technical specialization, history and heritage, communication,
globalization, ethics, business, public policy, teamwork, leadership, lifelong learning, and attitudes.

**Action Plan:** We will conduct a review of the curriculum, focused on the core, lab experiences, and capstone courses, to assess our ability to meet the needs as specified by the NAS and ASCE within the two years that we have our undergraduate students in the department. The undergraduate curriculum committee will conduct the initial review and develop recommendations that will then be discussed with and voted on by the entire faculty. The ability to meet ABET requirements will be a necessary part of those discussions. In addition, our surveying course, CEE 310, will be reviewed and updated according to current needs in the profession. In addition to the curriculum revision, we will develop and implement a construction management minor or certificate at the undergraduate level, which will be administered within the Sustainable Civil Infrastructure group. This area of civil engineering is in tremendous demand in the profession and very popular with our students and alumni. There would likely be a need for a new fixed-term faculty position to teach the courses and manage the minor or certificate.

**Measurements:**
- Quantifiable feedback from students, faculty, and employers
- Student evaluations of instructors and courses
- Quantifiable assessment of the curricula based on feedback from alumni, employers, and students
- Number of students involved in minors and certificate programs

**STRATEGY 4 → RESTRUCTURE THE MENG PROGRAM TO A HIGH QUALITY, ONE-YEAR DEGREE**

The requirements for the Civil and Environmental Engineering students identified by the NAS and ASCE as described in Strategy 3 cannot likely be met within a 4-year BS degree. In addition, the CEE profession is moving toward the MS degree as the entry-level professional degree. The requirement for licensure, a necessity for civil engineering practitioners, is also moving toward the MS or 30 credits beyond the BS degree as the minimum. Thus, it is clear that practicing civil engineers will soon need to hold a master level education in order to sit for the PE exam.

**Action Plan:** We will examine the possibility of restructuring our current MEng program to more closely reflect the changing needs of the profession. A one-year MEng degree in CEE will be developed by the graduate committee in the department and then proposed to the entire faculty for review and approval. This degree may have an emphasis on general civil engineering and/or specialty areas. Factors that will determine whether the degree will be implemented include financial enhancements based on student enrollment, entrance requirements, adequacy of the facilities, and instructional capacity. These factors must be satisfied prior to implementation.

**Measurements:**
- Quantifiable feedback and assessment from students, faculty, and employers
- Number of students enrolled in the program
- Financial income generated by the program
**STRATEGY 5 → DEVELOP HIGH IMPACT RESEARCH INITIATIVES**

During the next five years, we will focus on 4 new and continuing research initiatives: (1) Sustainable Civil Infrastructure; (2) Water, Energy and the Environment; and (3) Transportation Systems.

*Sustainable Civil Infrastructure.* The infrastructure of the built environment includes bridges, roads, transit, airports, water, water treatment, dams, navigation, and other public works. According to the ASCE, an estimated $1.6 trillion is needed over the next five years to bring the nation's infrastructure to an acceptable condition. Over the next several years, NSF will focus on the intelligent renewal of civil infrastructure systems in the built environment, promotion of advanced information technologies to condition assessment, deterioration, and asset management sciences, and intelligent design, construction, maintenance, operation and decommissioning of the built environment. The US EPA has as a strategy for the period of 2008-2011 to sustain and secure the network of pipes and treatment facilities that constitute the nation’s water infrastructure, adopt sustainable management practices, and increase water efficiency. NSF has recently announced the 2008 Emerging Frontiers in Research and Innovation (EFRI). One of the two key topic areas is Resilient and Sustainable Infrastructure which focuses on an integrative and interdisciplinary approach. The PSU department of Civil and Environmental Engineering is well situated to respond to these sustainable civil infrastructure research needs.

Civil Engineering Materials deals with the development, characterization, and specification of materials that are used in civil engineering infrastructure construction. Materials research has a long history in CEE, including materials ranging from concrete to pavements to polymers. Materials research can result in vastly improved production efficiency and environmental impacts. The Penn State Materials Research Institute provides an excellent environment for collaboration. Many current faculty members from all areas of CEE are members of MRI. There is a clear need for future research in materials that ties to improvements in all other research areas within the sustainable civil infrastructure framework.

Another important aspect of sustainable civil infrastructure is the protection of the U.S. infrastructure, including water supply, bridges, and transportation routes. Research has an important role in developing better means to detect terrorist threats and protect vital civil infrastructure. Given the vastness of the U.S. surface transportation system, it is unrealistic to try to protect all of the bridges, tunnels and transportation terminals in the country. However, understanding how the disruption or loss of service from which facilities would harm these vital networks is important in developing threat detection and protection strategies. Large scale simulations of people and goods movements on these networks would significantly aid in performing this task. The US EPA has included the abilities of utilities to plan for, prevent, detect, and respond to security threats as an important aspect of their strategic plan.

Examples of collaborative research activities that may be pursued in the area of Sustainable Civil Infrastructure are:

- continued rehabilitation and construction of pavements as alternative fuel vehicles decrease the supply of asphalt;
- sustainability and structural resistance of infrastructure to extreme events;
• bridge engineering processes, including material selection, analysis, design, construction, health monitoring and condition assessment;
• reliable methods for evaluating and treating conditions at bridge foundations;
• improvement of computational and experimental tools to examine component and system performance
• energy-efficient methods for processing and placing asphalt and concrete materials;
• micro-mechanics of materials, smart materials, structural health monitoring, constitutive modeling, numerical modeling, and/or recycling of materials;
• continued development of engineered materials, such as soils, and smart materials with application/property-specific design;
• continued development of advanced methods for recycling asphalt concrete, portland cement concrete and other cemented materials into new structures;
• advanced composites, concretes, steels and polymeric materials for structural components and systems; and
• creation of more durable structural components by improving material corrosion resistance; and the use of recycled materials, such as automotive tires, pozzolans, and glass in various structural applications.
• design and retrofit of structures and materials to resist shock and impact loads;
• modeling of blast waves by computational fluid dynamics for use with structural finite element modeling;
• response characterization of infrastructure systems of unique geometry;
• development of fiber optic sculptured thin film (STF) sensors for detection of a wide variety of environmental contaminants;
• protection of vulnerable municipal and irrigation water resources via predictive models of contaminant transport downstream to determine when is it safe to use again, how long will it take to clear, and where will it go in coastal waters;
• potential of sensor, information and communication, and notification technologies to meet the demands placed on the transportation system because of new security requirements; and
• prioritization for the protection of critical infrastructure relative to the continued operation of essential national and regional transportation networks.

Water, Energy, and the Environment. Sustainability of the engineered or built environment is a function of our ability to provide safe drinking water, long-term energy, and a minimally disturbed ecological environment. Although there are many definitions of sustainability, sustainable design can be defined as a design that meets the needs of the present without compromising the ability of future generations to meet their needs in terms of resources, flexibility, and economics (from Brundtland (1987), World Commission on Environment and Development (WCED). Our Common Future. Oxford University Press, 43 pp. http://www.brundtlandnet.com/brundtlandreport.htm). Clearly, water, energy, and the environment are essential aspects of this definition in terms of civil engineering design, as efficient utilization and appropriation of energy resources reaches all branches of civil engineering. Examples of collaborative research activities planned in the area of water, energy, and the environment include:
• recycled and green materials in structural components, such as the use of recycled admixtures in advanced cementitious materials for buildings and bridges and recycled steels;
• numerical modeling of coastal and estuarine waters in order to determine their response to climate change;
• study of the linkages between hydraulics and biological abundance and productivity;
• integration of systems analysis in hydrologic modeling for improved water resources decision making;
• development of strategies for a more integrated approach to terrestrial water resources and predictive capabilities of climatic and hydrologic extremes;
• bioenergy production, including biomass conversion to various energy carriers, including hydrogen, methane or electricity, and alternative fuels such as biodiesel;
• environmental impact and sustainability of structural engineering projects; and
• stream and watershed dynamics related to water quality protection, including total maximum daily load (TMDL) analyses, remediation technologies for industrial and agricultural systems, and modeling water quantity and quality at the watershed scale.
• bioremediation, including the development of innovative, microbially-mediated technologies for the treatment of soil, groundwater, and surface water pollutants.

In addition to the areas listed above, current engineering educational research in the hydrology area will be expanded to improve hydrology education through a new modular curriculum for hydrologic advancement.

Transportation Systems. The nation’s highway infrastructure is evolving to a new level of sophistication that is leading to a need for innovative analyses methods, sustainable design, and systems engineering. Transportation networks are increasingly influenced by advanced technologies that require frameworks extending beyond the conventional systems approach. In addition, there continues to be a need for high quality research in the area of mobile source pollutant emissions. The U.S. DOT has set strategic initiatives related to safety, mobility, global connectivity, environmental stewardship, and security for the near future. Examples of research planned that may be pursued in the near future include:

• innovative analysis methods to mine data from new technologies, including vehicle position sensors, vehicle performance metrics, and driver behavior measures, for safety analyses and efficient system utilization;
• collaborative research on vehicle emission factor models; and
• network performance measurement.

Action Plan: We will continue to seek new industrial research collaborations as well as collaborative opportunities within and outside of the university in order to increase the CEE research base. New research areas within the PTC will be explored as described above to create additional collaborations with academics and industry and to expand the center’s research base. We will continue efforts to collaborate with existing institutes, particularly the Materials Research Institute and the Penn State Institute of Energy and the Environment. New faculty hires will be focused on these areas.
Measurements:
- Number of research project
- Diversity of funding sources by funding agency
- Quantity of external funding
- Number of peer-reviewed journal publications
- Impact of publications as measured by citations, awards, and other recognition methods
- Number of faculty and students actively involved in center activities
- Number and dollar amounts of research conducted at centers
- Faculty hires in strategic areas

Strategy 6 — Improve Faculty Retention Efforts and Increase Faculty Size
In recent years, the CEE department has made tremendous efforts and has done an outstanding job of recruiting a high quality, diverse faculty. As a result, our junior faculty, represented by these hires, is second to none in the world. Many of the strategies laid out in this plan will help us continue to recruit the highest quality faculty. However, less has been done to retain our faculty. In the past, some have left to become department heads elsewhere, to live closer to family, or to take positions that are perceived to be better in some way. We want to retain our faculty because of their high level of productivity, tremendous service to the department, university, and profession, and their importance as part of our CEE team. But we can also look at the very high cost of replacing faculty members. In the current budget climate, when a faculty member leaves the college, we are “taxed” about 1/3 of that faculty member’s salary, whereas prior to this time, the entire salary line was left in the department. This means that we cannot bring in a new person at higher than an Assistant Professor rank, and do not have an adequate means to save for the start-up package. Advertising, interviewing, moving, and start-up costs are enormous, typically exceeding $200,000 per hire. Therefore, retaining our faculty is not just good for our morale, it is an economic necessity and the best way to uplift the department to where it could be by retaining the best and brightest. In addition, our actual faculty size has decreased in recent years as a result of the budget cuts. Faculty expansion is an important part of a department’s growth and critical to retaining good faculty. Given the potential impact that our faculty has on our rankings as they take on leadership roles in their technical research and professional service, expanding and retaining our faculty can help our rankings improve and is crucial for the growth and advancement of our department. One of the critical points in faculty retention appears to occur around the tenure time and into the early years of the Associate Professor rank and so special attention should be given to that period.

Action Items: Over the next five years, we anticipate that we will have several retirements. One current opening is to be filled in the Sustainable Civil Infrastructure area in Fall, 2008. In addition, over the next five years, we plan to increase our total faculty membership through recycling money supplied by the college and university in support of the decreased faculty numbers and plans for expansion in research and the graduate program. An additional hire in the Sustainable Civil Infrastructure (Materials) and/or Water, Energy, and the Environment areas is possible as the result of the Energy initiative ongoing across the campus. We will also discuss the possibility of several fixed term appointments to assist in undergraduate teaching as well as conducting scholarly activities. As part of enhanced retention efforts, we will work with the COE to fund Development Chairs for faculty geared toward the newly promoted Associate Professor rank. These will be similar in nature to the Development Chairs created for
recruitment. Such chairs are typically held for about 3 years and supply the faculty member with money that can be used for travel, to pursue new initiatives, and attend workshops. In addition, development workshops for Associate Professors, which were started in this past year, will continue, with 1-2 conducted each year. The subject of the workshops vary, but will include such topics as expectations for promotion to Full Professor, gaining visibility, networking, establishing new collaborations, and finding balance.

**Measurements:**
- Faculty retention rate
- Number of tenure-track faculty
- Improvements in rankings
- Numbers of PhD and MS graduates

**STRATEGY 7 → IMPROVE FACILITIES FOR SAFE AND EFFICIENT UTILIZATION**

Major renovation of the Sackett Building is needed. The immediacy of this need is highlighted by the increasingly unsafe working conditions in parts of the building, the high level of energy usage for the building, and the overall poor working conditions for staff, faculty, and students. With a major energy initiative in progress on this campus, it is not only embarrassing for a Civil and Environmental Engineering unit to be housed in such a way, but unacceptable in terms of safety and working conditions. Without these improvements, faculty, staff, and graduate students will continue to experience disruptions in their work, productivity and efficiency will be negatively impacted, and unsafe conditions will remain. Continued improvements at CITEL are also warranted based on the percentage of our faculty and graduate students who use this facility.

**Action Plan:** We will continue to press for renovations of the Sackett Building. Given the safety and climate issues, it will not be acceptable to continue with minor upgrades and “bandaid” solutions. At a minimum, the following are needed: steam pipe replacements (this is a major safety issue), complete asbestos removal (this is a major safety issue and removal of much of the asbestos is in progress), steam pipe insulation, tuning and repair of the HVAC system, electrical upgrades to include grounded outlets, complete window replacement, and lighting upgrades. A Safety Audit should be completed by the first quarter of 2008. Work identified by the safety audit should be complete by first quarter 2009. We will also explore the relocation of the remaining pavements laboratory at PTI to CITEL to allow for enhancement of materials research, particularly in the asphalt mixtures area. This will substantially enhance productivity and efficiency to have the entire laboratory situated in one location along with other materials labs. Other specific needs for the operations at the Civil Infrastructure Testing and Evaluation Lab are an impact hammer and expanded strong floor and reaction wall.

**Measurements:**
- Number of hours spent on building-related maintenance by the laboratory supervisor
- Number of hours that faculty, staff, or graduate students are displaced from work stations
- Safety record
- Qualitative feedback from external visitors
- Funding related to lab facilities at CITEL
- Publications based on CITEL related research
STRATEGY 8 → ENHANCE THE GRADUATE RESEARCH PROGRAM

The CEE department has a lively and productive graduate program. Considering the strength of the graduate faculty and the desire to recruit and retain high quality graduate students and faculty, enhancements to the graduate program could improve our rankings and gain recognition as one of the premier graduate programs in the world. As the undergraduate enrollment cap takes effect in 2009, we will place more emphasis on our graduate program.

**Action Plan:** Enhancements to the graduate program will begin with an in-depth review by a panel of outside reviewers. Researchers from high ranking CEE departments representing the different areas within CEE will be asked to conduct the review. The members of the panel will be selected by the Graduate Committee and the Department Head. The report culminating from this review will then be the basis of our enhancements. In addition to increasing the quantity and quality of our graduate students, improvements to the graduate curriculum may be realized along with other possible enhancements, such as restructuring of the admissions review process, candidacy and comprehensive exams, funding mechanisms, and review processes and other interventions to expedite student enrollment time.

**Measurements:**
- Number of MS and PhD students graduating per year
- Number of MS and PhD students per faculty member
- Time to completion for MS and PhD students
- Graduate program rankings

STRATEGY 9 → IMPLEMENT NEW DEPARTMENT ORGANIZATION TO SUPPORT STRATEGIC PLAN

Based on the results of the office assessment conducted in 2007 and the initiatives set forth in this strategic plan for education and research, an organizational reform will be conducted to enhance our ability to accomplish our objectives. The office assessment showed that minor changes to operations involving the lab and computer facilities and maintenance could produce a more efficient system, especially given the large workload overseen by the computer and laboratory technicians.

**Action Plan:** Recommendations from the office assessment report will be implemented, primarily in the computational and laboratory sectors. A project tracking system will be developed for the work performed by staff involved in facility operations. This will provide accurate cost accounting for completed projects, historical data that could be used to forecast time availability for up-coming work, and data to ensure that resources are allocated in line with department priorities. In addition, sample preparations could be evaluated for cost comparison for outsourcing. A work request tracking system for the duties of the IT staff will also be developed to process work requests more efficiently, document and track major projects to monitor status of implementation milestones, and provide historical data to determine time available for projects and routine work. A computerized system will be maintained for equipment management to track equipment maintenance actions and to forecast preventative maintenance or replacement needs, assist in prioritizing and planning the activities of all staff involved in equipment maintenance and operations, and develop and maintain a comprehensive IT tracking database to assist in the technology planning process.
Measurements:
- Quantifiable assessment of efficiency in facilities requests, IT support, processing of graduate applications, and other staff duties identified in the report.

**STRATEGY 10 → IMPROVE DEPARTMENTAL VISIBILITY**

The CEE department has a world class faculty, a highly rated research program, and undergraduate and graduate programs that consistently rank in the top 20 of all CE departments in the country. Increased visibility of the departmental research and educational activities will largely bring attention to the department that will improve our student recruiting efforts, alumni support, and research opportunities. During the past year, the CEE website underwent significant improvements to update our appearance and provide a far more efficient web flow. The website will require constant updating to maintain relevance to undergraduates, graduates, alumni, and those seeking information on our research activities. We also currently publish an annual newsletter that is distributed to all alumni and send out press releases to newspapers and other sources. In a 7-month period in 2007, we averaged 3 press releases per month that represented 5 of our faculty members.

**Action Plan:** In order to elevate our departmental visibility over the next five years, we will consider increasing the number of press releases and the number of faculty represented by those releases by establishing an awards and news committee. The newsletter will be continued and will be tied to the website and press releases. An updated newsletter layout will be explored that highlights the educational and research initiatives described in this plan. Although an alumni section is already on our website, it will be expanded to include relevant news and activities for the alumni, including participation on IPAC and the newly established Alumni Advisory Board. The newsletter will remind alumni to check the website. A section will be added to the website for listing recent publications and projects of all faculty members in the department. Faculty holding leadership positions in professional societies also provide significant visibility for the department. Methods for encouraging and supporting faculty participation in appropriate technical and professional society activity at leadership levels will be explored and implemented.

Measurements:
- Number of press releases
- Number of faculty represented in press releases
- Number of faculty in professional leadership roles
- Undergraduate and graduate rankings
- Number of graduate students presenting papers at conferences
- Number of hits on the website

**STRATEGY 11 → ENHANCE ALUMNI RELATIONS AND DEVELOPMENT ACTIVITIES**

The university has requested a 1% budget recycling from each department annually over the 5 years of this plan to help offset the costs of health insurance and rising salaries. In addition, for the first time in recent history, partial salaries of faculty who retire or leave the university are being returned to the college so that only a portion of the original salary is maintained in the department for future faculty positions. It is assumed in this plan that both of these practices will
continue over the 5 years of this plan. The annual decrease in the amount of money available to
the department is being felt in all aspects of departmental life. Thus, the need for increasing
development activities has never been greater.

Currently, funds are being solicited from CEE alumni through the COE development office. In
Fall, 2007, the CEE Academic Enrichment and Excellence Fund was endowed by two generous
gifts of $50,000 each from our alumni. This fund is critical to the healthy operation of this
department in that it provides discretionary funding that can be used to provide support for
rewarding excellence and developing initiatives in research and educational activities that meet
the objectives of our vision and mission.

**Action Plan:** In order to reach goals described in this strategic plan, a development plan will be
developed in cooperation with the COE development office. The plan objectives will include the
financial goals and methods for targeting alumni and companies. The CEE office staff will be
reorganized so that the current bookkeeper position will have development duties as part of
his/hers responsibilities. Ties with alumni through IPAC, OEA, and faculty contact will be
strengthened in to promote our development needs. Activities to increase ties with both the
alumni and corporations will include creating an active Alumni Advisory Board which will have
development as a focus, hosting annual alumni reunions, organizing receptions for targeted
alumni in nearby cities, and inviting alumni to our events, such as the undergraduate scholarship
banquet.

**Measurements:**
- Number of donations per year
- Amounts of annual giving
- Annual expansion of endowment for the Academic Enrichment and Excellence Fund
- Increase in number of scholarships
- Quantitative feedback from alumni, advisory council, IPAC
RECYCLING AND FACULTY LINE SALARY CUTS

The current financial climate of the university and college calls for a 1% budget cut each year and significant cuts to faculty salary lines as faculty leave the university. These cuts will negatively impact the ability of the Civil and Environmental Engineering Department to sustain current and past levels of activity, achieve the goals of this plan, and remain a highly rated program. A Financial Planning Committee, consisting of the department head, administrative assistant, bookkeeper, and a selected faculty member, will be established to create several options for a budget model that can help us to best sustain our program while development activities are ongoing. We will examine the use of buyout money, increased revenue from the possible MEng program, and the use of development money as ways to improve the financial situation. However, given the very high student (especially undergraduate) to faculty ratio compared with our peer institutions as well as some of the departments within the College of Engineering at Penn State, sustainability of our current productivity and retention of our excellent faculty will require additional faculty positions and return of recycled money from the college and university to be used for faculty salaries.
**APPENDIX**

**Table A-1.** The CEE faculty as of January 3, 2008.

<table>
<thead>
<tr>
<th>Faculty Name</th>
<th>Title</th>
<th>Area of Specialization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brennan, Rachel A.</td>
<td>Assistant Professor of Environmental Engineering</td>
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<td>Burgos, William</td>
<td>Associate Professor of Environmental Engineering</td>
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<td>Cannon, Fred</td>
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<td>Chehab, Ghassan</td>
<td>Assistant Professor of Civil Engineering</td>
<td>Pavements</td>
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<td>Dempsey, Brian</td>
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<td>Donnell, Eric</td>
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<td>Professor of Civil Engineering</td>
<td>Water Resources</td>
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<td>Jovanis, Paul</td>
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<td>Kasal, Bo</td>
<td>Professor of Civil Engineering and Hankin Chair of Residential Building Construction</td>
<td>Construction Management; Structures</td>
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<td>Laman, Jeffrey</td>
<td>Associate Professor of Civil Engineering and Professor in Charge of Graduate Programs</td>
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<td>Mason, John Jr.</td>
<td>Associate Dean of Graduate Studies and Professor of Civil Engineering</td>
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<td>Matson, Jack</td>
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<td>Pietrucha, Martin</td>
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