Preface and Executive Summary

Engineering enrollments in the United States have declined by 8% since a peak in 1983 (Engineering Workforce Commission), while the overall population in the U.S. has increased 25% during this time (U.S. Census Bureau). And, yet, engineering disciplines represent half of the top 10 degrees in demand by employers (National Association of Colleges and Employers). Moreover, studies such as Rising Above the Gathering Storm and The Engineer of 2020 by the U.S. National Academies recommend an investment in education and research in science, technology, engineering, and mathematics (STEM) to drive innovation and global competitiveness and to meet the technological needs of society.

With this backdrop, our Engineering 2020 strategic plan was developed to guide the College of Engineering and Applied Science at the University of Colorado at Boulder over the coming years as we grow in size and stature and nurture outstanding educational and research programs to meet the needs of students, society and employers. It is aligned with the visionary Flagship 2030 plan of the CU-Boulder campus. Our planning process was formally initiated in February 2008, with a series of mini-retreats on People, Places, and Programs. Further input was gathered from the college’s Engineering Advisory Council, Administrative Council, and other groups.

The overarching vision of the College of Engineering and Applied Science at CU-Boulder is to enhance our standing as the premier engineering college in the greater Rocky Mountain Region and be distinguished as one of the leading engineering research and educational programs in the world.

After presenting our mission, vision, and value statements, an overview is provided of the current state of our college. While we are smaller than the average size of our peer group, our program is distinguished by strengths in integrated and discovery learning and in engineering for global society, with tremendous opportunities to enhance research and educational excellence through interdisciplinary and multi-institutional partnerships. The plan then sets forth bold and broad objectives in three areas:

**People:** We will attract and develop outstanding and diverse students, faculty and staff, with objectives of growing our student enrollments by 15-20% and our faculty and staff by 30% by the year 2020.

**Places:** We will provide modern facilities for world-class research and education, with objectives of adding about 175,000 square feet of new engineering building space within five years and creating the first phase with at least 150,000 square feet of a new engineering complex by the year 2020, while also improving the quality and effective use of current facilities and space.

**Programs:** We will make targeted investment in innovative research and educational programs that meet societal needs and transcend traditional academic and geographic boundaries, with objectives of creating an engineering-centered research institute and doubling our sponsored research by the year 2020, and we will involve every undergraduate in hands-on learning and team-based design throughout the curriculum and in at least one extracurricular, personalized learning experience prior to graduation.

An implementation plan to meet these objectives is then described. It includes specific initiatives and strategies that will be undertaken in the next few years, while leaving flexibility to accommodate new opportunities. Finally, the plan concludes with a set of quantitative metrics that will be used to measure progress. I look forward to working together with you to accomplish our ambitious goals.

Robert H. Davis, Professor & Tisone Chair
Dean, College of Engineering and Applied Science, CU-Boulder
Table of Contents

1. What Are Our Mission, Vision, and Values? 1

2. What Is the State of the College of Engineering and Applied Science? 1
   2.1 Departments and Programs 2
   2.2 Faculty and Students 3
   2.3 Funding and Expenditures 4
   2.4 Rankings and Peer Institutions 5
   2.5 Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis 6

3. Where Would We Like the College to Be in 2020? 7

4. How Will We Get There? 8
   4.1 People 8
      Initiative #1: Increase undergraduate and graduate student enrollments, quality, and diversity 8
      Initiative #2: Promote faculty and staff excellence, diversity, and growth 10
      Initiative #3: Create and support a culture of diversity and engagement 11
   4.2 Places 12
      Initiative #4: Construct engineering building additions and begin a new engineering complex 12
      Initiative #5: Improve utilization of existing space 13
   4.3 Programs 14
      Initiative #6: Develop programs to advance engineering for global society 14
      Initiative #7: Expand opportunities for integrated and discovery learning 16

5. What Are the Resource Requirements? 17

6. How Will We Measure Success? 18

Works Cited 19
1. What Are Our Mission, Vision, and Values?

*If your vision is for one year, plant wheat.*
*If your vision is for ten years, plant trees.*
*If your vision is for a lifetime, plant people.*

- Old Chinese Proverb

The University of Colorado at Boulder is the flagship research university in the state of Colorado, with selective admissions standards and a comprehensive array of undergraduate and graduate programs. The mission of its College of Engineering and Applied Science is to generate new knowledge in engineering and related fields and to equip students from diverse backgrounds as future leaders and responsible citizens in these fields for the betterment of individuals and society. Our vision is to be a world leader in engineering research and education, with an emphasis on *integrated and discovery learning* and on *engineering for global society.*

*I hear . . . I forget.*
*I see . . . I remember.*
*I do . . . I understand.*

- Confucius, c 500 BC

We embrace the following core values:

- Innovative research, creating knowledge to improve the global society
- Integrated learning, where students learn through team-based projects and other hands-on experiences integrated with traditional theory-based curricula
- Discovery, professional and service learning, where students learn by undertaking research, internships, international experiences, and campus or community projects
- Inclusive excellence of diverse faculty, staff, and students, with high ethical standards of integrity, responsibility, honesty, and respect for others from differing backgrounds

And, we seek the following outcomes in our graduates:

- Technical excellence and knowledge in modern engineering, mathematics and science
- Ability to communicate effectively with diverse peoples and other cultures
- Ability to think critically, analyze data, and formulate and solve complex problems
- Ability to contribute effectively as individuals and in multidisciplinary teams
- Knowledge of contemporary issues and preparation for societal leadership and world citizenship
- Desire and skills for life-long learning and personal and professional development
- Passion for serving others and commitment to sustainability

2. What Is the State of the College of Engineering and Applied Science?

The College of Engineering and Applied Science is a top-tier public research institution, founded in 1893. It has six academic departments, with (as of Fall 2007) 156 full-time regular (tenured/tenure-track) faculty, 23 full-time instructional faculty, 11 full-time research faculty, and 10 regular faculty rostered in institutes. In Fall 2007, the college enrolled 2,914 undergraduate students and 1,206 graduate students. The current Engineering Center was completed in 1966. With the addition of the Integrated Teaching and Learning (ITL) Laboratory in 1997 and the Discovery Learning Center (DLC) in 2002, the entire complex has 660,000 gross square feet (gsf) of classrooms, research laboratories, computing facilities, offices and other space in support of our education and research efforts.
2.1 Departments and Programs
The six academic departments in the college, each offering BS, ME/MS and PhD degrees, are
- Aerospace Engineering Sciences (24 regular faculty)
- Chemical and Biological Engineering (18 regular faculty)
- Civil, Environmental, and Architectural Engineering (30 regular faculty)
- Computer Science (22 regular faculty)
- Electrical and Computer Engineering (36 regular faculty)
- Mechanical Engineering (22 regular faculty)

Bachelor's degrees are also offered through affiliated departments and programs in Applied Mathematics, Engineering Physics, and Environmental Engineering, while master's degrees are also offered in Engineering Management and Telecommunications. In addition, the college has several programs and facilities that provide an enriched education and research environment:

- Women in Engineering Program (WIEP) – The WIEP provides mentoring, support, and community activities to promote the recruitment and success of female engineering students and to increase the awareness of engineering and applied science among prospective students.

- Multicultural Engineering Program (MEP) – The MEP provides a community dedicated to academic excellence through recruiting and retaining multicultural and first-generation students historically underrepresented in engineering and applied science.

- Interdisciplinary Research Centers – The college is host to 17 grant-funded interdisciplinary research centers, spanning biotechnology and bioengineering, energy and environmental engineering, information science and technology, materials science and engineering, and space sciences and engineering.

- Integrated Teaching and Learning (ITL) Program – The award-winning ITL Program pioneers a multidisciplinary learning environment that integrates engineering theory with practice and promotes creative, team-oriented problem-solving skills for undergraduates and K-12 students, serving 4,000 students each year.

- Engineering for Developing Communities (EDC) – The EDC program provides student teams with service-learning experiences through sustainable engineering solutions and projects to meet basic needs of developing communities, partnering with the communities, the CU-founded Engineers Without Borders, and other groups.

- Discovery Learning Center (DLC) – The DLC provides a 45,000-square-foot, technology-rich research and learning environment where multidisciplinary teams of undergraduate and graduate students, faculty, and industry partners collaborate on state-of-the-art, discovery-based learning through research participation.

- Colorado Space Grant Consortium (CSGC) – This NASA-sponsored program provides opportunities for about 200 students to participate each year in a range of space-related activities, from hands-on development and operation of space craft and satellites to multidisciplinary courses and seminars on space science, technology, and policy.

- Center for Advanced Engineering and Technology Education (CAETE) – This partnership with the Division of Continuing Education and Professional Studies offers master's degrees through the College's departments, Engineering Management Program, and Interdisciplinary Telecommunications Program. Graduate courses for professional development, certificates and degrees are offered both on campus and through distance learning in a variety of fields related to engineering, technology, and applied science.
2.2 Faculty and Students

Figure 1 shows that the numbers of students and faculty in the college have nearly doubled in the past 40 years. The graduate program has nearly quadrupled during this time, and the majority of this growth parallels a major increase in research funding (see Section 2.3).

![Figure 1 – Numbers of full-time regular (tenured/tenure-track) faculty (not including faculty budgeted elsewhere, such as in institutes or administration) and of degree-seeking students in the College of Engineering and Applied Science at CU-Boulder. Master’s enrollments include distance education.](image)

A comparison of enrollments by major and level in Fall 2003 and Fall 2007 is provided in Table 1. At the undergraduate level, large gains in enrollment in the past four years have been experienced by Architectural Engineering, Chemical Engineering, Chemical & Biological Engineering (new degree starting Fall 2006), Civil Engineering, Engineering Physics, Environmental Engineering, and Mechanical Engineering. In contrast, Computer Science, Electrical Engineering, and Electrical & Computer Engineering have experienced substantial declines. The decline in master’s students is largest in Telecommunications, but that program is rapidly recovering from a low of 85 students in 2005. PhD enrollments have been relatively steady over the four-year period.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>386</td>
<td>391</td>
<td>78</td>
<td>57</td>
<td>71</td>
<td>69</td>
</tr>
<tr>
<td>App. Math</td>
<td>59</td>
<td>74</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Arch. E.</td>
<td>165</td>
<td>277</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Chem. E.</td>
<td>201</td>
<td>274</td>
<td>2</td>
<td>1</td>
<td>84</td>
<td>90</td>
</tr>
<tr>
<td>Chem. &amp; Bio.</td>
<td>0</td>
<td>89</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Civil E.</td>
<td>185</td>
<td>250</td>
<td>137</td>
<td>107</td>
<td>89</td>
<td>71</td>
</tr>
<tr>
<td>Comp. Sci.</td>
<td>432</td>
<td>235</td>
<td>46</td>
<td>74</td>
<td>85</td>
<td>96</td>
</tr>
<tr>
<td>Elect. E.</td>
<td>189</td>
<td>145</td>
<td>168</td>
<td>143</td>
<td>109</td>
<td>105</td>
</tr>
<tr>
<td>Elect. &amp; Comp.</td>
<td>220</td>
<td>171</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Eng. Man.</td>
<td>--</td>
<td>--</td>
<td>141</td>
<td>148</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Eng. Phys.</td>
<td>60</td>
<td>108</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Envir. E.</td>
<td>38</td>
<td>72</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Mech. E.</td>
<td>536</td>
<td>589</td>
<td>74</td>
<td>33</td>
<td>47</td>
<td>62</td>
</tr>
<tr>
<td>Open Option</td>
<td>196</td>
<td>239</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Telecom.</td>
<td>--</td>
<td>--</td>
<td>198</td>
<td>150</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,667</strong></td>
<td><strong>2,914</strong></td>
<td><strong>844</strong></td>
<td><strong>713</strong></td>
<td><strong>485</strong></td>
<td><strong>493</strong></td>
</tr>
</tbody>
</table>
Figure 2 shows that the enrollment of female undergraduates rose steadily throughout the 1990s, reaching a peak of 21% in 1999, but subsequently declined, mirroring data for the nation as a whole. Our percentage of underrepresented minority (URM) students (African American, Hispanic, Native American) has been nearly steady at about 7.5% of the undergraduate students, which is one half of that for national engineering enrollments and well below the general population (25% URM in Colorado, and 30% URM in the U.S.).

The percentage of female graduate students in the college has increased substantially, from 15% in Fall 1992 to 24% in Fall 2007, while the percentage of URM graduate students during this period has increased only from 3.9% to 4.4%. The most recent (2006) national data show 22% women and 5.4% URM among engineering graduate students. Faculty diversity in the college has seen gains, from 6.8% to 15% women and from 4.8% to 5.1% URM between 1992 and 2007. The most recent (2007) national data show 12% women and 6.0% URM among engineering faculty.

2.3 Funding and Expenditures
Figure 3 shows that research contract and grant awards to the College of Engineering and Applied Science grew tenfold from the mid-1980s to the mid-1990s, from about $4 million per year to nearly $40 million per year. Awards have fluctuated since, without sustained growth. The sources of the $40 million received in fiscal-year 2007 include the National Science Foundation (25%), industry (24%), Department of Defense (13%), National Aeronautics and Space Administration (9%), subcontracts from other universities (8%), National Institutes of Health (6%), Department of Energy (5%), Department of Education (3%), and other (7%).
Expenditures in the college during fiscal-year 2007 (FY07) totaled approximately $71 million. As shown in Figure 4, the major sources of funds for these expenditures are research contracts and grants, followed by student tuition. Although CU is a state (public) university, the state portion of our college budget is only 6.5% of the total, which is nearly equaled by gift funds. We currently raise about $5 million in gifts per year and have an endowment of about $90 million.

2.4 Rankings and Peer Institutions

Annual rankings of engineering programs are provided by the U.S. News & World Report. In the most recent survey, our college is ranked 35th (20th among publics) at the undergraduate level and 39th (23rd among publics) at the graduate level, among nearly 200 comprehensive engineering colleges participating in the survey. All of our graduate programs rank in the top 40, with four programs in the top 25: Aerospace Engineering Sciences (15th overall, 10th among publics), Chemical Engineering (19th overall, 10th among publics), Civil Engineering (24th overall, 15th among publics), and Environmental Engineering (19th overall, 12th among publics). The most recent comprehensive rankings by the National Research Council were published in 1995, with a new report expected in late 2008.

For a peer group, we have selected those public engineering colleges ranked within the range 20-39 at the graduate level by U.S. News & World Report. These colleges also serve as an “aspiration” group in some respects, as our college is currently ranked at the lower end. Besides CU-Boulder, it includes 10 schools: Penn State, Florida, Minnesota, Washington, Virginia Tech, Ohio State, North Carolina State, U.C. Davis, U.C. Irvine, and Virginia. Table 2 provides a comparison of selected data for our college and the average of these 10 programs. Most striking is that these programs, on average, have more students, faculty, space, and research expenditures than do we. Moreover, the overall student:faculty ratio for the peer group is lower than ours (23:1 vs. 26:1), whereas its number of PhD students per faculty (3.6 vs. 3.2), nonclassroom space per faculty (2270 asf vs. 2060 asf), and research expenditures per faculty ($386K vs. $327K) are higher than ours. The Engineering Development Forum reports a larger average endowment ($170M vs. $90M) and annual cash gifts ($15M vs. $5M) than ours for a peer group of 19 engineering schools, though the median endowment ($80M) is smaller.
For a diversity aspiration group, Michigan, Texas, Texas A&M, UCLA, UCSD, and Arizona State are public institutions having high percentages of underrepresented students among their engineering BS graduates (11% URMs and 21% women, on average). Even among this group, only the two Texas schools have seen increases in both female and URM percentages over the past five years — averaging about 2% relative annual increases. In contrast, none of the four schools in the peer group cited above has seen an increase in the percentage of female graduates over the past five years and only four of ten have recorded increases in the percentage of URM graduates.

2.5 Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis
Listed below are key internal strengths and weaknesses, and external opportunities and threats, facing our college. This analysis serves as background for the objectives and actions described in the succeeding sections of this plan.

**Strengths**

- **Top-ranked engineering program** in the mountain time zone (by *U.S. News & World Report*, both graduate and undergraduate)
- **Research excellence** in areas such as bioengineering & biotechnology, computational & information technologies, energy & power, environmental engineering & sustainability, materials & mechanics, optics & photonics, space science & engineering
- **Outstanding faculty** (e.g., 49 have won young faculty awards from the National Science Foundation, including one of only four engineers to receive its Waterman Award, and 42 of these individuals are still on our faculty)
- **A leading institution in engineering for global society** (e.g., *Engineers Without Borders, U.S.A.*, with now over 200 student and professional chapters, was founded by one of our faculty)
- **National prominence in innovative K-20 engineering education** (e.g., leaders of our *Integrated Teaching and Learning Program* and our *Interdisciplinary Telecommunications Program* have won two of the six Gordon Prizes of $500,000 awarded by the National Academy of Engineering)
- **Excellent students** with entering undergraduates averaging 3.79/4.00 high-school GPA, 85% class rank, and 29/36 composite ACT; and entering graduate students averaging 3.54/4.00 college GPA and 757/800 quantitative GRE
- **Student-faculty interactions** through innovative programs (e.g., *Discovery Learning, Earn-learn, Herbst Humanities, and Integrated Teaching and Learning*)

**Weaknesses**

- **Inadequate space and facilities** with the current engineering building over 40 years old, double the numbers of students and faculty, and quadruple the PhD program since it opened
- **Lack of diversity** as measured by nearly flat representation of our female and URM students at only about one-third that of high-school graduates in Colorado, and even lower representation among our faculty
- **High student:faculty ratio** of 26:1, compared to the peer average of 23:1, which translates to larger class sizes and less faculty time for research and individual instruction
- **Insufficient size of PhD program** with our PhD:faculty ratio of 3.2:1 compared to the peer average of 3.6:1
- **Modest research funding** with our expenditures per faculty at only 84% of the average of our peer group and without substantial increase over the past 10 years
- **Insufficient engagement of faculty in research** (43% of the faculty have annual research spending under $100,000, and 34% are under $50,000)

Table 2 – Size comparison with peer group. Only full-time, regular faculty rostered in the college are included, and "Endowed" refers to endowed chairs and professorships. Master's enrollments include distance education. Research expenditures include gift funds and grants for college faculty through other units. Assignable square feet (asf) does not include classrooms, and its peer average is for just five reporting schools whose average student body and faculty sizes are 10-12% smaller than the overall peer average.

<table>
<thead>
<tr>
<th></th>
<th>Fac</th>
<th>Endowed</th>
<th>Ugrads</th>
<th>Masters</th>
<th>PhD</th>
<th>ASF</th>
<th>Res. Exp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CU-Boulder</td>
<td>156</td>
<td>23</td>
<td>2,914</td>
<td>713</td>
<td>493</td>
<td>322K</td>
<td>$51M</td>
</tr>
<tr>
<td>Peer Average</td>
<td>239</td>
<td>31</td>
<td>4,055</td>
<td>650</td>
<td>872</td>
<td>483K</td>
<td>$92M</td>
</tr>
</tbody>
</table>
Opportunities

- Science collaborations (CU-Boulder has outstanding science departments and institutes, and UC Denver has excellent health sciences programs)
- Regional partnerships, including national laboratories (NCAR, NIST, NOAA, NREL), other academic institutions (CSM, CSU), and industry (aerospace, biotechnology, energy, etc.)
- New sources of state funding, including seed grants and matching funds in targeted areas such as biotechnology and energy, and the use of oil and gas revenues for higher education
- Population growth (the Western Interstate Commission on Higher Education predicts a 28% increase in Colorado high-school graduates from 2004-05 to 2021-22, compared to only 9% for the entire U.S., with most of the increase from Hispanic students)

Threats

- Declining interest and preparation of students for engineering study and careers (see Rising Above the Gathering Storm, published in 2007)
- Increased competition for external funding from a growing number of institutions and faculty seeking limited federal and private research funds
- Low state funding (CU-Boulder’s state funding per student is the lowest in a study of 26 AAU public universities, at only 36% of the average of the other institutions for 2007-08, and future reductions are likely without a new funding model)
- Lack of institutional and administrative support, leading to more faculty time spent on administrative tasks and seeking funds for basic infrastructure, and cumbersome or slow processes in building approvals and renovations, contract and grant negotiations, etc.
- Loss of top faculty to schools with more resources

3. Where Would We Like the College to Be in 2020?

The overarching vision of the College of Engineering and Applied Science is to be not only the premier engineering college in the greater Rocky Mountain region but also distinguished as one of the leading engineering research and educational programs in the world. Further, we aspire to be a national model for promoting diversity in the engineering community. To meet this vision, we have established broad objectives to achieve by 2020, in the key areas of people, places, and programs. These objectives reflect a focus on excellence, growth, and the unique strengths and opportunities of our college. They also support the core and flagship initiatives of the campus-wide strategic plan, Flagship 2030. As a flagship research university, a primary emphasis is placed on improved graduate education and research, and yet undergraduate education will also be greatly enhanced through growth of an outstanding faculty and the synergistic relationship of education and research emphasized by our paradigms of integrated and discovery learning and engineering for global society.

People - We seek to grow our undergraduate student population by 15% and our graduate student population by 20% by the year 2020, while increasing student quality, diversity, access, funding, and retention at all levels. Enhanced diversity will be a hallmark of our college, to more broadly serve the state population and prepare our students for the global society. We will differentially grow our PhD program by 35% to enhance research and competitiveness. We also seek to grow our faculty and staff by 30% by the year 2020, while enhancing their quality, diversity, performance, and support, to not only accommodate growth in student numbers but to also reduce the overall student:faculty ratio and provide more emphasis on research and student preparation through smaller classes and individualized learning opportunities.

Places – We are planning four building projects to add nearly 175,000 gsf of new engineering space by the year 2013, and we seek to complete an additional 150,000 gsf as the first phase of a new engineering complex by the year 2020. We will also improve the quality and capabilities of college laboratories and facilities, so that they are used more efficiently and effectively throughout the year to support our educational and research missions.

Programs - We will make targeted investments to meet societal needs through innovative research and educational programs that transcend traditional academic and geographical boundaries, with objectives of creating an engineering-centered research institute and doubling our sponsored funding by the year 2020. We will also enhance student learning and preparation by involving every student in team-based design projects and at least one summer-long or semester-long personalized learning experience such as a student-faculty research project, an industry internship or co-op, an international experience, and/or a service-learning project.
4. How Will We Get There?

To achieve the overarching objectives of our strategic plan, an implementation or tactical plan is outlined below. It focuses primarily on initial steps to be taken in the next few years, while providing for flexibility as new opportunities and directions unfold in the coming years.

People are our greatest assets — excellence in research and education depends on diverse and outstanding faculty, staff, and students

4.1 People

People are our greatest assets, as well as our main customers. Initiatives and strategies to build excellence by growing the numbers, quality and diversity of our students, faculty and staff are summarized below. They support the following Flagship 2030 initiatives for the CU-Boulder campus: Enhancing Education and Scholarship, Fostering Research Excellence, Enhancing Graduate Education, Ensuring Access, Supporting the Mission, Learning for a Diverse World, Serving Colorado, the Community, and Our Graduates, Residential Colleges, Customized Learning, Experiential Learning, and Making Enterprise Work.

Initiative #1: Increase undergraduate and graduate student enrollments, quality, and diversity

Enhancing student quality and diversity while also increasing enrollments will require enlarging the applicant pools and improving retention. Strategies to accomplish this objective include:

Undergraduate Enrollments:

Partnerships

To expand the pool of prospective undergraduate students with the interest and preparation to study engineering, we will further our partnerships with key schools and communities that represent the diverse population of our state. Current partnerships include the Denver School of Science and Technology (DSST) and the Centaurus High School Pre-Engineering Academy (PEA), both which have high percentages of minority, female, low-income, and first-college-generation students. DSST graduated its first senior class in 2008, and all 79 graduates are enrolling in engineering colleges. All 14 admitted Centaurus PEA graduates in 2007 enrolled in our college this past fall. At these partner high schools and their feeder elementary and middle schools, we teach elective engineering courses and place CU students in math and science classes to help teachers use engineering as a tool to inspire about 1,600 kids each week. We plan to expand these partnerships to several other diverse schools throughout Colorado, starting in Fall 2008 by forming the Skyline High STEM Academy in Longmont. We also plan to partner with community colleges to provide a pathway for engineering study, starting with Mesa State College where we are working together to establish in Fall 2008 a pre-engineering transfer program and the first bachelor’s engineering degree program in Western Colorado.

Deep partnerships with individual schools are labor-intensive. To have broader impact on student preparation and interest, we will share curricular resources and best practices, and show how our models can be replicated and owned by other schools to improve student performance. To help disseminate this information, we will draw on rich partnerships with a variety of agencies and organizations, including the Society for Hispanic Professional Engineers (SHPE), the National Society for Black Engineers (NSBE), Mathematics Engineering Science Achievement (MESA), the American Society for Engineering Education (ASEE), and industry.

Engineering GoldShirt Program

The Engineering GoldShirt Program will provide a performance-enhancing year for high-school graduates who have the talent but lack sufficient preparation to immediately succeed in a traditional undergraduate engineering program. It is expected to attract many students from backgrounds that are underrepresented in engineering. During their GoldShirt year, students will take classes with small groups in pre-calculus, introductory chemistry and physics, writing, critical thinking, and hands-on engineering projects. They will also arrive two weeks prior to the start of classes for a Summer Bridge program focused on building community and developing leadership and study skills. After the first year, they will transition into standard engineering curricula, and continue to participate in community building and service-learning activities. We will pilot the Engineering GoldShirt Program in AY2009-10, and we expect that it has the potential to double the enrollment of underrepresented minorities in our college within five years.
Engineering Honors Program
To attract top-performing and diverse high-school students from across Colorado and other states, we aim to grow the Engineering Honors Program (which was started in 2006 and now has 65 students) to include 10% of each entering class. A Residential Academic Program for engineering honors students will be started in Andrews Hall when its renovation is complete in Fall 2009.

Engineering Leadership Program
We also plan to create an Engineering Leadership Program, to which top high-school applicants from around the country with leadership skills and aspirations as well as outstanding academic credentials will be invited to join. It will start in Fall 2010 and include guaranteed participation in the Earn-learn Program and/or Discovery Learning Program, college leadership and service activities such as the Engineering Fellows program, and a student advisory group for the Dean’s Office.

Community building and retention
To enrich the student learning experience and aid in retention and student satisfaction, we will initiate or expand several programs that build community and provide a supportive environment for students. The Women in Engineering Program and Multicultural Engineering Program will be broadened to be inclusive in supporting all students seeking help. A peer-mentoring system will be established through the Engineering Honors Program and through a Residential Academic Program within the Engineering Quad. Key first-year courses will be revised, and Engineering Fellows will provide support to at-risk freshmen. Opportunities for individual student-faculty relationships will be enhanced through expansion of our Earn-learn and Discovery Learning programs. A first-year experience coordinator will be hired in Fall 2008 to oversee retention efforts and open-option advising of first-year students. Further, we will analyze why students leave engineering, and respond with college-wide faculty involvement to promote student success.

Marketing of CU engineering
Drawing on the National Academy of Engineering study Changing the Conversation, on improving public understanding of engineering, we will actively market engineering study and the college to prospective students. In addition to traditional brochures and mailings, our websites will be enhanced, a recruiting video and presentation will be produced, YouTube will be used to display student projects, and appropriate classes will be marketed to top high-school students and community members. In addition, materials targeted for parents, teachers and counselors will be prepared and distributed. We will also use electronic and print media to enhance our general marketing of the college and its innovative programs to other constituents, such as alumni, corporate recruiters, and engineering deans and department chairs. Press releases will be used to communicate college success stories with the general public. Finally, we will host regional events for prospective students and supporters.

Financial support
To attract and retain the best students, and ensure access for low-income students, we will use private fundraising, engineering differential tuition, and campus support by 2020 to
• Double undergraduate scholarships from current total of $1.4M (in 2008 dollars)
• Fund 150 earn-learn students per semester
• Fund 100 discovery learning students per year

Graduate Enrollments:

Partnerships
Less than 30% of our entering graduate students are Colorado residents and about 30% are from foreign countries, so our partnerships will be focused on national and international universities. In particular, fledging partnerships with historically black and Hispanic serving colleges in southern and southwestern states will be expanded.

Visiting scholars
Current programs to bring top undergraduates from around the country to participate in research in our college, such as the Summer Minority Access to Research Training (SMART) and Research Experiences for Undergraduates (REU), will be expanded. In particular, we will include opportunities for participation of students from our international partner schools. Short-term recruiting visits will also be used to encourage outstanding students to consider graduate study at CU-Boulder.

New degrees
We will add new degrees in interdisciplinary areas such as bioengineering, computational science and engineering, and materials science and engineering to broaden our graduate program (see Section 4.3).
Graduate leadership program
A leadership program will be established in 2009-10 to teach entrepreneurship and leadership skills, and to prepare top graduate students and post-docs for faculty careers.

Financial support
Engineering graduate students often require financial support, especially if they invest the 4-5 years typically needed for a PhD degree, so we aim to establish with institutional gift funding 100 assistantships ($30K/year in 2008 dollars) and 100 supplemental fellowships ($5K/year in 2008 dollars) to attract and support top PhD students. In addition, we will continue to develop graduate training programs in key areas of strength, with support from federal agencies such as the Department of Education, the National Institutes of Health, and the National Science Foundation.

Initiative #2: Promote faculty and staff excellence, diversity, and growth
Increasing the size, diversity, and performance of our faculty will require new financial resources and programs to nurture and support all faculty members. Strategies to accomplish this objective include:

New hires clustered in targeted areas
We seek to grow our tenure-track faculty by 30%, requiring 47 growth positions, by the year 2020. Many of the new hires will be clustered in targeted areas, such as the interdisciplinary programs identified in Section 4.3, where our college has unique opportunities to be a world leader. To accomplish this goal — as well as the campus-wide goal of 300 new faculty lines over 10 years — will require a new funding model (see Section 5). Besides competitive salaries and benefits packages, campus investment will be required to provide faculty startup packages — for which the average is approaching $0.5 million in our college — and housing assistance.

Alternative career paths
We will continue to hire and nurture instructional faculty and expand our complement of research faculty, as key contributors to the educational and research mission of the college. Moreover, we will encourage and support differential workloads, to allow faculty to emphasize different responsibilities (teaching, research, service) at appropriate times in their careers. Finally, our annual faculty evaluations and promotion and tenure criteria will be modified to better recognize interdisciplinary and team efforts, as well as contributions to enhancing diversity.

Faculty Excellence Program
Our Faculty Excellence Program was started in 2004 and includes a variety of financial-support opportunities as well as training sessions. Starting in Fall 2008, it will be enhanced to (i) expand the college orientation and sessions on research, education, mentoring, and diversity and community, (ii) add workshops on engineering education, drawing from recent studies on creating better learning environments and more effective methods of instruction than traditional lectures, (iii) provide more training and support to new (and experienced!) faculty for writing successful grant proposals, (iv) expand the number and amount of Dean’s Faculty Fellowships, which provide a semester relief from teaching for faculty to focus on research or a special project, and (v) increase funding for seed grants, especially to encourage collaboration on interdisciplinary projects.

Staff support and excellence
We will seek to grow our support staff from 87 to 115 by 2020, to meet growing needs for program and faculty administrative support, laboratory support and safety, finances and accounting, student advising, and program assessment. At the same time, we will work with campus administration to reduce requirements for low-value administrative work so that staff can take on more essential roles. A particular need is additional staff to assist with research proposals and grants processing. A new Staff Excellence Program will be formed in 2009 to promote excellence and a sense of community among the support staff for the college. It will include (i) funds and opportunities for staff training and professional development, (ii) performance-recognition awards, (iii) a peer-mentoring program, and (iv) engagement in social events and college activities.

Financial support
To attract and retain top faculty and staff, we will work with the campus to provide competitive salaries, startup funding, and resources for professional advancement. In addition, private funds will be raised by the year 2020 to (in 2008 dollars)

- Double endowed chairs ($2M min.) to 22
- Double endowed professors ($500K min.) to 24
- Create 12 fellowships ($5K/yr) for junior faculty

2008 Gordon Prize Winners
Initiative #3: Create and support a culture of diversity and engagement

Diversity is a natural and enriching hallmark of life, and a core value of the College of Engineering and Applied Science. It includes, but is not limited to, ethnicity, race, gender, age, socioeconomic class, sexual orientation, religion, disability, veteran status, and political affiliation. A climate of healthy diversity is one in which people value individual and group differences, respect the perspectives of others, and communicate openly. We are committed to fostering an environment of inclusion and respect in which students, faculty, and staff can excel, and where the exchange of ideas, knowledge, and perspectives is an active part of learning. Promoting diversity of students, faculty, and staff provides an enriched experience for all members of the college and helps prepare students for their future careers in an increasingly global workforce. The value of diversity extends beyond the walls of the campus, as an expanded and diverse population of engineers is needed to address state and national needs for technological leadership and to improve society.

We seek to be a national leader and model for the engineering community in developing and applying best practices in support of diversity and inclusive excellence. While maintaining high standards, we aim to achieve relative increases in faculty and student diversity measures that equal or exceed the achievements of the top-performing schools in our peer and diversity aspiration groups. Our strategies to improve diversity include:

**Partnerships with key schools**
The model partnerships described above are with schools having large populations of students from groups underrepresented in engineering; these models will be used to expand the interest and preparation for engineering study by students with diverse backgrounds from many more Colorado schools. We will also develop partnerships with engineering colleges and graduate programs having diverse populations, to expand our pool of applicants for graduate and post-doctoral study and faculty positions. A particular focus will be on partner colleges with high Hispanic enrollments, to reflect the projected demographics of Colorado.

**Student-engagement programs**
The student-engagement programs described above — such as Engineering GoldShirt, Engineering Honors, and Engineering Leadership — all provide opportunities for attracting diverse students and providing them with a supportive community for success. Additional programs, such as the High School Honors Institute, Summer Bridge, and Success Institute, bring high-school-students to live on campus and engage in an engineering experience for short periods during the summer, helping them better foresee the possibilities and prepare for enrolling in our college. We will do an outcomes assessment of these programs, to be data driven and determine which programs most effectively attract students to engineering and help them succeed.

**Faculty hiring and support**
All faculty searches will advertise broadly and draw on partnerships with minority-serving institutions to attract diverse candidates, and the importance of diversity to our college’s success will be emphasized during the interviews and faculty orientation. Progressive programs and policies that support faculty diversity — such as spousal hiring opportunities and family leave with pay and adjustment of the tenure clock — will be emphasized.

**Faculty and staff engagement**
We will more broadly engage all faculty and staff in promoting diversity and building an inclusive community. In addition to informational sessions, shared ownership will be developed by defining department-specific participation and goals. Financial incentives will be provided to reward departments and faculty that successfully advance diversity.

**Diversity action committee**
This committee will be established with people from across the college and campus. It will be charged with reviewing successes (and failures) of our diversity efforts, benchmarking best practices of other institutions, and making recommendations on investments to expand diversity within the college.

Diversity provides an enriched experience for all — we seek to be a national leader and model in achieving inclusive excellence through enhanced diversity.
4.2 Places
Our ability to attract the best faculty, perform world-class research, and provide an outstanding education for students requires modern laboratories, classrooms and facilities, with sufficient space to accommodate growth. Initiatives and strategies to meet both near-term and long-term space needs are summarized below. They support the following Flagship 2030 initiatives for the CU-Boulder campus: Enhancing Education and Scholarship, Fostering Research Excellence, Investing in the Tools for Success, Customized Learning, Experiential Learning, Colorado’s Research Diamond, Transcending Traditional Academic Boundaries, Building a Global Crossroads, Creating University Villages, and Year-round Learning.

Initiative #4: Construct engineering building additions and begin a new engineering complex
In 1999, the College of Engineering and Applied Science commissioned CU-Boulder’s Department of Facilities Management and an external architect to do a strategic analysis of space needs to meet current and projected (10-15 years) requirements. The report concluded that 147,000 additional assignable square feet (asf) were required, corresponding to about 260,000 gross square feet (gsf). Since the study, 45,000 gsf have been added as the Discovery Learning Center, which opened in 2002. Table 3 presents a fresh (though less detailed) analysis of space needs to meet growth projections by the year 2020. It shows that 163,000 asf of new space is needed, which corresponds to 286,000 gsf using a standard factor of 57% assignable space. To meet this need plus a modest amount of expansion space for growth beyond the year 2020, we are planning four buildings projects totaling about 175,000 gsf (engineering portion) to be completed within five years and 150,000 gsf for the first phase of a new engineering complex to be completed by the year 2020.

Table 3 – Current assignable square feet (asf) in the Engineering Center and projected needs by the year 2020

<table>
<thead>
<tr>
<th>Current space (asf)</th>
<th>Additional need (asf)</th>
<th>Projected total (asf)</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices &amp; conference rooms</td>
<td>105,000</td>
<td>46,000</td>
<td>151,000</td>
</tr>
<tr>
<td>Classrooms, teaching labs, study areas</td>
<td>94,000</td>
<td>24,000</td>
<td>118,000</td>
</tr>
<tr>
<td>Research labs &amp; support facilities</td>
<td>136,000</td>
<td>68,000</td>
<td>204,000</td>
</tr>
<tr>
<td>Building support &amp; mechanical</td>
<td>49,000</td>
<td>25,000</td>
<td>74,000</td>
</tr>
<tr>
<td>Total</td>
<td>384,000</td>
<td>163,000</td>
<td>547,000</td>
</tr>
</tbody>
</table>

Systems Biotechnology Building
The Systems Biotechnology Building will house 60 faculty and 600 researchers associated with the Department of Chemical and Biological Engineering, the Biochemistry Division of the Department of Chemistry and Biochemistry, and the interdisciplinary Colorado Initiative in Molecular Biotechnology, and it will catalyze interdisciplinary research and education and partnerships with the Colorado biotechnology industry and CU’s Anschutz Medical Campus. This building of 220,000 gsf, of which about 30% involves engineering faculty and students, will be located on CU-Boulder’s east campus, 0.7 miles east of the current Engineering Center. It has already received university and state approval, and the architectural design phase is underway. Building completion is currently targeted for June 2011.
Aerospace and Energy Systems Building
The Aerospace and Energy Systems Building will house an expansion of the Department of Aerospace Engineering Sciences and a multidisciplinary program on alternative sources of electric power, such as wind and solar. It will promote projects-based research and education partnerships involving engineering, science and industry, to help ensure Colorado’s pre-eminence in space and energy systems. This building of approximately 78,000 gsf will be connected to the current Engineering Center, adjoining the aerospace wing and the Discovery Learning Center. Its program plan has received university approval and is pending state approval in 2009. Targeted completion is 2012.

Geosciences Building
The Geosciences Building is a campus-wide effort to bring together several programs related to the environment and energy, for study in an integrated fashion of the interaction of human and natural systems in climate change, energy development, natural disasters, and water resources. This building of approximately 100,000 gsf will be located on the east campus. About 10% of the space will be occupied by engineering research laboratories, primarily associated with the Colorado Center for Biorefining and Biofuels (C2B2). Its program plan has received university approval and is pending state approval in 2009. Targeted completion is 2012.

Integrated Teaching and Learning Laboratory
The first phase of the Integrated Teaching and Learning (ITL) Laboratory was completed in 1997 and includes about 34,000 gsf. A second phase of approximately 20,000 gsf is planned for the south side of the current facility. The addition is needed to accommodate the steady growth in student and faculty demand for design space and to sustain the College of Engineering and Applied Science as a national leader in hands-on engineering education and K-12 student preparation. A program plan for the ITLL expansion will be written in the year 2009. Targeted completion is 2013 or 2014.

New engineering complex
With the current Engineering Center over 40 years old, and built when the college had about half as many students and faculty and much smaller research programs than at present, we face a critical need for not only more space but also for better space that provides infrastructure for modern engineering research. A new engineering complex, as opposed to continuing upgrades to the existing buildings and infrastructure, may not only be cost effective in the long run but also would facilitate a transformation of the College of Engineering and Applied Science with modern educational and research facilities to attract outstanding faculty, staff and students. A decision on location (east or main campus) will be made in partnership with campus master planning and consider where there will be the most vibrant and supportive community for our planned growth in people and interdisciplinary programs. By the year 2020, our goal is to complete the first phase, with at least 150,000 gsf, of the new complex.

INITIATIVE #5: IMPROVE UTILIZATION OF EXISTING SPACE
No discussion of facility needs and plans is complete without considering how existing space can be used more effectively. Strategies to better use our existing (and future) space include:

Summer session and evenings
To make better year-round use of limited classroom and laboratory space, and provide more options for students, we will seek to at least double the course offerings and enrollments in summer session by the year 2020. We also plan to offer more courses in evenings, especially where laboratory and design space is limited.

Annual renovation program
With its prior strategic plan, our college began a formal program of annual renovation projects. Prior to the approval of a new engineering complex, we will continue to allocate funds for research and teaching lab improvements, office remodels, development of common/interaction space, general improvements or “beautification” to provide a more appealing work environment, and repurposing of underutilized space such as storage and drop-in, general-use computer facilities for more effective use. The to-be-vacated chemical engineering wing will also be repurposed to meet other college needs for expanded research and educational programs and co-locating faculty and labs around common themes.
Specialized research facilities
CU-Boulder has relatively few specialized research facilities with shared equipment supported by campus funding. We propose to partner with campus leadership to invest in select, interdisciplinary facilities. A Nanomaterials Characterization Facility, opened in our Discovery Learning Center in 2006, will be expanded as our research emphasis in materials science and engineering grows. A companion Nanofabrication User Facility is planned for 2009. A High-performance Computing Facility, originally planned for the Engineering Center, will now be a campus facility on the east campus, with expected opening in 2009. The Systems Biotechnology Building will include a Small-animal Facility and a Microscopy and Spectrometry Facility. Additional facilities will be developed as part of the interdisciplinary initiatives described in Section 4.3.

Modern education laboratories
Through private fundraising, the annual renovation program and the Engineering Excellence Fund, we will upgrade our education laboratories and renew them with state-of-the-art equipment. We will also expand lab scheduling to accommodate growth.

We will invest in innovative research and education that transcend traditional boundaries and support Engineering for Global Society and Integrated and Discovery Learning

4.3 Programs
The College of Engineering and Applied Science at CU-Boulder has a rich history of innovation in engineering research and education. Initiatives and strategies to build on this history and provide distinction as one of the leading engineering research and educational programs in the world are summarized below. They support the campus Flagship 2030 initiatives in Fostering Research Excellence, Enhancing Graduate Education, Customized Learning, Experiential Learning, Colorado’s Research Diamond, Transcending Traditional Academic Boundaries, Building a Global Crossroads, and Year-round Learning.

Initiative #6: Develop programs to advance Engineering for Global Society
With a history of caring for the environment and societal needs, the College of Engineering and Applied Science at CU-Boulder is ideally positioned to be a world leader in several key areas under the general theme Engineering for Global Society. The initial strategies below, which will be expanded as new opportunities arise, address societal needs at the state, national, and global levels in areas such as materials, health care, security, communications, energy, natural resources, and education. In each area, we will partner with science departments and institutes, and with regional and other institutions, to develop large-scale, innovative research and educational programs that transcend traditional academic and geographical boundaries. Targeted investment of new and reallocated faculty positions, graduate-student support, facilities, and interdisciplinary seed grants will be made in selected areas.

Materials science and engineering
Materials such as metals, plastics, fabrics, and concrete are part of our everyday lives, and advanced materials such as semiconductors and nanostructured composites have helped revolutionize communications, transportation, health, and other aspects of society. CU-Boulder has tremendous strengths in several facets of materials science and engineering (e.g., liquid crystals, polymers, bio-materials, micro/nanostructured materials, and optical materials), which we propose to draw together in an interdisciplinary program. This Materials Science and Engineering Program will involve faculty from across the campus, as well as collaborators at NIST and other institutions. A formal graduate certificate and then new MS and PhD degrees will be developed in 2009 along with shared facilities and large-scale, multidisciplinary research programs.

Bioengineering and biotechnology
The University of Colorado is a leading research institution in biotechnology and biomedical fields, and the State of Colorado has over 16,000 highly skilled jobs within about 400 companies in these fields. Moreover, there are bioengineering coursework and research opportunities across the College of Engineering and Applied Science. To leverage these programs, meet workforce needs, and make life-saving and life-improving advances in human health, we propose to develop innovative programs in bioengineering and biotechnology by (i)
partnering with UC Denver and its Anschutz Medical Campus to offer new MS and PhD degrees in bioengineering and (ii) partnering with CU-Boulder’s College of Arts and Sciences to grow the Colorado Initiative in Molecular Biotechnology as it moves into the new Systems Biotechnology Building. These efforts will include an interdisciplinary graduate program, research, and technology transfer in key areas such as biomedical devices, restorative biomaterials, tissue engineering, early cancer detection and treatment, cardiovascular health, human pathogens and diseases, and vaccine and drug development, including applications for the developing world. In addition, our new BS degree in Chemical and Biological Engineering (started in 2006) will be expanded to an estimated 200 students, and we will seek its accreditation in 2009.

**Aerospace systems science and engineering**

CU-Boulder has more collective expertise in space science and engineering than perhaps any other university in the world. We are one of the top producers of astronauts, and our funding from NASA is first among public institutions. However, this expertise is scattered among different groups, with only limited facilitation of interdisciplinary education and research. The Aerospace Systems Science and Engineering initiative will start in 2008-09 and foster collaboration between the space science and engineering communities beyond what one group could accomplish alone. When combined with the considerable local aerospace industry (Colorado trails only California in total number of employees in the aerospace sector, and is first on a per-capita basis), this effort will provide benefits to the state and nation, including civilian applications such as weather and communications, and it will help meet our strategic goal of being the nation’s pre-eminent university in space science and engineering. The key to the success of this initiative is recognition that space missions are tightly integrated systems, with scientists and engineers working together from conception to integration. Plans include (i) multi-disciplinary research projects, (ii) development of a suite of projects-based courses, (iii) establishment of a graduate certificate program in aerospace systems science and engineering, (iv) recruitment of talented and diverse graduate students, (v) partnerships with industry, and (vi) the proposed Aerospace and Energy Systems Building.

**Energy systems and environmental sustainability**

To help address the global need for secure and sustainable energy and clean air and water, we aspire to be a world leader in research and student training in energy systems and environmental sustainability. By partnering with regional institutions (NREL, NCAR, NIST, U.S. Bureau of Reclamation, CSU, CSM) and national or international companies, partners of the University of Colorado Boulder (CU-Boulder), we will seek its accreditation in 2009. This center will be an important resource to (i) study and expand the

CU-Boulder is positioned for a lead role in areas such as biofuels, wind energy, photovoltaics, energy-efficient power electronics and building systems, and air/water resources, while also serving Colorado’s extensive oil and gas industry of 71,000 employees and $23 billion in economic output. The College of Engineering and Applied Science will work with the campus-wide Energy Initiative and our partner institutions to establish and grow educational and research programs such as the Center for Biorefining and Biofuels (C2B2), the Center for Research and Education in Wind (CREW), the Center for Revolutionary Solar Photoconversion (CRSP), and the Colorado Power Electronics Center (CoPEC). A new BS degree in Electrical and Energy Engineering will be proposed to start in Fall 2010.

**Computational science and engineering**

High-performance computing and networking are emerging as core technologies for diverse applications in biotechnology, material science, energy science, disaster mitigation, natural-resource distribution, and climate modeling. In partnership with national laboratories in and near Boulder (NCAR, NIST, NOAA, NREL) and regional universities, CU-Boulder is ideally positioned to take a leadership role in interdisciplinary computational science and engineering (ICSE) involving large-scale computer simulations in key areas such as weather, genomics, and energy requiring cooperation between scientists and engineers. We propose to form a major new research and education program in ICSE, to include (i) shared computational facilities, including a campus data center with high-performance computing infrastructure, (ii) new faculty hires, (iii) interdisciplinary, team-based research grants, and (iv) coordination of courses, new degrees (PhD, MS and combined BS/MS) and certificates.

**Engineering education research and assessment**

In recognition of the importance of research and advances in the science of learning on effective teaching and learning processes, a Center for Engineering Education Research and Assessment will be formed in 2009. This center will be an important resource to (i) study and expand the
knowledge base on effective teaching and learning processes, (ii) equip faculty for successful implementation of this knowledge to improve teaching and learning, (iii) integrate design throughout engineering curricula, (iv) perform assessments of learning and program effectiveness, and (v) assist faculty with educational and assessment components of contracts and grants. It will form collaborations with related campus learning initiatives including the Physics Education Research Group at Colorado, the Faculty Teaching Excellence Program, and the Alliance for Technology, Learning and Society (ATLAS). The center will also help develop quality-based metrics to assess and reward successful implementation of research-validated teaching methods to improve student learning and create more welcoming learning environments to enhance retention.

Engineering-centered research institute
Research institutes at CU-Boulder are long-standing organizations with independent budget structures and faculty lines budgeted within the institute but with tenure homes in traditional departments. They traditionally report to the Vice Chancellor for Research, and most of the current 10 institutes have a science focus. We will seek to establish by the year 2020 a new institute that has a strong engineering focus and will enhance the research funding and programs in our college. A competitive process will be used to select the theme of the institute, and a major and stable funding source will be required.

Initiative #7: Expand opportunities for integrated and discovery learning
To meet our objective of enhanced student learning through Integrated and Discovery Learning, we will integrate hands-on, active-learning and design experiences throughout the curriculum. We also seek to involve every student, prior to graduation, in at least one semester-long or summer-long personalized learning experience outside of the traditional classroom. Several strategies are planned to expand these opportunities:

Global engineering leadership
We propose an ambitious program to provide in-depth, global leadership opportunities for students and faculty. These opportunities include International Engineering Certificates (including language and culture training plus an overseas corporate or university experience), an International Research Exchange program for faculty and graduate and undergraduate students, international engineering projects sponsored by Engineering for Developing Communities or Engineers Without Borders, and tailored overseas experiences for students, including those in the Engineering Honors Program. We will seek to establish at least one large-scale program with an international partner.

Discovery learning
While graduate students are traditionally involved in research, we will also foster the participation of undergraduates in the research-based, discovery learning process alongside graduate students and faculty through our Discovery Learning Program and Engineering Honors Program, the campus Undergraduate Research Opportunities Program (UROP) and Bioscience Undergraduate Research Skills and Training (BURST) program, the National Science Foundation’s Research Experiences for Undergraduates (REU) program, senior thesis, and independent study.

Professional learning
Opportunities for our students to have internship or “co-op” experiences during the summer or a semester will be expanded through our corporate partnerships. A staff member will oversee this program by working with the students, departments, companies and Career Services. Starting in Fall 2008, we will partner with the Leeds School of Business to offer Engineering Entrepreneurship Certificates at both the graduate and undergraduate levels, for which students will obtain combined business and engineering experience.

Service learning
In service learning, students perform projects that benefit the community or campus and provide practical learning experiences in applying engineering principles. Our Earn-learn Program, in which students work on projects such as assisting a faculty member with a course or facilitating a K-12 outreach project, will be doubled from its current size of 75-80 students per semester. Additional opportunities for service learning will be provided through our programs such as EDC, ITL, CSGC, MEP, WIEP, and the campus INVST Community Studies Program.
5. What Are the Resource Requirements?

Achieving the objectives of our strategic plan will require substantial new resources. Besides grants for research, these resources primarily come from general funds (tuition and state appropriations) and gift funds (individual, corporate, and foundation donations). A new funding model should reflect practices of best-in-class peer institutions (i.e., higher state appropriation, tuition, and private support, with more financial aid for students having need). Estimates of the financial resource requirements are given below (using 2008 dollars and costs, unless otherwise noted).

From institutional general funds, the primary continuing costs associated with our strategic plan are salaries for the additions of faculty, staff, and graduate assistants, plus the associated graduate tuition and growth in operating expenses, as summarized in Table 4. These new positions will total $9M in annual costs by the year 2020. Benefits and other overhead at the campus level – estimated at 67% of direct costs – bring this total to about $15M per year. Using present rates, the projected enrollment growth while maintaining a 2:1 resident:nonresident mix would generate about $10M in annual tuition and state appropriations. The $5M in additional revenue required could be generated by an additional state appropriation (above inflation) of about $1600 per in-state student per year or a tuition increase (above inflation) of about $1000 per student (resident and nonresident) per year. With current undergraduate in-state tuition and fees at CU-Boulder at $6,635 per year versus $7,805 for the AAU public average, and state appropriation at $4,460 per in-state student per year versus $12,784 for the AAU public average, these increases would still place CU-Boulder below the peer averages.

<table>
<thead>
<tr>
<th>Current amount</th>
<th>Additional required</th>
<th>New total (2008 dollars)</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty salary</td>
<td>$18.7M</td>
<td>$4.0M</td>
<td>$22.7M</td>
</tr>
<tr>
<td>Staff salary</td>
<td>$3.5M</td>
<td>$1.1M</td>
<td>$4.6M</td>
</tr>
<tr>
<td>Graduate stipend</td>
<td>$2.0M</td>
<td>$2.0M</td>
<td>$4.0M</td>
</tr>
<tr>
<td>Graduate tuition</td>
<td>$0.8M</td>
<td>$0.9M</td>
<td>$1.7M</td>
</tr>
<tr>
<td>Operating &amp; other</td>
<td>$5.4</td>
<td>$1.1M</td>
<td>$6.5M</td>
</tr>
<tr>
<td>Total</td>
<td>$30.4</td>
<td>$9.1M</td>
<td>$39.5M</td>
</tr>
</tbody>
</table>

From gift funds, the primary needs are for endowed chairs ($22M for 11 chairs), professorships ($6M for 12 professorships), graduate fellowships ($12.5M to provide $500K/yr for 100 fellowships), undergraduate scholarships ($25M to provide $1M/yr in new scholarships), earn-learn and discovery learning apprenticeships ($7.5M to provide $300K/yr in new apprenticeships), and programmatic support ($7M), as shown in Table 5. In addition, current gifts of about $3-4M/yr will be required for annual programmatic and student support. For capital support, the building projects totaling about 325,000 gsf would require over $200M at $650/gsf, from a mix of state, university, and private support.

<table>
<thead>
<tr>
<th>Current endowment</th>
<th>Additional required</th>
<th>New total (2008 dollars)</th>
<th>New total (2020 dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>$35M</td>
<td>$28M</td>
<td>$63M</td>
</tr>
<tr>
<td>Students</td>
<td>$31M</td>
<td>$45M</td>
<td>$76M</td>
</tr>
<tr>
<td>Programs</td>
<td>$24M</td>
<td>$7M</td>
<td>$31M</td>
</tr>
<tr>
<td>Total</td>
<td>$90M</td>
<td>$80M</td>
<td>$170M</td>
</tr>
</tbody>
</table>
6. How Will We Measure Success?

Progress toward meeting the objectives in Section 3, undertaking the actions in Section 4, and acquiring the resources in Section 5 will be assessed on an annual basis. As part of this assessment, the following quantitative metrics and outcomes will be measured and compared to the short-term (2010) and long-term (2020) targets listed in Tables 6 and 7. In addition, the peer/aspiration groups will be monitored annually, and the target metrics will be updated as needed. The monetary amounts listed below are in current dollars, with targets selected based on assuming 2.5% average annual inflation.

<table>
<thead>
<tr>
<th>Metric</th>
<th>2007 baseline</th>
<th>2010 target</th>
<th>2020 target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite ACT of undergraduate students</td>
<td>28.0</td>
<td>28.2</td>
<td>28.5</td>
</tr>
<tr>
<td>3rd-semester undergraduate retention</td>
<td>81%</td>
<td>83%</td>
<td>86%</td>
</tr>
<tr>
<td>6th-year undergraduate graduation rate</td>
<td>53%</td>
<td>56%</td>
<td>70%</td>
</tr>
<tr>
<td>Quantitative GRE of graduate students</td>
<td>757</td>
<td>760</td>
<td>765</td>
</tr>
<tr>
<td>% faculty with expenditures ≥ $100K/yr</td>
<td>57%</td>
<td>62%</td>
<td>75%</td>
</tr>
<tr>
<td>Faculty teaching evaluation (1-6)</td>
<td>4.8</td>
<td>4.9</td>
<td>5.1</td>
</tr>
<tr>
<td>Ranking of diversity progress among peers</td>
<td>--</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Satisfaction with the college (1-5)</td>
<td>3.8</td>
<td>3.9</td>
<td>4.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metric</th>
<th>2007 baseline</th>
<th>2010 target</th>
<th>2020 target</th>
</tr>
</thead>
<tbody>
<tr>
<td># BS students</td>
<td>2914</td>
<td>3100</td>
<td>3350</td>
</tr>
<tr>
<td># MS students</td>
<td>713</td>
<td>730</td>
<td>785</td>
</tr>
<tr>
<td># PhD students</td>
<td>493</td>
<td>540</td>
<td>665</td>
</tr>
<tr>
<td># full-time, regular faculty</td>
<td>156</td>
<td>175</td>
<td>203</td>
</tr>
<tr>
<td># classified &amp; exempt staff</td>
<td>87</td>
<td>95</td>
<td>115</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metric</th>
<th>2007 baseline</th>
<th>2010 target</th>
<th>2020 target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotech building</td>
<td>approved</td>
<td>near comp.</td>
<td>completed</td>
</tr>
<tr>
<td>Aerospace &amp; energy building</td>
<td>prog. plan</td>
<td>approved</td>
<td>completed</td>
</tr>
<tr>
<td>Geosciences building</td>
<td>prog. plan</td>
<td>approved</td>
<td>completed</td>
</tr>
<tr>
<td>ITL laboratory expansion</td>
<td>--</td>
<td>prog. plan</td>
<td>completed</td>
</tr>
<tr>
<td>New engineering complex (first phase)</td>
<td>--</td>
<td>feas. study</td>
<td>completed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metric</th>
<th>2007 baseline</th>
<th>2010 target</th>
<th>2020 target</th>
</tr>
</thead>
<tbody>
<tr>
<td># Earn-learn apprentices/semester</td>
<td>79</td>
<td>95</td>
<td>150</td>
</tr>
<tr>
<td># Discovery learning apprentices/year</td>
<td>36</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Ugrad participation in personalized learning</td>
<td>65%</td>
<td>80%</td>
<td>100%</td>
</tr>
<tr>
<td>Annual grants to support research</td>
<td>$40M</td>
<td>$50M</td>
<td>$80M</td>
</tr>
<tr>
<td>New engineering research institute</td>
<td>--</td>
<td>planned</td>
<td>formed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metric</th>
<th>2007 baseline</th>
<th>2010 target</th>
<th>2020 target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduates scholarships awarded</td>
<td>$1.4M</td>
<td>$2.0M</td>
<td>$3.8M</td>
</tr>
<tr>
<td># Dean’s PhD fellowships awarded</td>
<td>30</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td># Dean's PhD assistantships awarded</td>
<td>7</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td># Endowed professorships awarded</td>
<td>12</td>
<td>15</td>
<td>24</td>
</tr>
<tr>
<td># Endowed chairs awarded</td>
<td>11</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>Total college endowment</td>
<td>$90M</td>
<td>$120M</td>
<td>$230M</td>
</tr>
</tbody>
</table>
Works Cited


Engineering Workforce Commission. Enrollments. <www.ewc-online.org>


College Websites:
Aerospace Engineering Sciences — http://www.colorado.edu/aerospace
Center for Advanced Engineering and Technology Education — http://caete.colorado.edu
Chemical & Biological Engineering — http://www.colorado.edu/che
Civil, Environmental, & Architectural Engineering — http://civil.colorado.edu
Colorado Space Grant Consortium — http://spacegrant.colorado.edu
Computer Science — http://www.cs.colorado.edu
Discovery Learning Center — http://engineering.colorado.edu/dlc
Electrical & Computer Engineering — http://ece-www.colorado.edu
Engineering for Developing Communities — www.edc-cu.org
Engineering Management Program — http://emp.colorado.edu
Environmental Engineering Program — http://www.colorado.edu/engineering/EnvEng
Herbst Program for the Humanities —http://engineering.colorado.edu/herbst
Integrated Teaching and Learning Program — http://itll.colorado.edu
Interdisciplinary Telecommunications Program — http://telecom.colorado.edu
Interdisciplinary Research Centers —www.colorado.edu/engineering/research/interdisciplinary-centers
Mechanical Engineering — http://www.colorado.edu/mechanical
The BOLD Center (MEP and WIEP) — http://bold.colorado.edu