The Strategic Planning process for the Dwight Look College of Engineering is a driver of the final phase of the Faculty Reinvestment initiative toward transforming the college. Between 2003 and 2008, we added 180 new faculty members to the Look College. The timing is ideal for building a set of strategies for engaging this new talent in the most creative and promising teaching and research directions.

A Strategic Planning Steering Committee was chartered to cross-cut various constituencies of the Look College community and to integrate input from across the college to build a shared vision of the future of engineering, reflecting on the global landscape and contemporary developments in science and technology.

The overall product resulting from this inclusionary process is to be an actionable set of strategies for transforming the Look College in the next five years, building upon the framework of Vision 2020.

I am pleased with the tremendous thought and diligence the Strategic Planning Committee has put forth on this endeavor of highest significance.

G. Kemble Bennett, Ph.D., P.E.

The Dwight Look College of Engineering’s Strategic Plan was developed under the leadership of G. Kemble Bennett, who led the college as vice chancellor and dean of engineering from 2002 to 2011.
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>2</td>
</tr>
<tr>
<td>Vision and Mission</td>
<td>5</td>
</tr>
<tr>
<td>Core Values</td>
<td>6</td>
</tr>
<tr>
<td>Strategic Objectives</td>
<td>7</td>
</tr>
<tr>
<td>Overview: Engineering Challenges in the New Century</td>
<td>8</td>
</tr>
<tr>
<td><strong>Focus Area 1: Undergraduate Academic Experience</strong></td>
<td>10</td>
</tr>
<tr>
<td><strong>GOAL 1.1</strong> Base the transformation of engineering education on a foundation of experiential learning, drawing on solid research findings and best professional engineering practice.</td>
<td></td>
</tr>
<tr>
<td><strong>GOAL 1.2</strong> Create an Institute for Engineering Innovation within the college to serve as a crucible for creative and practical approaches that would enhance engineering education.</td>
<td></td>
</tr>
<tr>
<td><strong>GOAL 1.3</strong> Demonstrate that Texas A&amp;M engineering graduates have distinguishing world-class capabilities.</td>
<td></td>
</tr>
<tr>
<td><strong>Focus Area 2: Graduate Academic Experience</strong></td>
<td>17</td>
</tr>
<tr>
<td><strong>GOAL 2.1</strong> Attract top-notch students to our graduate programs.</td>
<td></td>
</tr>
<tr>
<td><strong>GOAL 2.2</strong> Nurture a diversity of perspectives in the graduate program.</td>
<td></td>
</tr>
<tr>
<td><strong>GOAL 2.3</strong> Enhance the quality of graduate education by maintaining the highest standards and emphasizing the central importance of research within the broad engineering enterprise.</td>
<td></td>
</tr>
<tr>
<td><strong>GOAL 2.4</strong> Create a nationally recognized forum for conversation on new paradigms in graduate education and engineering research.</td>
<td></td>
</tr>
<tr>
<td><strong>Focus Area 3: Research Portfolio</strong></td>
<td>21</td>
</tr>
<tr>
<td><strong>GOAL 3.1</strong> Establish multidisciplinary research institutes that cut across the college and university departments to address nationally significant technology challenges.</td>
<td></td>
</tr>
<tr>
<td><strong>GOAL 3.2</strong> Incentivize faculty to pursue dilemma-based research as a departure from traditional discipline-based research.</td>
<td></td>
</tr>
<tr>
<td><strong>GOAL 3.3</strong> Adopt a portfolio management approach to strategically grow research in the signature research areas.</td>
<td></td>
</tr>
</tbody>
</table>
Focus Area 4: Faculty and Staff Development

GOAL 4.1 Achieve 30 NAE members as full-time, tenure-track faculty by 2020.

GOAL 4.2 Retain and accelerate careers of faculty hired during the reinvestment period from 2002 to 2008.

GOAL 4.3 By 2020, increase the total percentage of underrepresented minority (women, Hispanic, and African-American) faculty members from 32 percent to 40 percent of the total tenured/tenure-track faculty headcount, with a goal of 8 percent improvement in all three categories.

GOAL 4.4 Create uniform and transparent standards of staff support across the college and its departments, as well as centers and institutes.

GOAL 4.5 Create a sense of shared commitment to the college’s mission among the administrative and professional staff.

Focus Area 5: K-14 Engagement

GOAL 5.1 Be viewed nationally as a resource for model K-14 programs that address the strategic workforce needs of the engineering profession.

GOAL 5.2 Influence the content of approved engineering high school courses in Texas.

GOAL 5.3 Develop targeted strategic K-14 partnerships to recruit quality prospective engineering students.

GOAL 5.4 Seek to align engineering student enrollment with demographics of Texas, including a complementary focus on national student designations of excellence, such as National Merit, National Achievement, and National Hispanic Scholars.

The Path Forward: Challenges of Implementation

Appendices
VISION
The Dwight Look College of Engineering will meet the coming challenges and develop its future programs to achieve its vision. This vision is:

... to be recognized as a national and international educational leader in engineering and technology, by the public, our peers, and our profession

MISSION
Consistent with the historical responsibility of a land-grant university system, the educational mission of the Dwight Look College of Engineering is:

... to nurture and graduate students ready for professional practice

... to create, develop, and disseminate new knowledge and technologies

... to apply the results of the discovery process in order to enrich our undergraduate and graduate education programs, as well as to promote technology transfer and outreach activities

... to inspire students who can apply that knowledge to solve problems, foster entrepreneurship and provide leadership for the benefit of the citizens and the economy of Texas, the nation, and the world
CORE VALUES

Excellence in all endeavors and personnel ... by committing to discovery, dissemination, and discernment of knowledge through rigorous application of scientific method; by sharing our passion for engineering through an inspiring and engaging program of teaching; by pursuing the highest standards of quality in business practices and support functions.

Service in support of our state, nation, and community ... by designing and applying technology to enhance the quality of life for all people; by adhering to the principles of sustainable development and fostering a life-cycle or system approach to the application of technology; by striving to serve the public interest in all our undertakings.

Highest integrity, ethical standards, and accountability ... by exhibiting an uncompromising loyalty to the truth; by demonstrating responsible stewardship of public resources; by accepting responsibility for our actions, seeking and heeding critical review of our work, and offering fair and objective criticism of the work of others; by holding paramount the safety, health and welfare of our colleagues and public, and by protecting the environment in all of our academic and professional duties.

Respect for all participating in, or impacted by, our programs ... by nurturing an environment of collegiality, diversity, and enabled open expression; by harmonizing the diversity of perspectives into a refined unity of higher purpose; by demonstrating appreciation for the contribution of every individual in the college; by continually seeking full participation in our programs by underrepresented groups.

Leadership as an expectation of our students, faculty, and staff ... by promoting initiative, innovation and entrepreneurship; by exposing our students to multidisciplinary problem-solving that is at the root of all societal challenges for which technology offers solutions; by educating our students to develop global competencies, as well as good communication, organizational, and discernment skills that enable masterful leadership.
STRATEGIC OBJECTIVES

The overarching goal of this strategic plan is to transform Texas A&M University into the “institution of choice” for innovations and breakthroughs for the engineering challenges of the 21st century.

<table>
<thead>
<tr>
<th>FOCUS AREA 1</th>
<th>UNDERGRADUATE ACADEMIC EXPERIENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOCUS AREA 2</td>
<td>GRADUATE ACADEMIC EXPERIENCE</td>
</tr>
<tr>
<td>FOCUS AREA 3</td>
<td>RESEARCH PORTFOLIO</td>
</tr>
<tr>
<td>FOCUS AREA 4</td>
<td>FACULTY AND STAFF DEVELOPMENT</td>
</tr>
<tr>
<td>FOCUS AREA 5</td>
<td>K-14 ENGAGEMENT</td>
</tr>
</tbody>
</table>
In recent years, numerous studies and publications have identified, characterized, and heralded historic trends toward globalization and the creation of a "knowledge-based" economy. Driven in part by development and commercialization of computing, information, and telecommunications technologies, the world has indeed become a "flatter" place.

In recent decades reductions in major conflicts, liberalization of trade policies, and freer movement of peoples, capital, and information across national boundaries, have all added to the very real sense of a shrinking world.

Implications of this mega-trend for our educational system, and particularly for engineering education, are monumental. The rewards of future growth and development will go to nations that not only create the largest number of educated people, but that engage them productively for the benefit of society. In addition, a premium will be placed on the ability to quickly transform innovative ideas and concepts into technological products that will create value in the modern economy. The effect of Moore's Law (computing power available at a given price doubling every 18 months) has been a very dramatic expression of the exponential growth in computer technology development. In such a world, our engineers must not just be "tinkers" or empirically driven "gadgeteers." They must be analysts, innovators, and effective implementers driven by vision and passion. The 14 “Grand Challenges for Engineering” recently identified under the auspices of the National Academy of Engineering (NAE) illustrate challenges awaiting engineering graduates. They illustrate the growing expectations and desires of a highly interdependent world, one in which engineers will be challenged to grapple with "the problem of sustaining civilization's continuing advancement, while still improving the quality of life" (Ref. NAE).

Such contemporary trends challenge our models of engineering practice, and thus education. Modern multinational corporations will access and employ global human and natural resources in an optimum manner. Thus, the U.S. engineering profession will need to evolve its collective value proposition in order to justify higher costs of labor commensurate with the standard of living in the U.S. As knowledge services, such as software development or engineering design, become universally accessible and available at lower cost, U.S. engineering must find a niche in which it can continue to maintain its global competitiveness. The answer most definitely seems to revolve around creativity and innovation: our collective prowess to creatively translate new discoveries from basic scientific research into devices, products, technological systems, and services that benefit society broadly and address national and global missions. We recognize that engineering education must nurture not just the traditional subject-matter expertise in the individual technical disciplines, but a broader and deeper set of skills that would enable more effective and timely linkages between discovery and practical application. As the global village becomes dominated by scientific and technology issues (e.g., energy, climate change, genomic engineering, etc.), engineers will need to be prepared to be effective, innovative societal leaders, and not just passive “cogs” on an industrial “wheel,” doing 20th century jobs.

Finally, as we completed our environmental “scan” of key external drivers and trends, the committee became aware of an intrinsic tension that begs for balance at Texas A&M, and becomes an even more significant factor in our deliberations related to engineering education: the demands of successfully managing our land-grant legacy of broad, professional education of our engineers at the bachelor's level with the contemporary imperative to become one of the leading (“Top 10”) public research institutions in the country. This does not leave us to focus exclusively on teaching undergraduates for locally based employment and economic activity, but compels us to develop a world-class graduate research environment that reflects itself back in enhanced opportunities and experiences for undergraduate engineering students. Meeting our commitment to the State of Texas demands more than just preparing “problem solvers” that will enhance the
economic development of the state. As we live and work in a global village described above, diversity and an appreciation for societal values on a global scale will be unavoidable aspects of our professional effectiveness and success. In this context, the rich history and body of traditions at Texas A&M provide a strong set of values that are imprinted on our approach to globally informed problem solving. The result is a very distinct “brand” of engineering that characterizes the “Aggie Engineer of 2020,” and brings into clear focus a “distinctiveness created on a foundation of quality that is widely recognized and measured by world standards” (Vision 2020: Creating a Culture of Excellence, 1999). We reviewed and reflected on the traditional values of our university and college, and found special relevance to contemporary challenges. In this light, “integrity” maps to stewardship of finite resources and protection of environment, “service” links to public interest and sustainable development, and “leadership” finds expression through innovation and multidisciplinary problem solving.

The words and spirit of Texas A&M’s Vision 2020, championed by President Ray Bowen in 1997 and sustained in the various strategic planning exercises conducted at our institution in the intervening years, have likewise inspired and guided our own deliberations. In applying the principles and recommendations engendered by the 12 Imperatives identified in this vision, none are more compelling for today’s Dwight Look College of Engineering as the overarching commitment to the undergirding “culture of excellence” we seek in the teaching and research activities of our college. Nevertheless, the special needs and concerns of engineering education in the 21st century beg a somewhat more focused perspective that derives from the overwhelming pace of technological development in the world and its influence on the engineering profession.

“In view of these changes occurring in engineering practice and research, it is easy to understand why some raise concerns that we are attempting to educate 21st-century engineers with a 20th-century curriculum taught in 19th-century institutions.”

(Duderstadt, 2008)
FOCUS AREA 1: UNDERGRADUATE ACADEMIC EXPERIENCE

Continuing Transformation of Undergraduate Engineering Education Toward Excellence

BACKGROUND

The overarching goal of the Dwight Look College of Engineering Strategic Plan is to transform Texas A&M University into the “institution of choice” for those striving for innovations and breakthroughs that address the engineering challenges of the 21st century. Many studies and reports have identified the attributes of engineering graduates who must be able to meet contemporary challenges, create innovations and produce breakthroughs. Broad synthesis of these studies shows that engineering graduates should be people who can recognize, identify, pose, formulate, and refine future solutions, innovations, and breakthroughs that address extensive sets of contextual opportunities and not simply solve problems that other parties present. Ultimately, this goal will be realized as a result of “bootstrapping” through a cycle of educational innovation: successfully placing graduates on a broader national and international employment arena, solidifying and validating institutional reputation, and enhancing the diversity and potential of incoming undergraduate and graduate students.

Evaluated with respect to multiple metrics, the Look College has been a leader in transforming undergraduate engineering programs to prepare students for productive careers. From 1988 when the college received one of the first major curriculum grants after NSF resumed funding for undergraduate engineering education until about 1995, faculty members developed, institutionalized, and learned from an engineering core curriculum organized around the principles of “conservation.” Building upon this base, the college led in the formation of an NSF Engineering Education Coalition grant, the Foundation Coalition, in which six institutions translated core principles: active/cooperative learning, student teams, curricular integration, use of learning technologies, and application of assessment, evaluation, and feedback to new engineering curricula across the country. Even before funding for the Coalition expired in 2004, the Look College received one of the first NSF STEP grants to transform its first-year engineering courses to a project-based format in which students work on a sequence of carefully crafted projects to develop their engineering skills as well as their appreciation for their potential contributions to society and industry after graduation.

Today, as engineering leaders across the country have articulated challenging attributes for the engineering graduates of 2020, the Look College is solidly positioned to continue its leadership position in engineering education. However, there is no “silver bullet.” Work will continue on many fronts to develop undergraduate programs that are responsive and agile and prepare students for the sociotechnological challenges of the 21st century. However, resources—particularly faculty time and effort—are limited; therefore, the college must focus on a limited number of goals that can be achieved through diverse approaches:

**Goal 1.1** Base the transformation of engineering education on a foundation of experiential learning, drawing on solid research findings and best professional engineering practice.

**Goal 1.2** Create an “Institute for Engineering Innovation” within the college to serve as a crucible for creative and practical approaches that would enhance engineering education.

**Goal 1.3** Demonstrate that Texas A&M engineering graduates have distinguishing world-class capabilities.
GOAL 1.1  
Base the transformation of engineering education on a foundation of experiential learning, drawing on solid research findings and best professional engineering practice.

Ingrained in the philosophy of the faculty members at Texas A&M, initiatives that claim to create engineering innovations in the 21st century must be based on solid scientific findings and validated by engineering practice. Likewise, the college and its faculty members must ground their educational approaches and strategies in results from the neurosciences, learning sciences, education, and documented studies of organizational change. Applying these findings and then generalizing these findings to different learning environments, different student populations, and different departmental goals and climates is a challenging task for most faculty with a traditional disciplinary engineering background. Moreover, application of creative skills such as design and innovation applied under constraints in the “real world” of technology and commerce also are not always represented in the traditional academic model. However, there are several concrete actions that can be taken to translate these research results into transformation of our current engineering programs.

Strategy  
Create a “thick spine” of experiential learning running through four years of undergraduate engineering education.

Motivation  
Although debate will continue about the nature of learning environments and teaching approaches that develop the broader set of abilities required of future engineers, research on expertise and learning has concluded that these abilities are developed through practice with feedback within supportive communities. This “spine” of courses and experiences would be aligned from the first-year through the senior year and the capstone design courses that are typical of engineering programs. The implementation objective would be to combine experiential (adaptive, creative, experimental, entrepreneurial, societal, global) and design work running throughout the entire four-year undergraduate curriculum. A common comment among faculty members who teach capstone design courses is that students need to be adequately prepared for the mind-set, thought processes, and skill sets needed in such design-focused courses. A thick spine of courses would address development of many of the thought processes and skills sets that are vital to success both as students and graduates, but fall outside the boundaries of important content-oriented courses. The courses that comprise the “spine” cannot be all new courses that are added to existing curricula. Instead, some of the existing courses in each department’s curriculum would be adapted to support the strategic intent of the “thick (experiential) spine.” Such courses at all levels would help students build more accurate mental models of engineering thought processes and how what is learned in an undergraduate curriculum can be applied after graduation. Further, they would provide real-world contexts for the concepts and approaches taught in engineering curricula. The strategic intent would most definitely impact engineering retention: Students early in their college careers might be more inspired to continue in a challenging engineering curriculum (through graduation) if exposed to the real-world skills and professional rewards that accrue in contemporary engineering application and practice.

The specifics of such courses would depend on the details identified in a follow-up implementation plan. However, the implementation plan could include activities such as:

• Endow a student-supported and student-reviewed grant program supporting the development of hands-on courses

• Incentivize course development by increasing the weight such courses apply to the teaching obligation during the development semester

• Create teaching mentorships held by upperclassmen who create and present student-designed and faculty-reviewed demonstrations in the classroom

• Encourage innovation in the format of course assignments by creating more open-ended questions, through which students must first define the problems before creating a solution
• Create physical spaces that support development of sets of learning outcomes for innovation: ideation, opportunity analysis, quantitative decision making, creative resource utilization, and reflection

**Strategy**

*Incentivize the use of dilemma-based and scenario-based problem solving with student teams, assisted when appropriate by simulations and demonstrations.*

**Motivation**

Many successful academic programs that address real-world application and problem-solving environments demanding multidisciplinary, team-based solutions have employed “case study” approaches that fundamentally simulate the complexities of trade-offs and constraints that characterize the contemporary workplace. Use of problem-based learning or scenario-based problem solving simulations with student teams in our engineering courses would develop content mastery in the context of compelling real-world environments. Examples of applying problem-based learning to engineering courses can be found in curricula across the world. Industry partners might be engaged to present interactive course-relevant case studies. Inspired by National Academy “Grand Challenges” or Look College signature research areas, it may be possible to identify multi-disciplinary capstone design projects that would be vertically integrated across undergraduate levels and would address technology challenges that address contemporary global technology missions.

**Strategy**

*Incentivize undergraduate research in special tracts (including “honors tracts”) within the Look College.*

**Motivation**

Undergraduate research may be considered another example of “experiential learning” that would provide an essential transformative element in the educational experience of any engineer, notwithstanding any individual career choices to be made in the future. Doubtless it would be particularly enriching for a student interested in pursuing graduate studies and a research career. A challenge, particularly in a large land-grant university, would be to organize undergraduate research so that more engineering students could participate. Current resource limitations that constrain infrastructure pose a formidable barrier in this regard. Nevertheless, opportunities exist to apply research on learning and change to the design of an adequately sized undergraduate research program that would benefit this goal.

**Strategy**

*Support students as they develop self-awareness of their development toward professional objectives.*

**Motivation**

Although all engineering faculty and academic administrators have grappled with the new ABET criteria that emphasize program educational objectives derived from engineering practice, students are not necessarily aware of their own individual progress throughout their undergraduate careers. Socializing these objectives and assessments broadly would help them attain a more sharpened sense of professional development. Therefore, since each engineering program establishes learning outcomes and educational program objectives that it has decided are the penultimate expectations for its engineering graduates, individual students would benefit from feedback at the end of every semester about their progress toward achieving these objectives. Course grades, while helpful, provide information about the extent to which a student learned course material; however, course grades do not provide students with actionable information about their own achievement of professional skills and competencies. Instead, departments could be challenged to develop systemic, systematic assessments distributed throughout the curriculum to help students understand the status of their abilities and to develop plans for effective skill advancement. With more information about their current abilities relative to outcomes such as conceptual understanding, qualitative reasoning, engineering design, ethical reasoning, appreciating cultural diversity, and experimentation, students can more effectively transition to the environment after graduation. This is the ultimate basis of instilling an appreciation for and commitment to “lifelong learning.”
Indicators

• Published department plans for revising curricula to integrate effective experiential learning approaches. Such plans would be guided by findings from learning science and studies of organizational change, as well as promising practices from across the country.

• Emulation or adaptation by peer institutions of engineering education practices developed at Texas A&M.

• Positive feedback in student and graduate surveys reflecting on how the skills and competencies acquired at Texas A&M prepare graduates for professional employment and career challenges.

GOAL 1.2
Create an Institute for Engineering Innovation within the Look College to serve as a crucible for creative and practical approaches that would enhance engineering education.

Based on past experience, instilling an appropriate mandate for change, continuity, and ownership/accountability will demand certain structural changes in the college. The change would have to be effective enough to influence the strong organizational independence of the departments in the college. An incentivized, dedicated academic unit would facilitate and provide a resource for the methodical prototyping and integration of experiential learning. Such an entity would have to effectively interface innovative approaches with the programs in the discipline-based departments of the Look College. Structured as an institute, unlike a “Department of Engineering Education,” leadership will be provided by a core group of faculty members with nationally recognized preeminence in engineering education that can provide inspiration and direction for initiatives that would support continuing transformation of engineering education. Such programs would ideally attract needed funding from NSF grants directed at addressing the national challenges of the “Gathering Storm.” In addition, each year, a carefully chosen percentage (for example, 15 percent) of the faculty members in the college could participate in the institute (joint appointments) for terms ranging from one semester to three years. In this way, faculty members would have an opportunity to renew their teaching skills every six to seven years. Faculty members participating in the institute will apply practices under goals 1.1 and 1.2 to innovate courses in their home departments. In addition, it is anticipated that the institute will be the focal point for research and innovation in engineering education across the college. Graduate students could conceivably earn an engineering doctorate for their research in engineering education either through an interdisciplinary engineering program or departmental doctorate programs, if there is sufficient interest among a group of faculty members in any given department.

Given the current academic model in the college, a department is the most familiar and arguably the strongest entity to ensure quality and programmatic focus, it is nevertheless considered too divisive in the near-term to integrate a new cross-cutting Department of Engineering Education among the discipline-defined departments. In this traditional academic model, a Department of Engineering Education would compete with other departments for faculty members and resources, as opposed to serving a mission of enabling all the other departments generally. The institute envisioned here can be designed to support a broader scope of faculty development and to potentially influence teaching practices of all engineering faculty members. Moreover, the institute could admit as joint appointments faculty across the university with a vested stake in teaching undergraduate engineers. The institute is envisioned as interdisciplinary, including engineering faculty members as well as faculty from the science and math disciplines, learning scientists, education faculty members, and faculty members with expertise in organizational change.

Strategy
Identify and recruit a resident core faculty dedicated to the institute’s main mission of enhancing engineering education.

Motivation
The college will need to recruit a permanent faculty for the institute who would dedicate academic focus to the subdiscipline of engineering education. This would include development and teaching of cross-disciplinary...
courses to support the teaching of critical engineering skills and competencies (e.g., systems thinking, elements of design, technical communication, etc.), the development of competitive proposals to federal agencies (e.g., NSF) that award funds for innovative engineering education programs, as well as the conduct of publishable research needed to ensure the continued academic standing and reputation of this academic unit. Given the recommended structure of institute vs. department, faculty specializing in engineering education would not make up the entire complement of faculty for the institute, but would provide the intellectual focus and fundamental drive for the unit.

Strategies

- **Identify and incentivize faculty to hold non-permanent joint appointments with the college’s academic departments (or with other units across the university) to prototype an expanded cross-disciplinary teaching cadre for the institute.**

- **Recruit a new genre of faculty with significant practical engineering and design experience in industry to support the institute’s mission for enhancing experiential learning in the college.**

- **Develop a set of academic career incentives for faculty from across the college to participate with the institute.**

Motivation

The core faculty academically specializing in engineering education will need to be complemented by a certain number of faculty members recruited from the other departments of the college to spend a few years on an internal sabbatical in the institute. The goal of this assignment would be to enhance their teaching skills in areas that address critical engineering competencies (themselves not discipline-specific). Through collaboration with the permanent institute personnel, educational innovations could be developed and transferred over time to the rest of the college. A new role for visiting design professors or professors of design practice recruited from industry or the national laboratories could also be introduced to interface closely with the activities of the institute and to provide a fresh and ever-current perspective on design, systems thinking, and planning and execution of capstone-like design projects. This could serve a very meaningful outreach role to American industry, encouraging it to develop a more direct formational stake in the education of its future workforce. The institute would potentially serve to break down traditional stove-piped barriers between engineering disciplines and would begin to model for undergraduates the nature of the workplace into which they will transition. Based on past experience at other institutions, one of the key enabling conditions for these strategies to succeed will be to ensure that faculty of the institute will not in any sense be considered second-class citizens of the academic community. This obviously implies special consideration for this experience in the tenure and promotion process within the Look College, as well as a renewed emphasis on the peer-reviewed scholarly publication of literature addressing issues in engineering pedagogy. The enduring challenge to the college will be to maintain balance between developing a world-class engineering research effort in all the constituent disciplines, as well as multidisciplinary research in centers, while at the same time developing institutional balance through emphasis on engineering education and pedagogical tradecraft.

**Strategy**

*As an initial programmatic milestone, prepare a formal proposal for the re-engineering of the freshman or lower-level academic program.*

Motivation

The status of the freshman engineering experience—specifically the consideration of value provided by ENGR 111/112 (Foundations in Engineering) to the overall engineering education of Look College students—tended to dominate early discussions in our strategic planning process. However, with time we realized that this narrowly focused discussion was merely an iconic stand-in for the much broader need to transform engineering education. Transformation would need to address the uneven K-12 preparation of incoming engineering freshmen in the context of a fixed four-year curriculum designed to attain educational program objectives, itself challenged by the unprecedented creation of knowledge through discovery in the technology arena. When sophomore, junior, and senior students are exposed to multiple, concurrent, experiential learning experiences, transitions for students entering Texas A&M from high school
can be intimidating. Therefore, this plan envisions that redesign of the first-year experience will be critical, because in addition to addressing concerns about the number, diversity, and preparedness of students entering upper division engineering programs, there will be a need to prepare entering students for new demands of experiential learning opportunities in the upper division programs. Moreover, many foundational elements for the future first-year engineering experience that can address these expectations are advanced as follows:

- Proficiency with mathematical and scientific fundamentals
- Practice with design fundamentals
- Practice in applying systems thinking
- Hands-on and experimental competencies
- Critical thinking
- Abilities to structure approaches to complex problems

Therefore, one key aspect of the continuing transformation of engineering education involves key decisions about improving courses that are the core of the first-year experience: calculus, physics, chemistry, and English.

Finally, the entire undergraduate experience needs to be knit together in a way that provides continuity from freshman year through graduation. Therefore, although this plan envisions the first-year program proposal as a deliverable for the proposed Institute of Engineering Innovation, in practice it must result from a close collaboration among the traditional engineering departments and the institute. Our program will be more effective the sooner students can discern the specific engineering discipline in which they can thrive most productively, inspired by a realistic understanding of the careers they are pursuing. The interfacing of any re-engineered first year program with the upper level programs in the multiple departments of the Look College will be critical in this endeavor. Thus, the Institute of Engineering Innovation will need active support, feedback, and guidance from the disciplinary departments.

**Indicators**

- College attains staffing goals for the Institute of Engineering Innovation based on targets developed in the implementation plan
- Department surveys indicate satisfaction with the Institute of Engineering Innovation as creating positive value for their teaching mission (advancing teaching skills of faculty and preparing lower-level engineering students for upper-level disciplinary curriculum)
- NSF grants awarded to institute faculty reach $2 million and/or a sustainable level identified in the implementation plan
- Development activity results in the naming of the Institute for Engineering Innovation
- Physical space and facilities are dedicated to support multidisciplinary experiential learning through team-based and technology-enabled brainstorming, designing and prototyping

**GOAL 1.3**

*Demonstrate that Texas A&M engineering graduates have distinguishing world-class capabilities.*

Any initiative intended to promote increased student learning or improved student abilities with respect to widely valued learning outcomes, (e.g., analysis, problem-solving, innovation, design, ethical reasoning, lifelong learning, valuing diversity, leading diverse and/or global teams, etc.) that does not assess student achievement is destined to fail. This is so, either because achievement of intended goals is not demonstrated and documented, or because doubts about achievement of intended goals are not satisfactorily addressed. Thus, the development of what constitutes “world-class” must first be identified, then managed, and ultimately demonstrated. Assertions must give way to demonstrations, peer acknowledgement and ultimately, to self-realization.
Strategies

• **Annually provide to the departments a digest of best practices in engineering education from peer programs across the country, as well as a set of validated assessment tools for evaluating a broad set of potential learning outcomes.**

• **Employ college-wide systemic and systematic surveys and evaluations to assess that Texas A&M engineering graduates have world-class capabilities with respect to abilities most highly valued by graduate schools and employers, including development toward desired program objectives that reflect the broader set of critical skills and competencies needed for engineering practice.**

Setting this goal will certainly resonate with the ABET 2000 criteria, emphasizing program educational objectives and program outcomes, but will move assessment from a compliance and accreditation exercise to a more internalized dynamic continuing improvement process that emphasizes raising the bar rather than reaching the bar. Specifically, some avenue should be found to compare Texas A&M outcomes to broader indexes characterizing our institutional peer group.

Indicators

• **Reports in peer publications documenting capabilities of Texas A&M engineering graduates with respect to learning outcomes and developed professional competencies**

• **Positive feedback in student and graduate surveys reflecting on the skills and competencies acquired at Texas A&M, preparing graduates well for professional employment and career challenges**

• **Published descriptions of processes used in each engineering program and at the college level to assess critical engineering competencies**
FOCUS AREA 2:
GRADUATE ACADEMIC EXPERIENCE

Uncompromising Dedication to Excellence in our Graduate Program with a Focus on World-Class Research

BACKGROUND
Our long-standing and overarching objective is to be among the top five engineering graduate programs among public universities and among the top 10 overall by 2020. This objective, while ambitious, will focus our energies on making a necessary and substantial enhancement in our culture and approach to advancing the academic excellence and national perceptions of our graduate program. The key element in any strategy for attaining such recognition is the compelling relevance of the research undertaken by the college and its impact upon the engineering grand challenges of our time.

To propel the Look College graduate program into an excellent peer group in national and international arenas, it is important that the constituent college programs: be the choice departments of prospective graduate students; our graduates be the choice of hire by industry, academia, and national laboratories; and our graduate students and faculty be the choice resource for industry and government to address their mission-relevant technology challenges. In fact, contemporary engineering challenges, innovations, and breakthroughs also frame the objective of uncompromised excellence in graduate education. Such challenges are transdisciplinary, and the Look College needs to recruit students who have the passion, knowledge, and abilities to address these challenges. Correspondingly, the college needs to provide the interdisciplinary intellectual environment in which these emerging scholars can flourish and eventually build a reputation as nationally and internationally recognized leaders of thought and action in industry, government, and academia.

The goals and strategies identified in this area collectively address the challenge of attracting, inspiring, preparing, and promoting the most dedicated graduate students in the nation. The main vehicle for achieving this level of excellence will be the research program that will engage their intellects and passion.

GOAL 2.1
Attract top-notch students to our graduate programs.

Strategies
• Continue to be highly selective in recruiting graduate students, demanding demonstrated quality and diversity of backgrounds/perspectives over quantity.
• Benchmark assistantship rates to remain competitive among our academic peers.
• Promote more vigorously the dean’s National Excellence Fellowships and create a competitive climate among departments to seek and attract graduate student candidates who can win these fellowships.
• Create a supportive environment to assist prospective graduate students in preparing federally sponsored fellowship applications.
• Aggressively raise endowment to support graduate students in the form of fellowships and tuition and fee scholarships. Incentivize department heads and college administration to raise endowed graduate fellowships by emphasizing the critical role of research and development to the economic and national security of our nation.
• Incentivize faculty to increase faculty research funding productivity to support an appropriately large number of funded graduate student advisers.

Indicators
• Acceptance rate for incoming graduate students is methodically driven down under 30 percent
• Documented average quantitative and verbal GRE scores show consistent trending upwards over the next 10 years from the values recorded in Fall 2008 (754 and 492, respectively)
• Admissions of self supporting students are primarily directed toward the non-research based Master of Engineering (non-thesis) program
• Research teams supported by graduate faculty will incorporate undergraduate students as graduate students take ownership of research responsibilities and mentor undergraduates in the research teams.

GOAL 2.2  
Nurture a diversity of perspectives in the graduate program.

Motivation
A strong correlation can be drawn between innovation and the confluence of multiple, diverse perspectives. However, a strong volume of input from our students, faculty, and stakeholders suggesting that diversity initiatives are too often undercut when not aligned with academic performance and excellence. Any initiatives planned along these lines should be carefully implemented to maintain a central focus on excellence as it can be enhanced by the diversity of background experiences, cultures, and perspectives of our students and faculty.

In addition, the landmark National Academies’ “Gathering Storm” report also highlights attention to the importance of innovative science and technology as the mainspring of our nation’s economic strength. In its recommendations the National Academies’ panel recommends that the United States strive to provide “the most attractive setting in which to study and perform research so that we can develop, recruit, and retain the best and brightest students, scientists, and engineers from within the United States and throughout the world.”

Strategies
• Escalate outreach activities with predominantly undergraduate institutions to increase the pool of applicants to our graduate programs; in particular, engagement with institutions with predominantly underrepresented student populations must be a very high priority.
• Strengthen the “pipeline” of students from A&M System institutions, bringing their most promising undergraduates to pursue graduate studies in the Look College.
• Initiate active recruiting campaigns at our peer institutions with higher representation of underrepresented populations in undergraduate programs.
• Continue to conduct and advertise GEM Fellowship workshops (National Consortium for Graduate Degrees for Minorities in Science & Engineering) to recruit and retain underrepresented student populations.
• Continue to participate in recruiting events sponsored by underrepresented population professional organizations, such as the National Society of Black Engineers, Society of Hispanic Professional Engineers, and Society of Mexican American Engineers and Scientists.
• Aggressively seek NSF Research Experience for Undergraduate Students (REU) grants in order to maximize the benefit of diversity initiatives at the undergraduate level.
• Create a formal Graduate Forum to address the climate for diversity in the Look College and to provide regular feedback to the dean for continual improvements designed to enhance retention and placement of graduates with advanced degrees.

It is imperative that the demographics of engineering graduates with advanced degrees more closely mirror that of Texas to ensure maximal impact on the societal and economic wellbeing of the state. In order to prepare and nurture a diversified workforce along these lines it is imperative that the underrepresented student population increase. Although the college has made great strides in increasing the number of female, African-American, and Hispanic students, ratios of underrepresented students compared to the total enrollment have remained flat except for female students between Fall 2003 to Fall 2008.

In addition, historically over 60 percent of our graduate student body has been international. The college values educating international students with advanced engineering degrees who choose to make the United States their home, thus contributing towards the advancement of engineering technologies within the nation. In addition, these students are an asset to industries engaged in global business. However, as a state-supported institution, our priority is to educate American citizenry at large and Texans in particular. In this light, the Look College must maintain a better balance between domestic and international students. Currently the majority of international students are from India, China, and Korea. To achieve a better strategic balance and engage countries south of our
border, it is imperative that we increase the number of graduate students from Mexico, Central America, and South America. This would be consistent with numerous demographic projections that address the importance of growing trade relationships between Texas and its most proximate international neighbors. Specifically, we propose to achieve the following milestones in the next five years:

**Indicators**
- Increase the domestic graduate student body to 50 percent of the total graduate enrollment, simultaneously meeting the indicators for Goal 2.1
- Increase the underrepresented minority student body to 10 percent of the total graduate enrollment, simultaneously meeting the indicators for Goal 2.1
- Monitor the number of graduate students from Mexico, Central America, and South America. At least 10 percent of our international students should be from this strategically important geographic region

**GOAL 2.3**

*Enhance the quality of graduate education by establishing higher standards and emphasizing the central importance of research within the broad engineering enterprise.*

**Motivation**
At the graduate level, it is the quality of our program that attracts both faculty and student talent to our college and builds our reputation. While our college is ranked among the top 10 public institutions, we have the ability and strong ambition, but perhaps not the resources, to move higher. In order to impact national rankings it is necessary to dislodge some prestigious programs with long track records, realizing this ambition will be expensive and will require strength of inspired leadership. The venture will require a concerted, long-term effort focused on enhancing overall program quality. This will clearly be impacted by the quality of faculty, the quality of incoming students, and the quality of graduate education that we impart. However, stature is arguably most influenced at the graduate level by the quality and impact of the research that we conduct and publish. Therefore, program emphasis must align along the general direction of bringing graduate students to research readiness in a very timely manner. Other factors supporting general program quality include curriculum relevance and rigor, effectiveness of doctoral qualifying exams, interdisciplinary course offerings, and mission-inspired interdisciplinary research projects. All of these quality factors, superimposed upon our fine Aggie tradition of state and national service, are within our reach, provided the strength of our leadership can overcome the natural academic tendencies to protect the status quo. This will demand the nurturing of a shared vision between the dean and department heads of the Look College. However, the single greatest imminent threat to our relative standing among national programs is the rollback in faculty reinvestment prompted by recent budget cutbacks at the state level. If such a rollback serves to quash a historic initiative, it will take much more than a strategic plan to mitigate the consequences over the next five years.

Discussions should continue regarding the relative importance of encouraging Texas A&M undergraduates to seek graduate studies here, as opposed to encouraging them to diversify their academic careers by attending other graduate programs. The overarching emphasis on excellence dictates that we strive to ensure that our very top students consider themselves welcomed and recruited here, just as we recruit the very best students from other national undergraduate programs.

**Strategies**
- Incentivize departments to manage their graduate enrollment to facilitate smaller graduate classes and achieve the desired faculty-to-graduate student ratio.
- Incentivize departments to offer new and interdisciplinary graduate courses.
- Incentivize departments to require Ph.D. qualifying examinations on a timeline not to exceed two years.
- Incentivize faculty to participate in interdisciplinary research, establishing mission-oriented centers only if this helps to promote such collaboration.
GOAL 2.4
Create a nationally recognized forum for conversation on new paradigms in graduate education and engineering research.

Motivation
Recognized excellence of our engineering program need not be in conflict with the founding principles of land grant institutions. However, the ever-present tension between size and quality will demand innovative approaches that will need to be well founded in research and practice, and will demand resources for proper implementation. Although the primacy of both quality and impact of the college’s research program in securing national recognition will never be displaced, approaches for preparing graduate students for high-impact careers in academia, national laboratories, and industry will benefit synergistically from the activities and effort proposed by this strategic plan under the Institute for Engineering Innovation. Such approaches would also enable the benefits and excitement of a dynamic, world-class research program to feed back more effectively to undergraduate education.

Any developments in this regard will require a national audience to provide an avenue for sharing and validation. Texas A&M will need to participate in a more meaningful way in the global marketplace of ideas, negating any image it may have as a celebrated, but nevertheless parochially focused, institution.

Strategies
- Host an annual summit of leaders in engineering education and industry—as well as policy-makers in government and non-government agencies—to discuss future trends in graduate education and emerging “Grand Challenges” in research.
- Increase the number of distinguished Dean’s Lectures to one per month during regular semesters. Departments should take the lead in inviting and hosting at least one such national-level speaker per year.
- The Look College should play a leading role in the Texas Advanced Study Institute that has been proposed in the recent Academic Master Planning Process.

Indicators
- Graduate enrollment indicators make steady progress toward higher quality candidates, particularly from targeted peer undergraduate engineering programs in the United States
- Tracking indicators show a growing faculty interest in applying for joint appointments to the Institute for Engineering Innovation
- Engineering faculty begin to gain wider recognition in the American Society for Engineering Educators
- The number of undergraduate students participating on research teams with faculty and graduate students shows a continuing increase

• Raise funds to build new offices and/or acquire existing space on campus to enhance office space for graduate students.

Indicators
• At least 20 percent of the course offerings in the graduate curriculum are special topic (689) courses
• At least 10 percent of the graduate course offerings are cross listed among at least two departments
• All engineering departments conduct an objective Ph.D. qualifying examination to ensure that doctoral degree recipients have broad competencies in their discipline and are qualified to proceed with their Ph.D. program
• Increase graduate student office space to 50 square feet per student, an increase from 34 square feet per student in Fall 2008
• The floor space of college-wide interdisciplinary research facilities is monitored and shows continual increase over the next five years
• At least 20 of our Ph.D. graduates per year pursue their careers in academia
**FOCUS AREA 3: RESEARCH PORTFOLIO**

Developing a World-Class Research Portfolio

**BACKGROUND**

An early deliverable in this strategic planning process was the formulation of a 10-Year Research Plan that identified several signature research areas for the Look College inspired and informed by the current technical strengths across the college. This was accomplished and delivered to the university December 8, 2008. The plan, in its entirety, as posted during the University Academic Master Planning/Strategic Research Roadmap process, accompanies this report as a standalone volume. Salient findings and appropriate action plan are included here, integrated within the framework of the college’s strategic plan.

The five signature research areas for the Look College distilled by this process were designed to be at once both relevant to external sponsors of research funding, as well as inspirational to faculty and students. Correspondingly, these targeted areas necessarily lie at the confluence of compelling national missions and contemporary cutting-edge science and technology, the latter promising substantial transformative potential for the former. The five signature research areas are now summarized in turn:


   The imperative for our nation to seek energy independence cannot be overstated and it is inconceivable that the research portfolio of any university, national laboratory, or many commercial enterprises would not include an energy-related initiative. Continuous access to reliable, adequate energy is the foundation of any advanced civilization with a thriving economy and standard of living that is continually improving. The geopolitical realities of the 21st century no longer support our nation’s heavy reliance on fossil energy resources under the control of foreign governments that are hostile or significantly at odds with the democratic political principles and foreign policies of the United States. However, unlike responses of past decades, the most significant aspects of the today’s challenge will be to provide for economically attractive sources of energy as well as promote fuel efficiency so as not to exacerbate global climate. Energy production will only be sustainable with first the mitigation, then the elimination, of carbon emissions that currently contribute a huge fraction of the global warming effect. An integral element in all such systems will be impact on the water resources. From the standpoint of sustainability, the societal, environmental, and economic aspects of water resources cannot be overstated—these may be on par with energy itself. Virtually all energy alternatives affect and are affected by the availability of adequate supplies of water of sufficient quality. The competition for water resources in energy development must be balanced with the needs for human and environmental health. Whereas the energy technologies of the past focused mostly on the significant aspect of generating energy at the lowest cost, the contemporary science and challenge is to design and engineer complete energy systems that generate, convert, and use energy in an efficient manner, taking into consideration the full life-cycle effects on the environment: from obtaining fuels through managing all waste streams and effluents, as well as addressing other societal factors.


   In the next 10 years, the worldwide war against terror will define the international security regime like no other, and the technical community will be challenged to focus its attention on discoveries and innovative applications of technology to defeat such an asymmetric and ubiquitous threat. A terror attack with a WMD (nuclear, biological, or chemical) weapon could arguably destroy the political foundation of any targeted nation. Our nation may even have to face the possibility, and establish the capability, for absorbing and recovering from an isolated incident on this scale. To defeat such a threat, the nation will call on technology to offer a paradigm-changing capability with an effect on par with the nuclear
weapon in World War II. To date, there has been no “silver bullet” identified for this purpose. Arguably the greatest transformative impact on defending against terrorism will result from advances in technologies that enable improved intelligence-gathering and accelerate inferences that can be made, hopefully in real-time, from the data. A program of research is advocated that extends across the basic science and engineering disciplines, the social sciences, economics, and national and international policy disciplines. National security research challenges map well onto the traditions, current academic strengths and ambitions of Texas A&M. Fundamental advances offer many ancillary positive impacts in broad sectors of our society and economy. Furthermore addressing these challenges in a multidisciplinary fashion will engage the university broadly to ensure research priorities and goals address both engineering and technology solutions, but also broader policy, economic, environmental, and societal impacts. Three key pillars of scholarship and innovation include:

- Sensors, detectors, and imaging
- Mathematical modeling and simulation
- Autonomous systems

3. Engineering an Improved Quality of Life (Health Care)

At no time in history has the potential for revolutionizing health care been greater. Sequencing the human genome—coupled with parallel major advances in molecular and cell biology, biomedical imaging, computational methods, and the development of advanced biomaterials, biosensors, and biomedical devices—promises to enable personalized medicine and surgery in the near future. Advances made in this signature area will contribute most significantly to improving health care, and thus quality of life, while also advancing basic science and technology, and providing a significant economic impact at local, state, and national levels. Great potential exists at Texas A&M to continue to unravel the mysteries of life by gaining insight into the normal genetic, molecular, and cellular mechanisms that underlie biological processes, as well as by better understanding disease progression, responses to injury and clinical treatment, drug effectiveness, device-tissue interactions, and so forth. Indeed, engineering will be fundamental to achieving the goal of true predictive biology and pathobiology that will enable personalized medicine and surgery. Advances in this area must occur across scales—from molecular to organ-level—and there are will be opportunities to build multiscale understanding. Three pillars of scholarship are recommended for this area:

- Systems biology, computational biology, and medicine
- Biomedical imaging and biosensing
- Biomaterials and biomedical devices

4. Infrastructure and Transportation: Ensuring Capacity, Resiliency, Safety, and Sustainability

Our nation’s economy, security, and quality of life are inexorably linked to the quality, capacity, and sustainability (reliability, resiliency, and environmental impact) of our infrastructure and transportation systems. Infrastructure systems include buildings, bridges, highways, tunnels, railroads, airports, ports, dams, levees, offshore platforms, pipelines, power generation facilities, electrical transmission and distribution systems, and coastal structures. Many of these systems were built in the middle of the past century, have been poorly maintained, and were never designed for the demands that have resulted from population growth and shifts in population centers. Numerous studies and reports have identified the general condition of aging and failing infrastructure systems in the United States. The most notable has been a report card issued by the American Society of Civil Engineers in 2005 that gave an average grade of “D” to America’s infrastructure. The systems covered by the term “infrastructure” are critical to the sustainable habitability and economic development of communities, regions, and countries. In fact, the forces of globalization have now focused the spotlight on the imperative to modernize the fundamental structures that support civilization. Only by paying attention to these needs will the world be able to more broadly share the wealth and resources across the Earth and to level the playing field for worldwide economic development.
Moreover, focus on the war against terror since 9/11, as well as highly publicized impacts of natural disasters such as Hurricane Katrina and tsunamis in Southeast Asia and Japan, has heightened concern regarding the vulnerability of our infrastructure and the interconnected consequences of its failure. The problem is a global one, no longer limited to individual nations and regions. Key pillars of scholarship and innovation include:

- Advances in composites and materials
- Systems analysis, networks, and computational tools
- Next-generation infrastructure systems

### 5. Providing the Tools to Transform Research and Society: Informatics and the Knowledge Economy

The development and spread of computing and networking technology has transformed our society over the past two decades. The collection, transmission, and management of data and information are now critical components of our advancement in engineering and science, our national security, and our economic development. Improvements in our capability to reliably manage and use ever-increasing levels of data and information will thus be major catalysts of advances in a wide range of applications. Key application areas include emergency response; high-fidelity, predictive simulations employed in engineering analyses; ubiquitous sensor systems; military operations; scientific observational experiments; real-time monitoring and surveillance in intelligence gathering; manufacturing-process monitoring; treaty-verification monitoring; medical records and personal information; and digitalization of archival library and museum collections. More attention is now being paid to how such data can be effectively manipulated, transmitted, understood, and used. Often, the growth in data and information available has outstripped our ability to effectively deal with it. This poses a major research challenge, with common problems that cut across a wide range of application domains. Advancements will have an impact not just on the other signature areas, but also across a full range of research endeavors, and on the fundamental processes that are increasingly driving our economy. Key pillars of scholarship for this signature area include:

- Reliable communication networks
- Cybersecurity
- Management of data and its conversion to information
- Visualization and human interfaces

### The Action Plan

The following goals and strategies are recommended to help the college focus its activities and proposal development to be most attractive to external sponsors, especially federal agencies with significant research and development funding responsibilities.

#### GOAL 3.1

*Establish multidisciplinary research institutes that cut across the college and university departments to address nationally significant technology challenges.*

### Motivation

The dean of engineering has already chartered an Energy Engineering Institute (EEI) as an early first step in implementing this particular goal. With support from the chancellor and significant buy-in from the college’s departments, EEI has begun to craft a strategic plan based on scenario-building workshops that were represented by many of the departments and components of the A&M System. An organizational structure and governance mechanism has been discussed, but is awaiting more complete implementation.

The major implementation challenge in addressing this goal will be to create a truly engaging multidisciplinary intellectual environment in the institutes that will be attractive to college faculty (from a career perspective) and will inspire creative proposal activity that will substantially add value above what otherwise would be achieved within the individual departments. If departments need to dedicate as much, or more, effort to sustaining successful research efforts in these institutes, or if the flow of research funding through...
institutes is not substantially higher than could be achieved by developing successful proposals from the departments themselves, then the institute model will undoubtedly fail. Hanging an “institute shingle” is not enough to claim success.

Successful implementation will demand both leadership and resources, to include administrative staff and affiliated research staff for proposal preparation and support to program execution. Institute leadership will be required to focus on both external program development and relationship building with sponsors, as well as sustained internal focus on mentoring, collaborative problem solving, and research execution among institute faculty. The latter function is usually neglected in academic environments because faculty independence is typically a guarded and paramount academic value. However, building a signature brand among external sponsors that is founded on successful development of a creative technical approach to addressing mission-related challenges will be a key element of success for these institutes. Intellectual leadership and mentoring will be demanded from senior, seasoned researchers. Governance of the institutes must reflect explicit attention to both external and internal functions. It is recommended that faculty participation in the envisioned institutes be formally recognized in joint appointments with their departmental affiliations. In special cases, actual co-location of institute faculty will be required to build the unique intellectual identity with the proper depth of socialization.

**GOAL 3.2**

**Incentivize faculty to pursue dilemma-based research as a departure from traditional discipline-based research.**

**Motivation**

A key element in breaking down barriers to collaboration among faculty in separate departments will be creating a sense of uniqueness to the research that can be accomplished efficiently within the multidisciplinary climate of the institutes. The signature areas of research identified by this Strategic Plan were specifically structured to represent scientific and technology challenges that attended challenging dilemmas for contemporary society. Hence the importance of mission criteria that were employed in the strategic planning process. Problem formulation and execution in the institutes would be more akin to programs developed at the national laboratories, albeit at a more basic level of research or technology readiness most closely approaching publishable exploratory investigations. In order to attain this goal, the opportunity and time to publish in peer-reviewed journals must not be compromised for participating faculty. Thus the importance of providing a sufficient resource level for other non-academic functions of the institutes. The following two strategies are recommended to aid in the achievement of Goal 3.2.

**Strategies**

- **Create proper incentives in the tenure and promotion process.**
- **Establish special recognition for these efforts in faculty annual reviews.**

**Motivation**

In order to engage faculty—most importantly probationary faculty—in multidisciplinary research efforts, the university provides the Look College with enough latitude to integrate required incentives in the promotion and tenure process. However, this should be done explicitly with specific documented guidance. As part of the implementation process for this strategic plan, every college department would be encouraged to develop corresponding promotion and tenure guidance to incentivize junior faculty to work productively across traditional department boundaries in production of scholarship along the lines of the mission-inspired areas that are highlighted in the new institutes.

**Strategy**

*Create a dean-sponsored Invited Lecture Series to highlight national and global technology challenges.*

Finally, the dean regularly sponsors distinguished speakers from industry, academia, and government to visit the college and present lectures at specially designated events. It would be a simple adaptation to use this series of talks to specifically highlight the technology challenges in the mission areas identified by the strategic plan, providing another avenue for inspiring creative scholarly engagement in the Texas A&M engineering research and development program. In fact, the departments could sponsor such talks on behalf of the Look College on a rotating basis.
**GOAL 3.3**

*Adopt a portfolio management approach to strategically grow research in the signature research areas.*

**Motivation**

In the spirit of the popular maxim “If it is important, it should be measured; if it is measured, it will become important,” one simple way to develop energy around the college’s signature research areas would be to adapt TEES web-based research activity reporting to capture the specific cross-cuts that represent proposal and funding levels related to each of the signature areas. This could be done with or without standing up specific organizational structures, such as the institutes recommended in this plan. Generated data would document corporate college success in focusing a significant portion of its total research activity along the lines suggested by strategic considerations. Results would also provide useful information for the next cycle of strategic planning. Two specific strategies can be identified to support meeting this particular goal:

**Strategies**

- *Implement college-wide portfolio tracking in the EPIK research database to capture all activity across departments and institutes.*
- *Identify funding growth targets for the specific portfolios.*

The latter strategy would require prioritization among the separate research areas, factoring in the extramural funding climate and evolution of government and industry sponsored research priorities. As appropriate for an academic enterprise, the envisioned “portfolio management” would result less from edict and direction than from inspiration derived from faculty contributing to globally and nationally significant missions. Cyclical strategic planning would facilitate continuous alignment with these missions, validated by the tracking of growth in sponsored award funding.

**Indicators**

- Success in establishing at least three institutes aligned with the signature research areas in the next five years
- Attaining funding levels of $10 million to $25 million in each of the signature areas across the Look College (including funding in institutes, as well as unaffiliated research projects)

- Total funding level over all signature areas at least 50 percent of all college research expenditures
FOCUS AREA 4: FACULTY AND STAFF DEVELOPMENT

Enhancing Faculty Achievement and National Distinction: The Challenges We Face

BACKGROUND
Enhancing the strength and academic reputation of faculty in the Look College has been attributed to improving our national rankings from the mid-teens to the Top 10 among public institutions. Since 2000, we have already benefitted from a crucial first step, a major reinvestment of resources to hire a net increase of 113 new faculty. (When retirements and attrition are taken into account, 216 professors have actually been hired since 2002.) These hires have been mainly in the assistant (164) and associate (22) professor ranks, with only 30 full professor hires. These new faculty members were the result of national searches that netted an exceptional group of high achievers whose maturation will should result in substantial long term enhancement of our program. However impressive and vital, these hires are likely not sufficient to raise our faculty distinction at a rate needed to solidify a position for our program in the U.S. News & World Report top 10 rankings by 2020. Unfortunately, since our strategic planning process was initiated, plans for significant budget cuts at the university for FY11-13 pose a clear and present danger to these faculty reinvestment gains.

The reinvestment in primarily young faculty has also brought several challenges into focus:

- Startup packages to launch these new faculty hires have consumed most of the college’s discretionary funds over the past five years. The present economic climate indicates that discretionary funds for pursuit of excellence will remain difficult to obtain even though the rate of faculty growth has now flattened.

- Investment in facilities, equipment, and laboratories have not been able to keep pace with faculty growth. The new Emerging Technologies building and other space re-allocations are helping on space and laboratories, but acquiring needed resources for existing equipment/laboratory upgrades, and reinvestments remain a challenge. The need for such facilities is particularly acute in the emerging multidisciplinary technical areas that would serve as a crucible for future discovery and innovation.

- The academic climate must be optimized from the point of view of the career development of these 216 new faculty, in order to get the return on this human resource investment. There are multiple aspects of this issue, but perhaps the largest broad challenge is helping the 186 young assistant and associate professors connect with the best and brightest in their fields in ways that enhance their national and international visibility, and to position them for success at the highest level.

These challenges all involve finding new, or redistributing existing, resources, as well as implementing informed strategic planning to ensure a future with enhanced distinction of the college.

Besides direct application of resources to support the continued professional development of the new junior faculty, arguably the most important (but somewhat less tangible) factor for their success involves the degree of collegial support, collaboration, and mentoring that is available at Texas A&M. Such mentoring can best be provided by senior faculty enjoying national and international reputations in their chosen fields of endeavor. One indicator of such recognition is election to the NAE. As we look at our target peer group, we observe that our NAE membership lags all but one of our top 20 peers. The average NAE membership for top 10 programs is 45, whereas the average of the “second 10” peers is 22 (19, if we exclude UT-Austin), and the average of the public institutions in the top 20 is 27. Thus, there is a substantial gap in the NAE membership between Texas A&M and our peers. We see a compelling message in this comparison to significantly increase the number of our senior faculty with an NAE-level of distinction. Obviously, we should not pursue improving on this measure blindly, without paying attention to other aspects of our program, and especially without very carefully hiring and developing
stellar faculty at all levels who indeed add significant strengths to our program.

Our ability to attract and/or develop high-achieving senior faculty is coupled to many issues that define the overall quality and attractiveness of academic life in our college compared to our peers, including factors we can institutionally influence:

- Perceptions regarding the national visibility and desirability of our engineering programs
- Critical mass of existing faculty, students and quality of existing research programs
- Our ability to assemble competitive levels of resources needed to attract highly recruited faculty
- Availability of relevant and up-to-date laboratory facilities

In order to make progress significant enough to impact the national distinction of our engineering programs over the next decade, we will need to pursue several goals with sustained effort and commitment. This commitment will require active support from the university, the A&M System and the State of Texas.

**GOAL 4.1**

*Achieve 30 NAE members as full-time tenure-track faculty by 2020.*

It is felt that reaching this goal will place competitively in the top tier of public institutions in the nation. These numbers will change by an unknown degree in the future. Because the total NAE academic membership is growing by only about 30 new members per year, we know that dramatic average growth of new NAE members across all institutions is unlikely, but migrations and importing industrial NAE members is possible. If some institutions are increasing NAE members significantly, others will likely be losing NAE members at a comparable rate. During the current economic climate, there are likely opportunities to hire a few stellar faculty members from institutions where economics-related issues have degraded the attractiveness at their current home institutions. We anticipate approximately 15 faculty per year will be lost to attrition. Assuming authorization to replace these faculty in a no-net-growth environment, there would be opportunities to hire new faculty at a rate of about 15 per year. To address this goal, approximately half of the new hires (six to eight per year) should be aimed at very senior faculty with well-established career momentum, and at least two per year of these hires should be aimed at attracting NAE or NAE-caliber faculty. If successful, we should be able to ensure a net increase of our NAE pool of faculty and that one or more NAE faculty could be added to each department, approximately doubling our current NAE membership.

**Strategy**

*Extensively utilize the Advanced Study Institute proposed as part of the University's Academic Master Plan to bring candidates here for a one-year term to promote collaboration and to evaluate the feasibility of permanent relocation.*

The Advanced Study Institute has been proposed as an element of the Texas A&M University Academic Master Plan. The Research Roadmap Committee of the university-wide planning process recommended that the envisioned institute be composed of approximately 20 members continuously in residence as a five-year goal. A goal of actually recruiting one-third of those brought here as members was considered to be realistic. The institute was envisioned as a virtual unit, housed within the university as a cross-college entity. Each member appointee would be affiliated with one or more collaborating academic units. The Advanced Study Institute would “increase the visibility of the research being conducted at Texas A&M, foster affiliations and collaborations between our young faculty researchers and their most accomplished peers nationally, and encourage prominent scholars to join the Texas A&M faculty.” In the draft final report of the Academic Master Plan (September 2009), the creation of an Advanced Study Institute was included as a performance indicator, enabling the university to “attract a cadre of world-class senior scholars as visitors and permanent residents of Texas A&M.”

**Strategy**

*To create the proper environment for career mentoring, target half of all new hires (six to eight per year) at very senior faculty with well-established career momentum in selected fields,*
with at least two per year of these aimed at attracting NAE or NAE-caliber faculty.

With our own university academic budget under pressure, the specific sustainable hiring rate will need to be set by the dean, working closely with the department heads. However, some fraction of the replacement rate for attrition must be reserved for such senior faculty. This would address the stated strategic need, but would slow down the rate of closing the NAE gap.

**GOAL 4.2**
*Retain and accelerate careers of faculty hired during the reinvestment period from 2002 to 2008.*

**Strategies**
- Establish 12 or more Career Enhancement Faculty Fellow Awards of $25,000 each for five years to reward newly promoted associate professors (approximately one per department). This investment (equivalent to about $500,000 endowment for each Faculty Fellow) will incentivize and accelerate mid-career faculty and help retain some of the top performers from the 2002-2008 reinvestment hires.
- Highlight the research accomplishments of the reinvestment “cohort” faculty in special dedicated editions of the Look College research journal.

The imperative to ensure a diversity of perspectives as a means to promote innovation and creativity extends to the faculty of the college. However, any improvement in demographic representation will require a steady, continuing turnover of the faculty population in order to benefit most from any complementary changes in the make-up of the recruiting pool. This challenge is heightened if the demand for academic excellence is not to be compromised. In any conceivable circumstance, active (rather than passive) approaches to recruiting at the national level will need to accompany any, in fact every, faculty search. Again, budget constraints superimposed on the fundamental nature of a tenure-based seniority system create a very strong obstacle toward a timely reduction in the gap between identified diversity goals and availabilities in the national hiring pool. Nevertheless the urgent need to impact this issue by hiring role models for under-represented groups dictates that the status quo in faculty demographics be convincingly challenged.

**GOAL 4.3**
*By 2020, increase the total percentage of underrepresented minority (women, Hispanic, and African-American) faculty members from 32 percent to 40 percent of the total tenured/tenure-track faculty headcount, with a goal of 8 percent improvement in all three categories.*

**Strategies**
- Enforce guidelines to diversify the recruiting pool for all faculty hiring as an integral element of conducting a successful search process.
- Leverage development and endowment funds to create a college-level recruiting office that will assist all departments in promoting active, more extensive national searches. This effort would presumably include travel budgets for conducting seminars, presentations, and related recruiting activities.
- Join with the broader university to create a task force that would work with the appropriate civic bodies in Brazos County to identify joint initiatives aimed at creating a more welcoming civic environment that would satisfy the intellectual, cultural, religious, and social needs of a more diverse faculty in the neighborhood of the university.
- Make diversity of the faculty hired in each department an issue in department head evaluations, specifically in the charter/execution of each faculty search. A Diversity Plan, negotiated between the dean and department head, would set appropriate targets that reflect professional availabilities and the rate of hiring in the department.

Reflecting on our current faculty, state, and professional demographics, as well as the progress we have been able to make more recently, we recommend the percentage targets above—not because they are ideal in some sense, but rather to reflect our assessment that these levels are significant stepping stones consistent with exceeding our fair share of the national pools of well-qualified candidates.
Indicators
- Trending of the number of NAE faculty in the college over time
- Trending of the retained percent of reinvestment hires that remain in our faculty ranks over time
- Trending of the demographics in underrepresented minority faculty over time, compared to national availabilities

The trending referenced in the above indicators will depend on improved and centralized databases coordinated and maintained at the college level that will also identify corresponding baseline levels and benchmarks among peer institutions and professional groups.

Finally, although not a subject of extensive discussion during committee deliberations, the committee nevertheless believes that professional and administrative staff development and excellence must also be given appropriate attention in a comprehensive Strategic Plan. Many challenging goals have been identified in this body of recommendations. However, the paramount imperative to maintain academic excellence through research and teaching will continue to require the primary attention of the college faculty. Achieving the strategic goals in the implementation process will require substantial support from the ongoing efforts of the professional and administrative staff. With continued attention to streamlining bureaucracy, as well as improving efficiency and effectiveness while addressing academic budget pressures, greater management-level attention must be devoted to professional workplace standards and performance-based equity in compensation. The following goals are identified to promote uncompromised excellence in professional services and academic administration.

GOAL 4.4
Create uniform and transparent standards of staff support across the college and its departments, as well as centers and institutes.

Strategies
- Departments and other units publish their business plans annually, identifying their support functions and staffing levels.
- Merit “pools” are created at the college level for more flexibility in rewarding performance during annual raise exercises, particularly for positions that do not permit such “pool flexibility” in each individual unit.
- “Desktop audits” are conducted in job-leveling exercises by HR in order to gauge and facilitate and promote uniform standards of job content across the college.

GOAL 4.5
Create a sense of shared commitment to the college’s mission among the administrative and professional staff.

Strategies
- Involve administrative and professional staff in future strategic planning sessions.
- Create a formal set of coordination meetings in parallel to Department Head Council meetings as a means for creating a “sense of college” among the staff.

Indicators
- Timely coordination and completion of college-wide actions
- Improved communication and stronger alignment among departments
- Breaking down of barriers between departments
- Enhanced morale among staff (survey instruments)
- Improved administrative performance (survey instruments)
FOCUS AREA 5: K–14 ENGAGEMENT

Creating a Strong Partnership in Texas for Nurturing a New Generation of Engineers and Engineering Leaders

BACKGROUND

Over the past 50 years, technological innovation has improved the quality of life in the United States by creating new jobs and industries; developing new processes and products; enhancing the safety and efficiency of transportation systems; preventing and correcting environmental programs; and addressing the challenges of health care and development of new diagnostic methods and medical devices. The workforce of tomorrow will need highly qualified and creative engineers to translate scientific breakthroughs into innovative designs and products that will improve our nation's economic life and security. However, there is a very real danger that our engineering schools are not creating the most innovative professionals in sufficient numbers. The pool of available American engineers and scientists is decreasing even as the demand for them is increasing. Recent discussions in public forums gravitate to the threat of a possible elevated structural level of unemployment in the U.S. economy. This naturally points to the role of education in better preparing the modern workforce to adapt to new circumstances of the global economy, and to be more agile in career choice and development. The competitive future of the U.S. and the resulting quality of life depend upon successfully preparing our next generation of technology innovators.

The Look College readily accepts the challenge of attracting and inspiring the brightest students to pursue careers in engineering and technologically related fields. However, there are also aspects requiring consideration regarding the required rigor of engineering curricula and the challenges we face in addressing the academic needs and motivations of an undergraduate student population with less than ideal preparation for upper-level academic success. Although on close examination, attrition in engineering appears to be in line with attrition rates in other academic disciplines at Texas A&M, the attrition that nevertheless occurs has a disproportionate effect on the diversity of the eventual graduating population. In a professional field that is struggling to enhance its diversity, this outcome is decidedly unwelcome. Moreover, we also appreciate that, whereas continued focus on math and physics skills and knowledge is critical to engineering success; nevertheless, the inspiration needed to sustain students through a rigorous undergraduate program will depend more on perceived societal value of eventual career opportunities, together with the creative nature of the attendant problem-solving environments. These latter elements are typically not introduced into the educational process until attrition has already reduced the cohort of students. Developing both analytical skills, as well as the motivation to sustain students through engineering education, must begin significantly earlier than their freshman year at the university; hence the rationale for a focus area in K-14 engagement.

The importance of research to the engineering enterprise should also be reinforced in all outreach and K-14 engagement activities. Students who eventually contemplate engineering as a professional career should appreciate that mission-inspired engineering research, in addition to the more familiar basic exploratory scientific research, serves as an enabling driving force for development of applied technology. The latter is ultimately reflected in a growing economy and an enhanced level of national and global security. These links must be forged in the years before matriculation at the university, creating a stronger foundation for student success in a challenging engineering curriculum.

A more informed electorate should presumably result from enhanced K-14 engagement activities envisioned in our strategic plan. As observed in the recent budget cutbacks to higher education at the state level, the general public is not sensitive to the critical role engineering and engineering education play in generating the basis of a growing economy and preparing a workforce that has the skills, knowledge, and abilities to position the United States in a global
leadership role within the world economy. Key to regaining this role and maintaining it is the passion for lifelong learning and creative expression of design and innovation skill that inspire and motivate the most successful engineers. Our college must strive to cultivate an awareness and appreciation for these linkages among the voting public as an imperative for taking a pro-active step in shaping the general perception of our profession for the future.

GOAL 5.1
Be viewed nationally as a resource for model K-14 programs that address the strategic workforce needs of the engineering profession.

Strategies
• Scholarly research efforts in engineering education will be recognized and rewarded as part of the tenure and promotion process for faculty and staff.
• A focal point for coordination and direction of the college’s STEM activities will be created, including those with ESSAP.
• NSF CAREER faculty researchers will be regularly linked to Research Experiences for Teachers (RET) summer participants to help develop projects for their classrooms.
• Through the use of workshops and seminars, teachers will be engaged to help build greater public understanding of engineering and its benefits, with imparted knowledge and insights translated through their students and student families.
• K-14 STEM outreach will be effectively implemented through EPICS courses whereby engineering students will work with teachers to develop hands-on activities.

Indicators
• Publications in peer-reviewed journals and presentations at nationally known conferences, including those focused on community colleges
• Texas A&M engineering faculty will attain leadership positions within ASEE

GOAL 5.2
Influence the content of approved engineering high school courses in Texas.

Strategies
• Develop a focused and recognized Texas A&M collaboration among Texas educational institutions, directed at preparing secondary school teachers to introduce engineering principles and problem-solving approaches, as well as to highlight societal value of the engineering profession.
• Develop workshops for teachers at partnering high schools.
• Align new high school engineering courses with the knowledge needed to master a first-year engineering curriculum.
• Promote RET programs with greater strategic intent.
• Encourage graduate student involvement with classroom teachers on engineering applications of math and science related to cutting-edge research being conducted within Texas A&M Engineering. This would be modeled after best practices of the National Science Foundation GK-12 Program.

Indicators
• Survey data provided by incoming freshmen indicate a better appreciation for and understanding of engineering careers and societal value
• Students having taken engineering high school courses succeed in first-year engineering coursework
• Secondary school teachers demonstrate knowledge of engineering and prerequisite concepts needed for students to pursue engineering baccalaureate degrees
GOAL 5.3

Develop targeted strategic K-14 partnerships to recruit quality prospective engineering students.

Strategies

• Identify and target transition points on the pathway to a bachelor’s engineering degree, including high-school to four-year; two-year to four-year; and non-traditional and returning students (such as military veterans).

• Link developed materials and technologies into K-14 classrooms.

• Work with educators at the transition points to identify prospective engineering students prior to matriculation at Texas A&M.

Indicators

• Teacher and student knowledge and satisfaction, as discerned through survey instruments

• Increased number of students from these partnerships enroll in engineering at Texas A&M

• Higher averages of GPR and standardized test scores among engineering students enrolling at Texas A&M

GOAL 5.4

Seek to align engineering student enrollment with demographics of Texas, including a complementary focus on national student designations of excellence, such as National Merit, National Achievement, and National Hispanic Scholars.

Strategies

• Partner with Texas high schools strongly populated by groups that are underrepresented in engineering; focus projects, workshops, and tours for these schools.

• In recruiting high school teachers to the RET program, focusing especially on schools with high populations of underrepresented groups, particularly on such schools that send Texas A&M the highest-quality students.

Indicators

• Refine recruitment efforts and offers of support to National Merit, National Achievement and National Hispanic Scholars.

• Steady increase in minority enrollment every fall with 2010 as baseline

• Increase in number of students enrolling from partnering high schools

• Steady decrease in six-year attrition rates for these targeted cohorts

• Involvement of teachers in workshops and programs such as RET

• Increase in national scholars enrolling in engineering at Texas A&M by each designation (National Merit, National Achievement and National Hispanic)
THE PATH FORWARD: CHALLENGES OF IMPLEMENTATION

Sustaining the Benefits of Strategic Planning Will Demand Consistency of Focus Through the Execution Phase

SUMMARY OF THE PROCESS
The previous chapters have identified key issues that constitute the scope and outcome of deliberations that have engaged the Dwight Look College of Engineering’s Strategic Planning Steering Committee for nearly two years. This has not been a standard process as typically undertaken at numerous institutions. It has not been a staff exercise conducted on a schedule-constrained timeline, nor has it been the exclusive province of the college’s academic management team. Rather, it has maintained close fidelity to the dean’s charter: engaging a committee membership that cross-cut various college constituencies, emphasizing broad vetting and inclusion, and maintaining a strong focus on “actual planning” versus a “high-level, glossy planning document.” Most of the committee’s deliberations in 2008 focused on defining the signature research areas for the engineering college. The committee aligned itself with the broader Texas A&M Academic Master Plan in 2009 and worked in tandem with the institutional planning process. In late 2009 through the first half of 2010, focus shifted to the teaching and engagement areas that would help transform engineering education for the early 21st century in the context of the critical need for innovative scientists and engineers that are required for U.S. technological pre-eminence in the global economy. The college’s Strategic Plan 2011-2015 sets forth actionable goals, strategies and indicators for five key areas: undergraduate academic experience, graduate academic experience, a world-class research portfolio, faculty and staff development, and K-14 engagement.

No strategic plan can engender meaningful value unless the strategies that have been identified are carefully implemented and socialized throughout the academic community, which includes academic leadership, faculty, students, staff, and stakeholders. The strategies that we have proposed must be carefully integrated and seamlessly interwoven through the ongoing primary academic missions of teaching, research, and service, so that these ongoing programs can continue without interruption, for the benefit of the State of Texas and the nation. The Strategic Planning Steering Committee did not attempt to create the details of the implementation plan because such details must be based on the resources that can be applied for this multiyear task. Primary responsibility for the implementation of the strategic plan lies with the vice chancellor and dean of engineering, and eventual success must be owned together with the other college deans, the 12 department heads and their respective faculties. We have offered the college a set of comprehensive recommendations, and we anticipate that future planning will need to continue on a regular basis into the future to align the college with external environments and changes that transpire in the normal flow of time.

THEMES EMERGING FROM THE BROAD VETTING PROCESS
An initial set of our objectives and strategies was posted online and made widely available for input from faculty, staff, students, and stakeholders in February 2010. An initial update to the plan was submitted by the dean to the provost at the end of April. This allowed further vetting and discussion to take place. From February through April 2010 we noted over 1,000 hits on the strategic planning website whereby the committee collected input on the draft goals and strategies. An open forum was held, as well as a special discussion session for the department heads to discuss the draft plan. Of the 1,700 students participating in the Spring 2010 Student Engineers’ Council survey, 425 provided responses to questions regarding the Strategic Plan draft.

Among numerous general themes gathered from all the input:
• Focus should not be limited to revising the freshman year, nor exclusively on the teaching and outcomes of ENGR 111/112. The root causes and strategies for transformation need to address the broader issue of engineering education and pedagogy across all four years of the undergraduate program.
• The foundations of mathematics and physics, particularly in the application of these skills and disciplines to engineering problem-solving and design, need more attention in the preparation for upper-level undergraduate disciplinary coursework.

• Any initiative to promote diversity stands to lose credibility if seen at the expense of academic quality or merit-based excellence.

• Enhancement of experiential learning will also require the concerted support of non-tenure-track faculty and staff that can provide for carefully designed demonstrations, as well as more direct connection and experience-based mentoring in the engineering profession (e.g., lecturers, “design professors,” graduate student involvement, etc.).

• The emergence of “second-class citizens” in the academic community can be avoided if differentiation of roles is permitted to evolve and is properly understood and valued in the academic environment.

• Time for faculty to develop professionally and to interact with students is an essential “resource,” no less important than funding and facilities.

• Students welcomed the vision presented for engineering education in the Strategic Plan, and in some cases admitted that their own experience did not yet reflect this vision.

• Students expressed some concern for the “cost” of implementing some of the recommendations in the draft plan.

We offer these concluding thoughts as we bring this Strategic Planning Process (2008-2010) to an end. These should be interpreted as indicating key enabling conditions that will govern the successful implementation of this strategic plan.

**LEADERSHIP**

At several times during the discussion and vetting process it was brought to our attention that many of the ideas and thoughts presented in this strategic plan, while considered as being worthy of merit, had nevertheless been articulated and partially implemented in the college’s past history (e.g., Foundation Coalition in the early 2000s). We assert that the contemporary context and environment in which we again raise these issues demand that the college pay special attention to the evolving milieu which comes in the wake of the NAE’s “Gathering Storm” report, the transformational changes brought on by the globalization of the world economy, and the recent significant and historic downturn in the nation’s and the state’s economy. Research-inspired engineering education and the need for inspired, innovative, highly competent, and entrepreneurial engineers will play a significant role in bolstering and maintaining U.S. pre-eminence in science and technology. Texas A&M must play a central role and not remain on the sidelines. Our peer institutions are standing up innovative and attractive engineering programs to educate the next generation of degreed engineers. Although we should not jump prematurely to popular but untested models, complacency on the “eve of transformation” is also not a winning proposition for a university with aspirations to national recognition.

In this light, it should be observed that implementing change, especially in the academic environment, will require coherent, active, and engaged leadership in order to anticipate needed resources, assess the systemic impacts of proposed changes, mitigate unintended consequences, and provide patient focus and follow-through. It was conveyed to us that a start in these directions had been made by the Foundation Coalition, but the initiatives lost momentum, focus, and eventually resources needed for sustainability. ENGR 111/112 seems to be one of the only legacy remnants of a once-broader vision.

The most basic of leadership responsibilities involves ownership and persistent emphasis on focus and academic excellence in any of the proposed initiatives. Although there are other alternative governance models to ensure this, the college’s departments currently are the units most immediately capable of providing such ownership and accountability. This is one reason why it was difficult within the committee to recommend establishment of a “center” or a “department” model as the formal academic unit to nurture and promote credibility, validity, and excellence in the innovative teaching of engineering. Such focus would have to thrive even alongside a
long-term foreseeable emphasis on faculty research. However, the departments need to also demonstrate greater willingness to support a broader benefit than encompassed by the narrower mission domains of each separate department. Thus, regardless of which recommendations of this plan are eventually implemented, the outcome will demand a strong sense of jointly shared responsibility for the planning, execution, and ultimately successful implementation of the chosen strategies from this plan.

RESOURCES

Although much can be debated about efficiency and “bang for the buck,” excellence along the lines considered in this strategic planning effort cannot be attained “on the cheap.” Anything that is truly excellent must exact some cost that is transformed to long-lasting value through implementation. Facilities that are designed to enhance collaborative learning with modern instructional technologies require expenditure of resources. Any type of “exploratorium” or physical facility that would provide a welcoming environment to accommodate the multidisciplinary design, visualization, fabricating, and prototyping activities envisioned by the Institute for Engineering Innovation will require funding expenditure. Engagement of a cadre of tenure/tenure-track faculty or dedicated teaching faculty to promote broader use of recitation or experimental/technology-based demonstration to facilitate experiential learning will require additional resources. A “right-sized” cadre of faculty that are acknowledged widely for their research and analysis of engineering pedagogy will need to translate this intellectual capital into practice and value as expressed in the educational outcomes of our undergraduate students as they master their engineering disciplines. Collaboration is not learned en masse, but can be facilitated with more human and physical resources that will provide opportunities for more interactive, team-based learning.

Needless to say, world-class research will require laboratory space and start-up packages that are competitive enough to attract the caliber of faculty and graduate students that we will need to sustain a top-ranked program with a truly acknowledged world-class research portfolio.

It should also be noted that time itself is arguably the most precious resource of the tenured/tenure-track faculty who will ultimately guarantee the success of this, or any, academically based strategic plan. The imperatives for excellence in teaching; preparing successful research proposals and meeting research deliverables with ever-increasing accountability from budget-strapped external funding sponsors are unforgiving in their demands on faculty time. Implementation of the strategic plan will require careful integration to ensure sustainability in the academic careers of these faculty members. Incentives will need to be devised (for instance, in the tenure process) to promote success. Mechanisms will need to be identified for pursuing enhanced experiential learning for our undergraduates, while pursuing a research program that will undergird any attempt to strengthen national rankings. We may need to think about partially differentiating our faculty to attain both of these broad objectives concurrently, while still deriving key benefit from research-inspired and motivated engineering education.

This is why the recent downturn in state funding for higher education casts a disturbing pale over the prospects for a future in engineering education we anticipated as being possible throughout the strategic planning process. It will now be harder to improve the physical condition of facilities, increase faculty retention, strengthen national rankings, attain resource parity with our peers, and perhaps even meet the national need for the best-prepared engineers in the world.

In the final analysis, implementation will hinge upon the strategic targeting and allocation of resources to attain the desired indications of our recommended strategies. Without specific budgets for initiatives, there will be no way to protect the proper focus of the initiatives themselves, or to mitigate any unintended consequences associated with implementation. Without specific identification of resources, there can be no effective implementation plan. Therefore, we urge the dean to work with his team and department heads to pursue the resources that will be required to attain the vision of an engineering program recommended by this plan. Given the current climate, there is no expected “silver bullet” for funds; rather all available sources should be investigated:
• State education funds (specifically, any strategic re-allocation to be identified);

• Development funding and corporate gifts

• Targeted NSF grants for engineering educational initiatives

• Differential tuition to help align us with peer academic programs that have designed to enhance the value of engineering education (for example, the University of Texas, University of Illinois, University of Michigan, Penn State University and Purdue University, among others)

The costs should be borne broadly, because in this mission we are all common stakeholders of ultimate success in the enterprise.
## APPENDICES

### Mapping Criteria

<table>
<thead>
<tr>
<th>Vision 2020 Imperatives</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Elevate our Faculty and Their Teaching, Research, and Scholarship</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>(2) Strengthen our Graduate Programs</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>(3) Enhance the Undergraduate Academic Experience</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Build the Letters, Arts, and Sciences Core</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>(5) Build on the Tradition of Professional Education</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>(6) Diversify and Globalize the A&amp;M Community</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>(7) Increase Access to Knowledge Resources</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8) Enrich our Campus</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>(9) Build Community and Metropolitan Connections</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(10) Demand Enlightened Governance and Leadership</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(11) Attain Resource Parity with the Best Public Universities</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(12) Meet Our Commitment to Texas</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

### Key University-level Planning Documents and Resources

<table>
<thead>
<tr>
<th>Document</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus Diversity Plan</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Enrollment Plan</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Faculty Evaluation (teaching evaluation enhancements, plans for faculty,</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>staff and student development, guidelines or processes that support and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>enhance shared governance at the college/department level)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curricular support and assessment of all University Learning Outcomes</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(SACS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planned participation or enhancements for first year experiences</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planned enhancements for the experiences for graduate students</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Support of multidisciplinary research initiatives and support of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>potential emerging initiatives for the future</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plans for support and participation in the Advanced Studies Institute</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IP and commercialization</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>PK-14</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Non-degree or distance students</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Other coordinated stakeholder engagement (industry, government,</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>nonprofit organizations and philanthropic organizations)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Dwight Look College of Engineering

2011–2015

Strategic Planning Committee Members

Ray Juzaitis, Chair
Nuclear Engineering

N.K. Anand
Office of the Vice Chancellor and Dean

Deepa Kundur
Electrical and Computer Engineering

Tom Blasingame
Petroleum Engineering

César Malavé
Office of the Vice Chancellor and Dean

Norm Clark
Engineering Technology and Industrial Distribution

Marilyn Martell
Office of the Vice Chancellor and Dean

Abhi Deshmukh
Industrial and Systems Engineering

Katie Moody
Student Engineers Council President

Jeff Froyd
Office of Dean of Faculties

Zoubeida Ounaies
Aerospace Engineering

Jay Humphreys
Biomedical Engineering

Helen Reed
Aerospace Engineering

Arul Jayaraman
Chemical Engineering

Cathy Reiley
Office of the Vice Chancellor and Dean

John Junkins
Aerospace Engineering

Aaron Roney
Student Engineers Council President

John Keyser
Computer Science and Engineering

David Rosowsky
Civil Engineering