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1. Introduction

This document represents an updated version of our Strategic Vision which was created over the 2008-2010 timeframe. It synthesizes new strategic plans developed during 2015/16 by all the College’s Departments and Divisions, as well as a holistic view of what we have achieved since 2006 and where we are poised to go.

Since 2006, the College has grown in size, excellence, and impact. After a major restructuring of our departments, we have moved up more spots in the US News and World Report Graduate Rankings (54th to 35th) than any other engineering school in the nation that was in the top 54 in 2006. We have hired 56 new faculty, 46 of which are tenure-track. Our funding per faculty places us in the top 10. In 2008 we formally committed to a guiding principal called “Creating the Societal Engineer®”, which is now trademarked. This principal has attracted an extraordinary caliber of new students with the ambition to use critical life-success attributes to impact society. Our outreach programs have touched over 17,600 K-12 students in 26 states, helping to impassion future diverse generations to pursue engineering. We have partnered with our School of Education to create the first program in the nation that graduates students with a BS in Engineering and a Master’s of Arts in Teaching who can become middle and high school STEM teachers. We have amplified faculty diversity (30% of new faculty hired were from underrepresented groups). We have created perhaps the most extraordinary maker-space in the country via our new 15,000 sq. foot Engineering Product Innovation Center (EPIC), which has enabled students to engage in design and product creation early in the curriculum. We have partnered with the School of Business to create courses so that students learn how a company moves an idea or invention to a real product and nearly all our undergraduates take advantage of this course. We have grown a suite of professional Master’s Programs that now attracts nearly 300 new students a year, instilling in them both skills and habits of the mind that allow them to impact society and industry. These programs now include new, industry-driven specializations in data analytics, cybersecurity and robotics and in all they help provide substantive financial resources to reinvest in research and educational excellence. We have raised nearly $80 million in donations in the past 5 years, shattering records from years past, with funds to build EPIC, to support experiential activities for students, to help create societal engineers, and to endow seven professorships (from zero).

For the next 5-10 years, we will amplify our commitment to Creating the Societal Engineer® at the undergraduate level. This philosophy has distinguished the College nationally and will continue to brand us as leaders in the value proposition of higher education. In doing so, we must now transform engineering educational content and experiences to prepare students for recent emergent technologies that will have huge impact on society. We will become world leaders in key interdisciplinary research areas for addressing societal challenges. This document begins with a summary of the College as it stands today and how our new structure gives us a competitive advantage. We identify 5 major Strategic Goals inspired by how engineering and the resulting research, education and training and technology transfer can change and improve the quality of life worldwide. We will close with a summary of the resources and facilities needed to achieve these goals.

- **Goal 1**: Advance pedagogy—curriculum and experiences—to create Societal Engineers who are prepared for emerging transformative technologies and/or impactful lives.
- **Goal 2**: Recruit 20-25 new faculty and enhance research success and impact by prioritizing
  - **interdisciplinary areas** which cut across existing domains of excellence among departments, divisions and BU and which address societal challenges;
  - the creation of several new interdisciplinary research centers aligned with these areas
  - an increase sustainable research partnerships with industry; and
  - an infrastructure to stimulate and support translation of faculty research to societal impact.
  - an increase in quality and quantity of Ph.D. students entering and graduating, striving for the ambitious goal of graduating approximately one Ph.D. student per faculty each year
- **Goal 3**: To grow our Masters and LEAP programs by 50% and prepare these masters students to impact society and support innovation through careers in industry or research.
- **Goal 4**: To instill in faculty the mindset and provide the training to increase the diversity of the faculty and student populations as a critical requirement and strategy for improving excellence and Creating the Societal Engineer.
- **Goal 5**: To partner with alumni and advisory boards to establish, assess, and continually refine the vision and to help acquire resources for excellence.
2. The College at a Glance: Our Competitive Advantage

The core of our competitive advantage is that we have created a structure that retains degree programs at the undergraduate level if and only if they align with our strategic areas of research excellence. As we will convey, this allows us to pursue and achieve excellence in research and educational programs with greater flexibility, speed and strategic decisiveness than many of our peers with more numerous departments for the same number of faculty.

Structure:
As of Fall 2016, the College of Engineering will have approximately 1,650 undergraduate and 800 graduate students split about 50:50 between Masters and Ph.D. students. These numbers have grown faster than originally anticipated and were just 1,100 and 400 only 6 years ago. As of September 2015 the college had 123 full-time faculty or instructors, of whom 109 were tenured or tenure-track and the rest are teaching faculty. Based on recruitment success during AY15/16 these numbers will grow to 132 and 118, respectively, by July 2017.

The College is fairly young. It was created in 1964 with only undergraduate programs and did not have a Ph.D. in any discipline until 1992. With only 24 years at the Ph.D. level, the College has joined an excellent set of peer institutions and is considered among the nation’s top graduate programs. In 2016, the College’s graduate program was ranked 35th in the nation by US News & World Report and every one of our departmental graduate programs is ranked among the top 21 in their discipline among private universities. Biomedical Engineering is ranked 9th among all universities (public & private) and 6th compared to private universities.

Our 2010 Strategic Vision was designed to enhance our ability to educate engineers for the 21st century and to advance research that makes crucial contributions to society’s key challenges. To accomplish this aim we engaged in a fundamental change in structure so that all our departments and divisions align with our research goals. We now have three major departments maintaining four ABET BS degrees complemented by two major (interdisciplinary) graduate divisions. The departments are Biomedical, Electrical & Computer, and Mechanical Engineering. Each department also supports substantive Masters and Ph.D programs. By careful selection of three or more electives and an appropriate Senior Design project, mechanical engineering undergraduate students can concentrate in Aerospace Engineering, which is officially recognized on their transcript. Leveraging this concept, we created 4 additional College-wide interdisciplinary concentrations, three of which attend to the emergence of major job markets. These are Energy Technologies, Nanotechnologies, and Manufacturing Engineering. We also offer a concentration in Technology Innovation in partnership with our Questrom School of Business. We have designed these programs so that all the required courses for any of them would also count as acceptable electives for any ABET major. In 2010 we created two new graduate divisions that support MS and Ph.D. programs in Materials Science and Engineering and in Systems Engineering. These divisions represent fields that are interdisciplinary at the graduate level and draw faculty from all the Engineering departments, as well as several science, math, and even management departments outside the College.

The structure above supports one of the most distinctive fundamental philosophies in the nation regarding the purpose and potential of our undergraduate educational program. We call it “Creating Societal Engineers®”. A Societal Engineer
is an individual with undergraduate engineering degree. Their foundational educational experience prepares them for careers in engineering as well as virtually any other career path. They learn to interact with people from all disciplines and backgrounds. The attributes that they acquire, include comfort working on cross-functional teams, a capacity to communicate with people of all backgrounds and functions in an organization, an understanding and passion for how innovation works (i.e., how a business converts an idea or invention to an actual product both from a business perspective and from the technologies associated with product deployment), an awareness and comfort with a global society in which innovation processes can be distinct, an appreciation for human culture such as the arts, literature, etc., and a sense of commitment to help impassion future generations to pursue STEM foundations. These attributes, together with their powerful problem solving skills, prepare them to move organizations forward and address all dimensions of societal challenges. Finally, the understanding of all this leads to an exciting social consciousness in which they can play a role, not just in an isolated dimension of invention, but in an exciting ecosystem that creates all forms of jobs, adds economic value to society and improves people’s quality of life.

To ensure that we are graduating Societal Engineers, we have created several extraordinary facilities and programs. The Engineering Product Innovation Center (EPIC) opened in 2015 and is one of the most extraordinary 15,000 sq. ft. maker spaces in the nation. EPIC is a hub that stimulates design thinking and doing and includes cutting edge design suites, 3D-printing, robotic manufacturing, laser cutting, materials characterization, sophisticated machining tools, and much more. Courses and open hours encourage students to innovate. Complementing EPIC is our Singh Imagineering Laboratory a 1,500 sq. ft “tinker” space for undergraduates to pursue any idea they might have outside their coursework. We also created a Technology Innovation Scholars Program that trains students to be Inspiration Ambassadors who visit K-12 schools and provide passionate presentations and design challenges. Their goal is to give the K-12 students a realistic experience of doing engineering and developing technology and inspire them with how such engineers can improve the world. There are many other extracurricular experiential activities designed to develop the attributes of our societal engineers.

In 2012, to complement our BS degrees and Ph.D. degrees, we began the process of expanding of our Professional Master’s programs. These programs now attract nearly 300 new master’s students per year spread throughout all our departments and divisions. Each degree program requires 8 courses including a practicum, which can range from a project in a design course, a directed study, or even a master’s thesis. In 2016, we added three specializations that constitute a 4-course sequence from a set of restricted electives and are accessible from any existing degree program. These are in Data Analytics, Robotics, and Cybersecurity. These programs produce many mid-level professional engineering graduates with the training and skills to support and impact the demands of industry and society.

**Competitive Advantage:** We have created a list of peer institutions that consist primarily of colleges of engineering that are: a) part of a larger full-service university; b) have engineering faculty and student body size similar to ours; c) are in an urban-like environment; and d) have strong biomedical engineering programs. This group includes Johns Hopkins University, the University of Pennsylvania, Case Western Reserve University, Washington University of St. Louis, Duke University, Rice University, the University of Pittsburgh, Yale University, and Northwestern University. We also include the University of Rochester and the University of Virginia because their geographic location makes them our competitor for students. Interestingly, most of these institutions have similar numbers of tenure-track faculty, with some exceptions: Hopkins has
become considerably larger since 2008, and Wash U and Yale are smaller.

Compared to our Peers with the same number of faculty, we now need to maintain only 4 ABET programs while all other Peer institutions have between 7-12 ABET programs. This gives us our competitive advantage. During the last 10 years, this has allowed us to be more nimble and flexible by strategically hiring faculty to amplify research excellence and impact simultaneously with insuring sufficient faculty for excellent undergraduate education. In other words, we do not have to use faculty lines to insure delivery of ABET programs that are misaligned with our research. Evidence that this strategy has been successful is revealed in how our Graduate Rankings have changed relative to our Peers during the past 10 years. We are currently ranked 35th in the nation. Remarkably since 2005 no College of Engineering that was in the top 54 then has moved up more in the rankings than Boston University. Another metric of excellence that has and will continue to derive from this strategy is that our funding levels have risen at a faster rate than our peers and we now stand among the top 10-15 of the top ranked schools in extramural funding per year. As mentioned, the agility that results from this strategy means that we have been able to rapidly launch a very large and vibrant set of Master’s Programs without having to invest upfront in a large set of new full-time or part-time faculty. Given the demonstrated success of the Master’s program, however, we can now think about growing our full-time size or add more non tenure-track faculty (see below).

**Research Programs:** The College now ranks among the very top engineering schools in the nation in terms of research expenditures per faculty member. Our Ph.D. population in total numbers and in Ph.D.s produced per year has grown, but we still need to amplify the number created each year per faculty.

Each of our departments and divisions have articulated several research areas for investment for the next 5-10 years in which they feel they can become world-class and have high impact. The Biomedical Engineering (BME) department supports two separate NIH Pre-Doctoral Training grants -- one in quantitative biology and physiology (from NIGMS), and one in biomaterials (NIBIB). BME boasts over 30 primary and affiliated faculty elected as Fellows of the American Institute of Medical and Biological Engineering (AIMBE). Looking ahead, BME has identified several key areas for investment and excellence. These include Synthetic & Systems Biology, Molecular, Cell and Tissue Engineering related to Biological Design, Mechanobiology and Regenerative Medicine, and Neuroengineering and these areas are supported by core foundational research strengths in Bioimaging, Computational Modeling, and Biomaterials. The Electrical and Computer Engineering (ECE) department boasts 22 major society fellows, 2 Former IEEE Society Presidents, 3 current or former major journal Editor-in-Chiefs, and 13 NSF CAREER award winners. For future areas of research investment they have identified Imaging and Optical Science, Photonics, Electronics, and Nanotechnologies, Intelligent Computation and Data Science, Mobile and Cloud Computing with Security, and Electrical and Computer Bioengineering. The Mechanical Engineering (ME) department has recently transformed its vision for research impact by embracing the extraordinary breadth of potential ways mechanical engineers connect with other disciplines to address exciting challenges in society. They boast 15 Fellows of professional societies from the American Society of Mechanical Engineers (ASME) to the Materials Research Society (MRS) to the Optical Society of America (OSA). Looking forward, their research areas for investment are Robotics, Dynamics and Control; the Mechanics of Soft and Biological Materials; and Nanomaterials, Fabrication and Systems. They also see the potential emergence of Energy Systems and Technologies as a core area.
The two graduate divisions uniquely compliment the departments to identify and pursue interdisciplinary research engaging dynamic systems engineering and materials science. The Systems Engineering (SE) Division is one of the most unique of its kind in the nation. Most Systems Engineering programs in the country are narrow and explicitly linked to Industrial or Manufacturing Systems. Our SE Division provides foundational and ubiquitous skill sets that can then be applied to virtually any current or emerging facet of society. They also have anticipated the emergence of data-driven and event-driven systems that are less reliant on creating traditional analytic models of the systems using a continuous stream of data for control and decisions. Key focus areas for the future include a) Cyberphysical Social Systems that engage networked sensor systems for wide spectrum of societal applications such as Smart Cities (e.g. smart traffic, parking, energy usage, healthcare, lighting, etc.) b) Dynamic Robotics including human-robot interactions, coordinated unmanned robots for applications from agriculture to and security, and resilient robotic systems c) Connected Autonomous Vehicles with applications to energy usage, transportation and environmental impact d) Data-Driven Systems to innovate for applications where analytic models are not readily accessible or applicable such as in healthcare and economics, and e) Systems Engineering in Biology and Medicine with a wide range of applications including cancer progression and bio-inspired robots.

The Materials Science and Engineering (MSE) Division has shown extraordinary growth in since its official inception in 2010. It now boasts 42 primary faculty whose joint (tenured) appointments lie in BME, ECE, ME, Chemistry, Physics, and the Dental School, as well as about 40 affiliated faculty. The MSE Division has created a world class materials characterization facility with over $5M of equipment, enabled by landing multiple large equipment awards. The MSE Division will invest in research that addresses the materials challenges needed for life, optical and photonic systems, for energy, and for advancing novel approaches to fabricate, control and characterize nanomaterials.

Complementing all these efforts, the University and College have several major research centers. Three new University Centers include the Institute for Sustainable Energy, the Center for Systems Neuroscience, and the Center for Healthcare Policy. Engineering plays a major role in all, either with the Dean on the Executive Advisory Board or with several faculty engaged in their research missions or both. Existing centers with major Engineering involvement include the Photonics Center, the Nanotechnology Innovation Center (BU Nano), and the Hariri Institute for Computing and Computer Engineering at the University Level, and the Center for Information Science and Engineering, the Fraunhaufer Center for Manufacturing Innovation, the Biological Design Center and the NIH-funded Center for Future Technologies in Cancer Care within the College of Engineering.

As of this writing, the University will open a new 170,000 square foot new building called the Center for Interdisciplinary Life Science and Engineering (CILSE) in Spring of 2017. This building will house and expand several neuroscience related research centers as well as the Biological Design Center all of which engage many schools and colleges at BU.
3: Our Challenges and Opportunities: Prelude to Strategy and Tactics

Faculty and Student Body Size vs. Distribution: Prelude to Hiring Strategy: While the total number of students (undergraduate and graduate) has grown dramatically in the past few years, the faculty size has not grown at a rate commensurate with sustaining quality undergraduate and graduate programs of this size or even larger. Interestingly, in total all three departments have reasonably similar size total students with BME and ME having far more BS students than ECE and ECE having far more Master’s students than either BME or ME. As pointed out below, one of our goals is to grow our Masters programs by 50% while also increasing our Ph.D. program size. This will require an aggressive hiring rate and a likely need to increase total faculty slots by 10% (5-10 additional faculty) as we close in on filling all existing slots.

Educational Content: Engineering undergraduate education needs to acknowledge an inflection point. The pace of innovation in key technological areas has far exceeded the pace of content and style provided to students. For example, there have been great leaps in the capacity to sense, process, store and analyze large amounts of data from a growing list of areas critical to societal function. These range from healthcare to urban function to social dynamics to business to whatever may be possible from the emerging Internet of Things (IoT). Nevertheless, few BS programs in the nation have transformed how they teach students statistics and modeling in order to attend to the era of big data with exposure to how this can impact all sectors of society. Similarly, cyberphysical and autonomous systems and smart devices have driven an increased need for powerful software skills across all engineering disciplines, not just computer engineering. Robotics and automation technologies are on the verge of becoming ubiquitous in society yet we have no coherent robotics courses or program available for undergraduates. Bioengineering will be able to manipulate, sense, and control behavior at cell and subcellular levels. New materials will be developed first at the micro and nanoscales to enhance macro function. In all these areas and more we need to consider how to prepare BS level engineers, and yet currently most engineering schools, including us, do not.

Educational Pedagogy: The academy and society has seen an explosion in digital technologies and facilities for enhancing the pedagogy of engineering education. We are well along at renovating several facilities to enable problem-based classroom experiences, on-line content, and the use of digital technologies in the classroom. The goals are a) to create a more engaging and fulfilling experience for students that might enhance their passion for staying in engineering; and b) improve or at least retain the fulfillment of learning outcomes if (a) is achieved. We have successfully implemented this approach in the core courses in the first two years, such as Intro to Computing, Mechanics, Electric Circuit Theory, Quantitative Biology and Introduction to Engineering Design. The next challenge is to incentivize more research active faculty to transform their courses to embrace this approach and spread the innovations to upper-division and discipline specific courses. Finally, with the tremendous success of using EPIC to create a new (flipped classroom) course in the sophomore year called Introduction to Engineering Design, we have the challenge of identifying how to introduce Freshman to design and building in a way that excites them about their choice to pursue engineering.

Research: The aspirational research goals developed at the department and division levels as described above showed remarkable overlap. The College can synthesize these interests and strengths to identify fundamental engineering science areas for research excellence that cuts across two or more departments and divisions. These areas then drive a hiring strategy in which our goal is to enhance powerful faculty collaborative groups in these areas. As we do this, we also aspire to create a balanced portfolio of basic-to-translational high impact research.
As described in more detail in the next section, our strategy will build on five core areas of investment. The specific themes we will invest in within these areas leverage our current and emerging strengths so as to sustain and/or achieve excellence, high impact and notoriety:

- **Bioengineering**,  
- **Imaging, Optical Science and Photonics Systems**,  
- **Micro & Nano Science and Systems**,  
- **Advanced and Applied Materials**, and  
- **Information Science, Data Analytics and CyberPhysical Systems**.

Synergistic with hiring faculty aligned with these areas, we will create Research Centers that cut across these areas. Recently we phased out several centers that were relevant to our initial growth as a research engineering college (e.g., Neuromuscular, Hearing, Biomolecular). Looking ahead, the University and College will collaborate for new centers in areas such as neuroscience, biological design, precision medicine, robotics, and advanced materials, all of which align with critical societal needs for the future. Such centers in turn can leverage our most mature and successful existing university and college centers such as Photonics, BU Nano, Hariri, and CISE.

**Space:** Because of the creation of EPIC and the new Center for Integrated Life Science and Engineering (CILSE) building, in principle the BME and ME departments have sufficient space to achieve their strategic goals via future research active faculty hires that replace primarily non-research active retirees. The ECE department is housed primarily in the Photonics Center building which insures growth capability for its goals in photonics, optics and solid-state devices, Growth space for its other strengths, especially in information and data sciences except perhaps in applications of Cyberphysical Systems to Robotics will require renovations of existing space associated with our related Center for Information and Systems Engineering (CISE) and exploiting the interdisciplinary spaces for Robotics and Cyberphysical Systems that align with our goal to build interdisciplinary research hires in ME and ECE. Similarly, the BME teaching space is designed mostly to support a laboratory course in bioinstrumentation and will need to be upgraded to create a new BME Innovation and Teaching facility that also allows for training in biotechnology and cellular engineering. Also, most of the ME department is in **110 Cummington St**, an aging building where major renovations for the cutting edge research goals of the department may not be cost effective. Long term planning will need to consider replacing this with a new ME-ECE building.
4. Strategic Vision and Tactics

4.1 Undergraduate Engineering Education

Goal 1: Advance pedagogy—curriculum and experiences—to create societal engineers that are prepared for emerging transformative technologies and/or impactful lives in their future.

Our mission at the undergraduate level is not simply to insure that each entering freshman receive a degree in some known engineering discipline. Nationally, a little over 40% of students getting a BS degree in engineering do not remain as practicing engineers 10-15 years beyond graduating. In addition to engineering, they are found in careers such as management, finance, law, medicine, media, entrepreneurship, education, journalism, etc. We would be irresponsible to prepare them for only engineering careers. Hence we must provide the most powerful foundation imaginable to move society forward and improve people’s quality of life regardless of career choices. To that end we will amplify our past theme of Creating Societal Engineers® and consider curricular content and structural enhancements that best position our graduates to intersect with emergent technological sectors that will transform and address society’s challenges and economic growth.

Tactics:

1) Continue to transform curriculum content for undergraduate engineering by creating a task force for designing how to engage the following areas into almost every student’s bachelors program.

   Engineering education has not kept pace with the extraordinary pace of technologies in several areas that will a) constitute major economic growth; and b) impact corporate and private lives. We will assess how to transform all of our bachelor degrees’ curricula to introduce students to the following emergent areas:

   Data, Statistics, and Analytics:
   • Introduce statistics and analytics applicable to large data sets including streams of real time data, Bayesian statistics, modeling, predictability; and how models catalyze new mechanistic questions.
   • A possible new Concentration in Data Analytics for undergraduates;

   Programming Literacy for Engineers
   • Introduce both problem solving programing skills (eg., MATLAB) and data and information manipulation software engineering skills (e.g., Python) in Year 1
   • Visual representations of data

   CyberPhysical Systems and Security: Robotics, Internet of Things (IoT), Networked System Defense
   • Mechanotronics, Control, Modeling, and Software for dynamic and coordinated robotic systems
   • Information and networking concepts relative to IoT including sensors to computers, computers-to-computers, computers-to-systems, and security
   • Basic concepts of malicious manipulating cyber-systems and protection from smart phones to large infrastructure systems such as grid, financials, medical etc.

   Technologies to Manipulate Materials at Small Length scales
   • Basic engineering concepts and challenges at micro and nanoscale;
   • Technologies that manipulate at this scale, including introductions to micro fluidics, MEMS/NEMS

   Controlling, Sensing and Designing Biological Systems at cell and sub cellular levels
   • Biotechnologies for sensing and assessing cell and molecular function
   • Gene and protein sensing or networks relative to cell function
   • Cell sensing/ properties (mechanical, electrical, etc)
2) **More substantively introduce freshman to the joy and ability to make things** from coding “apps”, to going from a paper design to a physical embodiment. We will use EPIC and introduce Freshman to CAD and “making” technologies. Several ideas will be assessed including revising the content of our current “Freshman Advising course (EK100), which is a 1 hour per week zero-credit requirement, to a two semester EK100/101 to add some design/making-like workshops and skills such as CAD.

3) **Continue to amplify the overall impact of EPIC throughout our curriculum and expand student design studio space below EPIC for enhanced student hands-on learning:** We need to insure our curricula are maximizing the potential of EPIC to introduce students from all disciplines to integrated and interdisciplinary design in fields ranging from medical devices to information technologies to manufacturing and robotic systems.

4) **Stimulate sustainable advances in engineering education pedagogy.**
   - Create software, hardware, classroom and staffing infrastructure to support new digital educational methods and flipped classroom pedagogy. Strive for 30-50% of upper division courses that engage new digital technologies and pedagogy using an active learning/flipped classroom style.
   - Provide incentives for faculty to engage this new infrastructure especially in upper-division more applied engineering courses such as signals and systems, controls, design courses, etc.
   - Create a “brown-bag” series for faculty to convey exciting new styles or approaches in engineering teaching, including the use of new technologies, to their professor colleagues.

5) **Partner with Questrom School of Business and other Colleges and Schools at BU to create a Student Innovation and Entrepreneurship Center.** Engineers need to understand the distinction between a technology or invention and a how a real technology-based product for society actually evolves. We want engineering students to become aware of and develop an entrepreneurial mindset. This is not the same as saying they should be entrepreneurs (this is a much smaller subset). Rather, the intent is to make them passionate about participating in the full innovation process. This aim must go beyond simply a set of courses, but must ensure experiential components that allow the students to internalize the passion for innovation. The specific steps to achieve this are:
   - Develop more experiential activities that create cross-functional teams of students from Questrom and ENG and College of Fine Arts.
   - Develop an effective network of entrepreneurial, IP, and venture capital mentors from friends and alums to help mentor student projects or concepts with translational potential to start-ups or licensing.
   - Grow and identify resources to sustain our **Concentration in Technology Innovation** to engage at least 100 bachelor graduates per year and to attract 80-100% of the students to the foundational course in the program (SI 481 The Business of Technology Innovation)

**Metrics of Success**

- Achieve an entering class ~ 400 per year via applicant selectivity between 25-30% and a yield 20-25% focusing on top applicants (DG1-DG3)
- Create engaging “societal engineering” curricula and experiences including more hands-on and enhanced pedagogy and >75% participation in experiential or curricular enhancements beyond the major (e.g. Concentrations, design contests, etc.) that results in a retention of 95% through senior year at BU, 90% in Engineering, and >95 % placement rate within six months post-graduation.
- Transform curricular content in statistics, robotics, internet-of-things, and bioengineering innovation facilities and teaching labs at all biological length scales within 3 years.
- Evidence of student and employer satisfaction and passion for our programs.
- Portfolio of Alumni in Leadership Positions 5-10 year post-graduation including a suite of “Star Alumni” and Alumni Advancing the Innovation Ecosystem.

**Resources Needed**

- EPIC costs between $300-400,000/yr to run. We have been fortunate so far to build constructive partnerships with the Industry Advisory Committee, which can be expanded. Ideally, we want to raise funds to endow and name EPIC ($5 Million).
• Expansion/Renovation of the space below EPIC to create open student-design studio space and design classrooms to address the growth in our student body and clubs will cost $4-5 Million
• Our current innovation programs, inclusive of running the Singh Imaging Lab and our Technology Innovation Concentration, cost about $100,000 annually. Minimally we want to endow these existing programs ($2.5 Million). More ambitiously a university wide student innovation and entrepreneurial center would need $5-10 Million for an initial 5-10 years of operation.
• Creating and supporting faculty engagement in digital learning pedagogy and facilities will cost about $1 Million with about 50% for facilities and 50% for faculty time.
• Create a modern Biomedical Engineering Innovation and Teaching Laboratory to address modern techniques and advanced in BME at both the cellular level and personalized medicine levels (interactions of sensors and devices with big data). This will require a $2.5 Million renovation.

4.2 Research, Graduate Education, and Innovation

Goal 2: Recruit 20-25 new faculty and enhance research success and impact by prioritizing
  o interdisciplinary areas which cut across existing areas of excellence among departments., divisions and BU and which address societal challenges;
  o the creation of 4-6 new interdisciplinary research centers aligned with these areas
  o an increase in sustainable research partnerships with industry; and
  o an infrastructure to stimulate and support translation of faculty research to societal impact.
  o an increase in quality and quantity of Ph.D.s entering and graduating, striving for the ambitious goal or graduating approximately one Ph.D. per faculty each year

4.2.1: Research Strategic Goals

Section 3 provided an overview of the current and future research strengths identified by each of our departments and divisions in their new strategic plans. By synthesizing these, we can identify several key Engineering Science areas that the College as a whole will prioritize for strategic investments particularly faculty recruitment and creation of new research centers. Already each of these areas brings in substantive new annual extramural dollars (see figure). These engineering science areas in turn will focus on several high impact application areas such as Healthcare, Security, Energy and Sustainability, Urban Function, Robotics, and the Internet-of-Things. Our strategy will be to build a set of faculty within each area that constitute a balanced portfolio of basic-to-applied-to-translational research and infrastructure to support such. Each area below describes faculty research strengths that stem from departments and divisions as well as outside the College.

BioEngineering:
  • Synthetic and System Biology: Applications will focus on infectious diseases and antibiotic resistance, cancer, understanding and then managing the design of complex multicellular systems, and exploiting and interacting with the microbiome.
• **Molecular, Cell and Tissue Engineering:** These areas uncover the fundamental mechanism of biological design at the subcellular, multicellular and complex heterogeneous cellular systems levels which can translate to the creation and control (engineering) of fully functionalized cells and tissues. This will require collaboration with nanotechnologies, imaging, and synthetic biology. It will also require the need measure and understand how dynamic mechanical forces control function and cell and tissue growth and remodeling perhaps leading to the eventual capacity to 3D print new functionalized tissue.

• **Neuroengineering:** Synthesizing photonic, imaging, optogenetics, modeling and advance data analytics, processing and modeling, these areas are dedicated to create transformative new understanding of how brain structure and biology leads to function. Key applications will focus on degenerative brain diseases such as Alzheimer’s and Parkinson’s disease, mental health disease, and brain cancer as well as sensory function. Included will be new technologies for the delivery and monitoring of therapeutics to the brain.

• **Mechanobiology and Biomechanics:** We will advance our understanding of how the interplay between dynamic forces and the micro-to-macro mechanical properties of cells and tissues critically control function in health and the transition between health and disease. Applications span cancer, wound healing cardiovascular, tissue regeneration, orthopedics, and manipulation of stem cells.

• **Biomaterials, BioImaging, Computation and Data Science in Medicine and Biological Systems:** These areas are foundational bioengineering science themes enabling the core areas above. They leverage strengths in all our programs. BioImaging will range from microscale biooptics for cancer detection and drug delivery to advance partnerships with local research hospitals to advance applications of macro scale medical imaging to understand structure and function via sophisticate computational imaging and image processing. Computational Imaging is included in this area to developed micro-macro understanding of structure and function in health and disease and new diagnostic imaging.

**Imaging, Optical Science and Photonic Systems:**

- **Bio & Neurophotonics** with applications from medicine to experimental physical chemistry to infectious disease to defense. This effort will advance small-scale, even individual molecular sensing, neural biophotonics with applications to neurological diseases
- **Photonic and electronic materials, integrated optoelectronics** with the modeling and creation of novel optical-electronic devices, and power electronics.
- **Nanophotonics and Nanoplasmonics** with applications for biomarker detection (protein levels, protein structure, etc.), biosynthesis, telecommunication, computer communications and speed.
- **High-Resolution Microscopy.** Single-cell or Intracellular and Label-Free Imaging and optics (e.g., tracking transcription events or up/down regulation of proteins and their interactions within cells in real time)
- **Photoacoustics** with applications in medical diagnostics or treatment, defense or homeland security technologies (e.g., nuclear compliance, mine detection, etc).
- **Medical and Computational Imaging:** We can synthesize mult-modality imaging to understand structure and function or to create high-resolution images from limited optical and acoustic information. Also using inverse-modeling we can extract higher resolution information regarding structural and biological properties of heterogeneous materials

**Micro and Nano Science and Systems**

- **Nanomedicine:** By partnering with our Nanotechnology Innovation Center and our medical school, inclusive of the Cancer Center, we will focus on how design and manipulation at the nanoscales can address cancer, drug delivery, and design of new therapeutics for a variety of disease. This will include advances in new biomarker detection technologies and point-of-care diagnosis.
- **Nanomaterials and systems:** sensors for energy source detection, nano/bio photonics for biodefense, NEMS and MEMS for integrated processing and control related to defense applications, especially chemical and biological defense.
- **Nanofabrication and manufacturing:** Large scale production of nano-sensors, devices and systems, 3D printing at the nanoscale inclusive of tissue engineering, nanomaterials for applications ranging from electronics to medicine.
Applied and Advanced Materials
- **Energy Materials**: Applications range from novel fuel-cell technologies, green manufacturing, low-energy computing materials and processes;
- **Optical Materials**: Application of nanoplasmonics and photonics to design materials for manipulating and sensing light for computational and sensing systems. Advancing graphene. Nanomaterials for new faster and more efficient electronics.
- **Biomaterials**: Understanding how specific biological materials can be fabricated and predict compatibility of non-biological materials with biological ones.
- **Digital Design of Materials**: Using computational modeling to predict complex, heterogeneous material properties and guide fabrication of new materials for specific applications.

Information Science, Data Analytics and Cyberphysical Systems
- **Intelligent Computing and Data Science**: Advances in machine learning, cloud based computing, and data analytic methods will focus on applications and new innovations that impact urban function, mining existing and real-time healthcare information (ranging from electronic health care records and real-time biomarkers to biomedical images) for more precision medicine, and genomics.
- **Cybersecurity**: Applications ranging from large data sets in society with a focus on healthcare, defense, and financial systems to smart phones and cloud based systems.
- **Computational Imaging**: Integration of physical sensing structures and models with advanced algorithms to produce reconstructions of complex heterogeneous structures using large data sets for unprecedented insight on how structure relates to function. Applications may range from image based elastography, to 3D reconstructions that include distribution of materials properties as well as structure.
- **Smart Social Communities and Sustainability**: Applications ranging from smart urban support systems (eg., traffic, parking, etc) that can reduce energy costs while improving efficiency of function to smart grid and energy systems and the role that economics, public policy, and community dynamics play in adoption of novel technologies.
- **Internet of Things**: Developing next-generation cyberphysical, data mining, and optimization methods to control, predict and detect critical events, to understand how distributed sensing and computing will alter cloud-based centralized methods, and to advance innovation for improving quality of life in communities based on IoT technologies in sectors ranging from healthcare to to autonomous vehicles to urban resilience and much more. This will also engage advancing new Cybersecurity methods to insure resilience of such systems.
- **Robotics and Control**: Synthesizing advances in mechanotronic and sensing technologies with autonomous and/or coordinated cyberphysical “robotic” systems. Such systems may range from nano-scale and soft robotics, to unmanned swarming and coordinated robots, to autonomous vehicles in general.

4.2.2) Strategy, Tactics, and Resources to Achieve Research Goals

To achieve the above we will pursue the following tactics:

1- Recruit 20-25 new faculty distributed throughout ENG with research strength aligned with at least one if not more than one key theme and center.

Following the recruitment season of AY 15/16, we will have 10 open faculty slots in the College. Projecting ahead another 8-10 will become available via retirement and departures. Because of the growth in the size of the student body at both the Undergraduate and Graduate levels we will request an additional 5-7 slots to be added to the Colleges base budget for a total recruitment of about 20-25 new tenure-track in the next 3-5 years. We anticipate 3-4 Endowed Professorships already pledged to become active during that time. Recently, because of the large number of open existing slots in Engineering, we have been less concerned with how to allocate new hires to appointments in a primary department. More or less, we will try and maintain similar size faculty in all three departments, a concept consistent with our competitive edge. Moreover, consistent with our overall strategy, more so than we have in the past, we will embrace and encourage interdisciplinary hires in the areas above. Here
we will design searches to identify faculty that are highly likely to seek and map into secondary and/or joint (if senior) appointments in other departments because their research aligns with other departments as well.

The total funds needed to support the faculty growth of 20-25 new people in the next 5 years is approximately $500-700,000 in continuing budget costs for salaries and $20 Million in one-time only startup costs.

Moreover, to retain and attract excellent faculty we will strive to raise another 4 Endowed Professorships ($10 Million) and another 3 named Endowed Distinguished Faculty Fellows for mid-career rising star faculty ($1.5 Million).

2. Create New Interdisciplinary Engineering and University Research Centers

We will solicit proposals to create and finance several new research centers that complement existing vibrant centers and which serve to bring together faculty from multiple departments and schools to address key themes consistent with the above areas. Those with stars(*) have charter drafts for some of these are already in progress or recently approved

- Precision Diagnostics Center*
- Center for Advanced Materials
- Biological Design Center*
- NeuroTechnologies Center*
- NeuroPhotonics Center*
- Robotics and Cyberphysical Systems Center

Each center requires about $1.5 - $2.0 Million for an initial 5 years of funding or about $6-7 Million to endow. We will primarily use our discretionary program income and philanthropy to secure at least $7.5 Million to seed the initial creation of these centers.

3. Major Extramurally-Funded Center Grants

In addition to research centers that evolve internally from emerging areas of interdisciplinary strengths, we will proactively identify opportunities to secure extramurally-funded centers aligned with our strategic areas. Specifically, we will provide administrative support to compete for programs such as Engineering or Scientific Research Centers (via NSF); U54 NIH Center Grants, MURI grants, and MRSECs and N-ERCs (Materials or Nanotechnology Engineering Research Centers via the NSF).

4. Corporate Research Partnerships

Over the past few years we have laid groundwork to help create lasting partnerships from corporate sponsored research. A few have evolved or are well along to evolving (e.g. Schlumberger and Philips Healthcare) but overall our industrial portfolio remains too small. We must put more effort and resources into identifying and nourishing a select set of companies that have interest in applied research aligned with our strategic areas of excellence. The focus will be mostly in healthcare, information systems, and material science and nanotechnology. We will consider creating a formal staff position in the college to facilitate the establishment and nurturing of such corporate research partnerships. This will require about $750,000 for five years of a position.

METRICS

- New Annual Extramural Funding of $65M/year from primary engineering faculty and >$100 Million when including all affiliated Centers and faculty.
- Secure several major Center grants from extramural funding during the next 5 years
- Strive for at least 75% of our faculty having 2 or more extramurally funded research grants at all times.
- Publications in top peer-review journals; highly cited faculty addressing the most important problems in our respective fields (not simply the most interesting and difficult ones).
- Faculty elected into prestigious organizations ranging from National Academies, to AAAS, to fellows of their primary disciplines, etc.
- Faculty with leadership roles in the most prestigious research organizations of their discipline
- Corporate funding near 10% of our total extramural funding per year
5- Graduate Student Recruitment and Incentivizing More High Quality Ph.D. Production

The capacity to compete for excellent faculty, engage in creative new ideas, take risk in pursuing the most important and challenging problems, and sustain a diverse pipeline of multiple research proposals necessarily derives from being able to recruit a rich pool of high quality graduate students. Matriculating such students is a very competitive process and becomes more difficult as each department/division rises in reputation. Compared to our peers we should be graduating 10-20% more Ph.D. students per year. The number of Ph.D. students any program (or the College) can support is primarily determined by the amount and stability of extramural funding we can attract. The college strives to support all first year students on open-fellowship funds such that all of these students will find funded research fellowships in faculty funded programs by their second year. The two primary extramural funding sources for Ph.D. students are PI initiated extramurally funded projects (single or collaborative) or Ph.D. Training grants. Biomedical Engineering has two of the latter via NIH funding about 10 students/year. The Photonics Center recently won an NSF NRT training grant for about 6 students per year in neurophotonics. Every research center should be coordinating and submitting such grants in the future. Key areas to prioritize to compete in would be Cyberphysical Systems, Nanomaterials and Nanofabrication, Biomedical Imaging, Biological Design, Robotic Systems, Precision Diagnostics, and Internet-of-Things. To incentivize these efforts, the College has instituted a new policy where it will support an additional Ph.D. trainee for the PI on any training grant (associated with that grant) for 4 years. We also need to motivate and support all US Citizens that can be competitive to apply for NSF Ph.D. Fellowships, and whenever applicable, NIH Ph.D. training fellowships.

The final source of funding would be to use some of the discretionary resources, specifically derived from tuition sharing via professional programs a portion of which is sent to departments and divisions to support more incoming Ph.D. students then their extramural and training-grant-based funding would normally afford, thus subsidizing the cost of engaging doctoral students. We should pursue this strategy with great care, however. This approach carries the risk of either supporting students to work for faculty otherwise unable or unmotivated to secure extramural funding and hence to work on non-peer reviewed projects that may not of high significance. To recruit the best students we must eventually convey they can become funded to work with highly research productive and reputable faculty who consistently are able to compete and attract such funding. Overall, amplified extramural funding and/or highly impactful scholarship needs continuous, rigorous and objective assessment as a whole and on an individual basis.

Finally, through philanthropy we will move to raise endowed graduate student fellowships, each one of which should fund at least 1 full semester of stipend ($10,000), preferably a full AY worth ($20,000). This means a single gift to endow one would be $250-500,000. If we strive for 1 per program this requires $1.25-2.5 Million.

METRICS
• Graduate about one new Ph.D. student per research-active faculty member each year (90-100 per year).
• Aspire for graduates to become leaders in their fields within 10-15 years post-Ph.D.
• Expect each research center funded by the college to submit or support/administer at least 1 Ph.D. training grant per year.
• Expect each department have at least 10% of its incoming US Citizen Ph.D. students win an NSF Ph.D. Fellowship or similar per year.

6 – Translation of Research to Society
The College already has an exciting portfolio of innovations that have engaged the technology transfer process. But past projects have seen limited success. We need to create programs that finance and stimulate translational research, that provide faculty expertise in the innovation and commercialization pipeline, and that can network these innovations and faculty to the right opportunities. The driving motivation should not be financial return on investment. Instead it should be to minimize barriers to entry for entrepreneurial or non-entrepreneurial faculty that periodically discover ideas with innovation potential, and then to maximize the probability that good ideas for improving society’s quality of life become commercialized. To achieve this goal we will work to
• **Transform the Technology-Transfer Support for BU:** We must develop a more seamless and supportive process to identify, disclose and mentor exciting ideas that might be candidates for technology transfer. This includes more support for patent filing, licensing relations, and in guidance for creating start-ups.

• **Seed Funding Programs:** We need to sustain seed funds for translational research opportunities such as:
  - Coulter Foundation Partnership Program in Biomedical Engineering
  - BU-Fraunhofer Alliance for Medical Instrumentation and Diagnostics
  - Deans Catalyst Awards
  - Nanotechnology Innovation Awards (via BU Nano)
  - MSE Innovation Grants

Total funds necessary for these seed programs will run around $500,000 per year or **$2.5 Million** for five years.

**METRICS**
- Ratio of Extramural Funding / Seed Funding dollars should be at least 5:1 and preferably 10:1.
- Disclosures per $1 Million of Funding
- Patents per $1 Million of Funding
- Start Ups per year
- New Licensing Agreements per year

### 4.3 Growth in our Professional Masters Programs

**Goal 3:** To grow our Masters and LEAP programs by 50% and prepare these masters students to impact society through careers in industry or research.

All of our programs want to increase the size of their Master’s program by 20-50% with the whole college striving for a 40-50% growth. This growth will result in about 100 to 150 additional Master’s students. To provide a quality educational program for these students will require hiring a combination of tenure-track faculty with instructors and professors of practice.

We are now at the point where our rankings and research reputation are driven by tenure-track faculty. This is also critical to insure the simultaneous goals of meeting our full spectrum of UG-Graduate education needs, offer a high quality intensive Ph.D. curriculum, portions of which are not compatible with courses of similar topics but designed for Masters students, and building a world-class research program with tenure-track faculty. We believe we now have a fairly stable minimum size for our master’s program for the foreseeable future (at least 20 years if not forever). To accomplish this goal we will

• Work with the central administration to design financial models in which a portion of our discretionary revenue is used as a permanent supplement to our base budget to support more tenure-track lines and another portion is used to support fixed-term instructor or professor of practice positions.
• Consolidate EE and CE programs into a single **Masters in Electrical and Computer Engineering** with foundational courses in ECE-based product and software design and practice to support the needs of an innovation economy.
• Design a unique and desirable revised **Masters in Product Design and Manufacture**
• Create more Corporate Masters-Program Partnerships (blended with Distance Learning?)
• Assess exploiting new specializations (Data Analytics, Cybersecurity, Robotics, and Systems Engineering)
• Hire a new permanent staff dedicated to growth of the programs, especially our LEAP programs, who will insure that the quality of the experiences here such as mentoring, advising and career placement create BU as a desirable destination for master’s students relative to our peers. Over the next five years this will require about **$300-500,000.**
4.4 Diversity, Community, Outreach

**GOAL 4: To instill in faculty the mindset and provide the training to achieve diversified faculty and student populations as a critical requirement and strategy for improving excellence**

In the past ten years the College has added 56 net new faculty, which includes 13 women, 2 Latino, and 2 African-American professors. This includes tenure-track and non-tenure track hires (e.g., Professors of Practice, etc). For tenure-track alone we added a net of 46 new faculty which includes 11 women, 1 Latino, and 2 African-American professors. The college has embraced the narrative that diversity is a critical measure and means for excellence, innovation, creativity and success. Search committees are now educated in advance about the importance and the expectation to actively work to attract and engage a diverse pool of faculty candidates. Since 2008, the number of undergraduate women in engineering has increased significantly from 27% of the freshman class to 37% entering in 2015. The number of URM undergraduates almost doubled from 9% to 17% of the freshman and 9% to 16% overall over this time period. The number of women doctoral students grew from 20% to 29% over the past five years and those matriculating grew from 21% to 35%. The number of URMs applying doubled from 2% to 4% and matriculating doubled as well from 4% to 8%. We need to provide a concerted effort to recruit and increase the yield of qualified, high-demand admits. While all of these are encouraging indicators of success, going forward we need a more comprehensive culture and methods to achieve diversity and integrate our mission of outreach into our processes. To do this, we have the following goals and objectives:

**Outreach and Student Diversity**

- Double the size of our TISP program and raise funds to support the staff to do so. We need to begin acquiring data as to the impact of TISP both anecdotal and statistical as to its how it serves to amplify students applying to STEM and engineering specifically from K-12, how it attracts applicants, especially diverse ones, to apply to BU’s College of Engineering, and how it has impact on the Inspiration Ambassadors themselves relative to their career choices and our goal of creating societal engineers.
- Partner with our undergraduate and graduate women and under-represented minorities including their affinity groups such as SWE, GWise, SHPE and NSBE and design flexible and effective ways to mentor these incoming students at the undergraduate and graduate levels.
- Grow our STEM Educator Engineer Program (STEEP) to sustain 5-10 BU students per year.
- Identify ways to replicate and scale the national impact of TISP and STEEP by creating sustainable partnerships with other universities and colleges and community institutions with extramural funding from foundations, corporations and government sources.
- Secure REU programs in unique areas of strength and use these funds to attract and cultivate underrepresented participants who subsequently apply to our graduate programs.
- Target financial aid for our Master’s admitted students to those from underrepresented groups with the potential for professional growth and transition to our Ph.D. programs and perhaps even faculty positions.

**Faculty Diversity:**

- Educate and incentivize department and division leaders to value diversity among our faculty as an additional and extraordinary benefit to achieve excellence, to produce innovative, high-impact research and to attract and propel our underrepresented students.
- Convey the diversity value proposition as integral to the College mission so faculty have the mindset and actions and partner to lead processes to recruit diverse faculty in all searches. To help engender faculty, we will use proven methods and constructive dialogue to help mitigate unconscious biases.
- Provide resources (e.g., extra start-up funding, extra faculty slots, etc.) for qualified diversity candidates in a timely manner and recruit these high-demand candidates in a proactive manner.
- Design and monitor effective faculty mentoring programs for female and underrepresented minority faculty as they begin their careers here.
4.5 Partnering for Advice and Resources

Goal 5: To partner with alumni and advisory boards for establishing and assessing vision and to help acquire resources for excellence

During the past 10 years we have created several advisory groups made up of alumni and friends of the College that have extraordinary success in their professional lives and span a wide range of industries. These groups include the Deans Leadership Advisory Board (DLAB), the West Coast Alumni Leadership Council (WCALC), and many individual societal and corporate leaders. These groups have made critical contributions in not just creating our original Strategic Vision, but in providing periodic assessment of our progress. They have been involved in addressing emerging trends that were not present or as relevant when the plan was originally created and in establishing any major new initiatives for implementing this plan. Examples were advising on directions and emphasis in areas like our Master’s programs, Data Analytics, creation of new Centers, our outreach programs of TISP and STEEP, the key ways to leverage each of our Divisions, convergence on the concept and vision for EPIC, and how to create a more effective way to partner in research with the corporate communities just to name a few. They have been huge ambassadors and supporters of ensuring we are successful at Creating Societal Engineers. Many of these individuals have also helped personally and through networking to raise funds to insure we can resource the initiatives identified. These resources played a critical role to accelerate our success and to amplify the quality of the student experiences and our impact. Without both the advice and philanthropy it is highly unlikely that the College’s extraordinary rise in the US News rankings could have occurred to the degree it has. Indeed, during the last 10 years Annual Fund giving has increased by nearly seven-fold, and no School or College at BU has raised a higher percentage of their original capital campaign goal than Engineering, this despite having one of the youngest alumni based on campus. We will leverage these wonderful relationships and grow our network to sustain this success. Going forward we will:

- Continue to identify, cultivate and add passionate successful Alumni and friends to DLAB and WCALC for their valued advice with an eye on a balanced representing a balanced portfolio of industry sectors ranging from healthcare to defense to information technologies and systems, to financial and investment, and perhaps even government.

- Create departmental visiting committees (like the one established by Mechanical Engineering) that engage successful alumni and friends from both academia and industry who are dedicated to advancing excellence at the programmatic level.

- Partner with our Advisory colleagues on initiatives that can amplify revenue sources from programs and relations that simultaneously add value to the BU brand and the quality of our educational programs and alumni. These include:
  - Grow existing and adding new professional master’s degree programs
  - Grow the number of companies that join the EPIC Industry Advisory Board.
  - Increase external research funding attracted by the faculty from corporate partnerships focusing on companies in the Boston area that want a more holistic, integrated and longer-term partnership rather than a “one-off” research project approach
  - Increase royalty return from faculty inventions

- Continue our commitment to educate existing and new potential donors about the programs and activities supported by the College of Engineering’s Annual Fund and how the satisfaction they can gain by adding the College to their personal philanthropic portfolio relative our vision and its impact.
5. SUMMARY and RESOURCE NEEDS

We remain committed to continuous advancement of compelling and unique educational and research visions to impact society. Educationally we will “double-down” on Creating Societal Engineers at the undergraduate level. Our societal engineers will have core knowledge and skills to impact the technological challenges and advances of the future combined with additional experiences to add attributes and foundation for life-long success in any career. Our research growth will focus on key identified interdisciplinary areas of strength for which we are already perceived as world-class, attracting excellent faculty and students and for which our key will be identifying the most important problems to be addressed in their field. Hence Growth in Impact will continue to be our mantra here.

Below we summarize the critical resources we will need in the next 5-10 years and the likely sources of them. In total we estimate the College will need around $65 Million during the next 5 years, of which $35-40 Million will need to derive from philanthropy and/or corporate partnerships with the rest deriving from revenue sources such as tuition from professional masters programs and typical investment by central administration toward faculty hiring and other initiatives. Our new Capital Campaign goal is $100 Million and we currently have raised about $75 Million. Thus we will need to exceed our goal by about $10 Million.

TOTAL NEEDED FOR ENTIRE PLAN: $61.25 to 66.5 MILLION as follows:

Undergraduate and Graduate Educational Excellence [TOTAL: 15.25 to 20.5 MILLION]
- Renovated new Biomedical Engineering Teaching and Innovation Lab: $2.5 Million
- Endow Engineering Technology Innovation Programs (eg., TISP, Technology Innovation Concentration Costs) OR Create new Student Innovation and Entrepreneurial Center $1 to 5 Million
- Name/Endow EPIC: $5 Million
- Expand EPIC to Basement To Create Student Design Studios: $4 Million
- Resource new Digital Learning Facilities and Faculty to Transform Pedagogy: $1 Million
- Create 3-5 Endowed Graduate Research Fellowships $1.25 – 2.5 Million
- Resource New Staff to Grow Professional Masters and LEAP: $0.5 Million

Institutional Reputation, Research for Impacting Society [TOTAL: 42.75 MILLION]
- Recruitment and Retention of Best Faculty
  - Start-up costs for hiring 20 new tenure-track faculty: $20 Million
  - Create 4 more Endowed Professorships at $2.5 million each: $10 million.
  - Create 3 more Distinguished Faculty Fellows at $500,000 each: $1.5 million.
- Resource Initial 5 years for Five New Interdisciplinary Research Centers ($1.25M each): $7.5 Million.
- Hire Dedicated Staff to Create/attract Corporate Research partnerships: $0.75 million
- Support Seed Funding Programs for Research: $2.5 Million
- Endow 2 named Distinguished Lecture Series at $100- 250,000 each: Total $0.5 million.

Outreach and Diversity and Experiential Programs for the Societal Engineer [TOTAL: 3.25 MILLION]
- Endow our Technology Innovation Scholars Program: $2.5 Million
- Create a Societal Engineering Endowment Fund: $1 Million

Long Term Challenge: Not built into any of these analyses is that in the long term the University will need to assess creating a new building for Engineering to replace the aging 110 Cummington with a $60-80 Million structure to house Mechanical Engineering and some ECE faculty in cross-disciplinary areas such as Robotics, Control, or Nanofabrication.