



Woodruff School Vision: *Engineering Life-Sustaining Transformations* **September 24, 2010**

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Introduction

Georgia Tech President and Woodruff School of Mechanical Engineering faculty member G.P. “Bud” Peterson has posed the question: “when the competitive landscape is flattened, mobile, and diverse, what will be the characteristics that distinguish our nation’s students from those at institutions around the globe?” According to Dr. Peterson, “None of us has a crystal ball, but what is clear is that our nation’s position as a leader in research and innovation will erode unless we make choices and investments that adequately prepare our students with the educational background, problem—solving and leadership skills necessary for a future we can only begin to grasp.” He then relates the oft-made point “...we are currently preparing students for jobs that do not yet exist using technologies that have not been invented in order to solve problems we have not yet identified.”

As part of Georgia Tech’s quest to become the “Technological University of the 21st Century,” and anticipating the celebration of our 125th birthday as Georgia Tech’s foundational discipline, the Woodruff School has conducted a strategic planning process to examine our strengths, consider the future needs of engineering education and research, and solidify us for a pre-eminent role as a national and international leader in mechanical engineering.

As one of the largest, most visible and highly ranked mechanical engineering academic programs in the USA, we aim to provide leadership by fashioning a new approach to engineering education and research that is synergistic at all levels and is relevant to the engineering fundamentals, methods, practice, communication, leadership, and collaborative skills necessary to address our most pressing global issues. Our vision is to re-invent The Woodruff School of Mechanical Engineering as the interdisciplinary academic model for engineering. We are poised to address a future no matter how uncertain, starting with the currently understood critical grand challenge issues that define human progress and well being in the 21st century, such as clean water, health, renewable energy, sustainable infrastructure,



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and mobility, to name a few. Technology trends in energy, infrastructure, sustainability, health, mobility, and systems are such that all great universities in this era must have a first rate mechanical engineering program.

Why will we do this? The vision statement *Engineering Life-Sustaining Transformations* (ELST) is by design succinct yet powerful. It means that we cultivate an atmosphere for basic and applied research that addresses technological “pinch points” that limit sustenance and quality of life globally, and we will direct the practice of engineering to enhance the prospects for transformational advances, whether achieved through evolution of existing approaches or by serendipitous leaps in capability – advances that punctuate equilibrium and serve to completely redefine challenges. As stated by College of Engineering Dean Don Giddens, “Engineering is not at all detached from the human condition, whether in this country or in the developing world. We at Georgia Tech have become deeply engaged in issues that affect people’s everyday lives; and we have so much potential to do so much more!” The foundations of ELST will be anchored by excellence in scholarly research contributions that address major challenges affecting human productivity and quality of life, providing the context for integrated and relevant education.

How will we do this? The second half of the 20th century witnessed the development of an engineering education approach with strong focus on traditional disciplines. We will re-design our programs of study and leverage technology to establish an environment that fosters education of mechanical engineers who innovate by defining transformational strategies addressing 21st century grand challenges that lie in the critical path of human development. As arguably the most diverse engineering unit on campus, the Woodruff School is well-poised to lead the transdisciplinary, transformational engineering basis for ELST. As a component of this strategic plan, we will embark on an initiative for Engineering Life-Sustaining Transformations to pursue this vision along all dimensions, serving as an incubator for innovation by engaging foundational studies, gap analyses, and seeding transdisciplinary collaborations that will lead to major centers of scholarly endeavor.



Core Values and Foundational Pillars of the Woodruff School

Since 1985, the Woodruff School has risen from a top 40 USA mechanical engineering academic unit to a top five USN&WR rating. The Woodruff School has built recognized strengths in manufacturing, microelectromechanical systems (MEMs) device design and fabrication technologies, tribology, dynamic systems, robotics, acoustics, mechanics of materials, and energy systems. There is also a strong bridge between mechanical engineering and bioengineering disciplines.

This plan attempts to chart a course that will enable a new level of leadership in education, research and service. To pursue this ambitious vision, our endeavors to address evolving challenges and opportunities must build on these strengths and hold fast to a set of immutable *core values* that define who we are and how we operate. These core values are established by Woodruff School Faculty as follows:

Excellence

Our endeavors are world class in originality, rigor and impact.

Scholarship

We foster an open and challenging environment for intellectual inquiry, discourse, and scholarly publication that develops world class engineers and thought leaders.

Innovation

We encourage intellectual curiosity through our passion for creating stimulating learning experiences, our boldness in the research challenges we define, and the novelty of our contributions to pioneering new technologies, products and services.

Service

We leverage our intellectual talents to innovate in areas that promote and guide the profession and engender a sustainable society and environment.

Collegiality

We collaborate to advance research and teaching excellence, and are committed to our mutual development and success.

Likewise, the vision for the Woodruff School must build upon a set of inviolate *foundational pillars*. These pillars are our competitive advantage in their synergy and totality. Based on faculty, student, and alumni input, the four foundational pillars of the Woodruff School are:

- Leading research institution



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- National/international university
 - Highly motivated faculty, drawn to leadership
 - Meritocracy
 - Interdisciplinary research without departmental barriers
 - Quality physical infrastructure and facilities
- Effective education
- Selective faculty hiring, selective student admission
 - Undergraduates are “strategic learners”
 - Students have great reputation for performance and rise to leadership levels in the workplace
 - Woodruff PhDs make an impact in leading academic institutions
 - Teaching practicum experience for PhD students
- Culture of collegiality and collaboration
- Lack of hierarchy in sharing ideas
 - Ability to work towards intrinsic satisfaction
 - Self-determination of achievement
 - Not governed by arbitrary metrics
 - Minimal internal politics, and limited administrative interference
 - Faculty empowered as entrepreneurs
- Atlanta, a global crossroads
- Atlanta is a global crossroads for transportation, commerce, and culture
 - Dynamic urban campus
 - GT is a strong brand radiating from the Southeastern USA
 - High value educational experience compared to peer institutions
 - Strong work ethic embedded in culture of GT students



Strategic Objectives of the Woodruff School

ELST Initiative

Lead an initiative for Engineering Life-Sustaining Transformations (ELST) as a campus-wide collaborative effort led by the Woodruff School, incubating and spawning scholarly communities and research teams composed of our faculty and students, as well as high profile visiting researchers and policymakers, to define and explore grand challenge problems through basic and applied research.

Renaissance in Engineering Education

Develop pathways for a renaissance in engineering education by pioneering technology and concepts of mass customization, promoting self-paced discovery in flexible degree programs, and emphasizing ELST themes that address grand challenges in the curriculum, entrepreneurial experiences, and capstone design projects.

Tactics

Objective 1 – ELST Initiative

Laying the Foundations: Years 1-2

- Organize the ELST initiative and define its unique vision and mission in supporting critical studies, conducting gap analyses in grand challenge themes that intersect faculty interests, and incubating transdisciplinary research and education initiatives across campus, with initial seed funding for exploratory studies and collaborative inquiry groups underway in Fall 2012.
- Clearly communicate the ELST vision, mission and scope to students, staff, faculty and alumni for its foundational role in coupling research and education in the next 25 years. Explore and define initial cross-cutting multidisciplinary themes for the ELST Initiative.
- Develop and reinforce the culture of ELST in the Woodruff School.
- Evaluate current structure, functionality, and effectiveness of Woodruff School research area groups, simplifying and broadening definitions by Fall 2011.
- Explore reallocation strategies for the Woodruff School endowment, which presently covers 65-75% of items that should be supported from state funding, to facilitate the above initiatives on a sustainable basis. At the same time, identify necessary additional funding mechanisms, working with the College of



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Engineering to attract additional state funding to cover Woodruff School operations as appropriate.

Building the Structure: Years 2-4

Developing the Resources

- Identify and develop incentive strategies to acquire additional resources to support re-invention.
- Charge development team to raise funds for seed grants to support innovative collaborations between faculty and students in ELST-relevant areas.
- Set and pursue goal of a \$100 million endowment to support the ELST Initiative and align development activities, including identification of additional space.
- Increase the number of endowed chairs for senior and junior faculty.
- Offer ten \$50-\$100k seed grants in ELST-related topical areas, including collaborative junior-senior faculty projects.

Emergence of ELST Themes

- Foster development of joint proposals supporting the ELST Initiative with other academic units in CoE, other Georgia Tech colleges, Emory, CDC and the Georgia Research Alliance, with the goal to incubate two research centers in ELST opportunity areas by 2014. Such areas might include, for example, devices and technologies to affect remote, distributed medical treatment, energy efficient and safe technologies to enhance personal and mass mobility, smart personalized environments and infrastructure, integrated and sustainable energy systems solutions, enhanced technologies for distributed collaboration of expert teams in education, research, and problem solving, customized learning environments, enabling opportunities and technologies for women to contribute to engineering solutions, and the intersection of biomedical devices and health related issues, among others. Areas will emerge as a consequence of faculty driven competitive studies and gap analyses to achieve a position of competitive excellence that maximizes Georgia Tech's potential for innovation.
- Implement on-campus ELST undergraduate research internships to explore integrative subjects, and enhance undergraduate student participation in research in ELST-related themes.

Supporting Environment and Infrastructure

- Enhance graduate student interactions across a broad spectrum of perspectives and experiences.
- Re-design the Woodruff School support infrastructure:
 - Develop a "mini-OSP" office to assist with proposal, budget and report preparation to enhance productivity.



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- Develop integrated high performance computing plans/facilities in the Woodruff School that complement Institute initiatives.
- Create and implement metrics for space allocation along with on-line tracking of equipment and space.
- Coordinate facilities that encourage collaboration and productivity:
 - Café-like service in the main Woodruff School facilities.
 - Improved family support services and awareness.
 - Improved interior and exterior spaces for informal interaction.

Fostering Global Awareness

- Communicate ELST directions, studies and themes to various external constituencies to foster and establish a “thought leader” position for Georgia Tech in grand challenge issues.
- Emphasize international student experiences:
 - Establish partnerships with premier research institutions worldwide for one semester collaborative research exchange of graduate students.
 - Create a Woodruff School student scholar exchange program.
- Increase the percent of Woodruff School undergraduates that participate in the international plan to exceed 20%.

Renewing and Retaining Faculty

- Provide the opportunity for “stay-baticals” – one semester with no teaching assignments to assist in redefining directions and seeding new research initiatives.
- Retain and develop a diverse faculty with a variety of incentive strategies.
- Provide discretionary funds in the form of ELST Junior Faculty Chairs for initiation of new research directions aligned with ELST.

Longer term

- Establish a formal sabbatical program within the Woodruff School.
- Develop international capstone design courses, targeted by continent/region, to address grand challenge problems.
- Create Woodruff School distinguished visiting scholar positions (from other top international institutions) with reciprocal exchange.

Metrics for Measuring Success – Objective 1

- Structure of research area groups in Woodruff School modified/consolidated by 2012.
- Reallocation strategy enforced for Woodruff endowment with additional state funding to replace 100% of endowment funds presently used for state-funding purposes by 2014.



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- *Initiative for Engineering Life-Sustaining Transformations* formalized in 2011 after planning effort.
- Incubatory transdisciplinary research and education structure of the ELST Initiative established by Spring 2012, with initial seed funding for exploratory studies and collaborative inquiry groups underway in Fall 2012.
- Development office in Woodruff School engaged in 2010 to raise endowment for the ELST Initiative at a level of \$20M by end of 2013, coordinating with Institute development office in cross-cutting themes.
- New administrative support initiatives and policies:
 - “Mini-OSP” established within the Woodruff School with appropriate staffing and benchmarked for efficiency and throughput; Woodruff School faculty proposal productivity to increase by factor of 50% within three years.
 - Management of physical space needs and allocation tools created by Spring 2011.
 - Café-like services established in ME space in Love and MRDC buildings by Spring 2012.
 - Improved awareness of existing family support services by Spring 2012.
 - Improved spaces for informal discussion by Spring 2012.
 - High performance computing (HPC) space in Woodruff School identified, funded and developed to complement OIT plans by 2013.
 - Pursue policy for direct re-investment of 10% overhead to PI for discretionary support of research program development and sustenance of existing efforts (e.g., laboratory equipment maintenance and/or replacement), with possible incentives for ELST-related program development.
 - Explore other means of equipment repair/upgrades and laboratory development based on overhead return.
- Woodruff School student scholar exchange program developed with European and Asian foci by Spring 2012.
- Greater than 20% of Woodruff School undergraduate students studying abroad.
- Two Woodruff School distinguished visiting scholar positions each Fall-Spring created and offered starting in Fall 2014, leveraging reciprocal arrangements as part of new Woodruff School sabbatical program.
- Pilot international capstone design courses run from ELST starting in Fall 2014.
- Formal Woodruff School sabbatical program for faculty renewal with two sabbatical semesters every seven years, developed and implemented by Fall 2016.



Objective 2 – Renaissance in Engineering Education

- Re-invent the Woodruff School degree program(s), curricula and its delivery, creating a new academic model for engineering:
 - Develop a flexible curriculum with breadth beyond engineering, requiring fewer courses while ensuring mastery of core engineering classes and foundational sciences, developing leadership skills, emphasizing interdisciplinary collaboration, communication, and student responsibility for configuring education.
 - Leverage emerging technology in course content delivery to foster faculty-student contact at an unparalleled level of richness, changing paradigm of student-instructor interactions and enriching the learning environment. Explore use of targeted internet-based learning, eBook readers, archived content, studio style courses. Utilize web-based and computer-assisted virtual spaces in delivering education.
 - Create an overarching connectivity of ELST themes addressing grand challenge problems, creating entanglement of research and education.
 - Emphasize international and study abroad experiences.

Laying the Foundations: Years 1-2

- Provide leadership in supporting construction of the Burdell Center and link it with the Woodruff School engineering education renaissance initiative to envision and create a learning community of students and faculty.
- Align student population and faculty size with resources and set enrollment caps to stabilize teaching load and enable faculty to devote time and energy to re-invention. Explore additional means of alleviating pressure from student:faculty ratio such as collaborative teaching among departments, hiring additional instructors, and providing graduate students more opportunities to be involved in the educational effort.
- Appoint ad hoc committees in a re-design and planning effort with charges to (i) map a re-invention strategy for a phased, exploratory approach to achieve flexible, modular and customized programs of study, considering accreditation guidelines and benchmarking best emerging practices at leading peer institutions, (ii) explore internet- and web-based delivery of information and evaluation/assessment methods, embedded publishing, immersive environments, synchronous and asynchronous delivery modes of instruction and evaluation, (iii) explore new models for faculty interaction with PhD students and instructors to develop, offer and update course materials, including assignment of teaching loads, and (iv) explore new structures for integrating research and education with capstone design experiences.



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- Define and flesh out the matrix of alignment of research areas, faculty, and courses with grand challenge themes as defined recently by the NAE, embracing flexibility for new themes to emerge with time.
- Engage constituencies (students, faculty, alumni, advisory board, and prospective employers) in discussions of re-invention.
- Define and approve methodology for re-inventing program of study and curriculum, along with initial transition plan, by Fall 2011.
- Identify courses as pilot testbeds for ELST themes (e.g., ME 2110, ME 4182, special topics ME 480#, etc.) with experimental subsets of students, as well as minors in grand challenge areas interwoven with programs such as public policy, computing, economics, etc.
- Implement regular informal lunches with panel discussions and presentations by faculty, graduate and undergraduate students.

Building the Structure: Years 2-3

Developing the Resources

- Leverage the capital campaign for the ELST Initiative into education renaissance with support for faculty and student effort in curriculum development, novel methods for education delivery and capstone design.
- Develop mechanisms to provide PhD students with opportunities to be involved in curriculum development and teaching within the ELST framework, and work with teams of students and faculty mentors to facilitate modular and customized undergraduate education.
- Identify and implement a plan for enhanced study abroad and service learning opportunities through collaboration with global peers.
- Use emerging technologies to enable and enhance student-to-student mentoring.
- Explore new modes of education delivery and concepts for flexibility; evaluate and benchmark student performance and satisfaction with pilot studies. Evaluate value-added relative to existing curriculum. Recalibrate plans and timeframe for re-invention as appropriate.

Evolving the Programs of Study and Curricula

Years 3-4

- Develop and approve flexible degree program(s), and map transition plan for sequenced curriculum implementation.
- Target, develop, and implement selective re-invented courses to expand pilot program in transition.
- Pursue course sharing mechanisms that achieve improved distribution of teaching assignments across the College, particularly in 1000 and 2000 level courses, providing more time and resources for customization of education.



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- Integrate with global programs such as GTL and various international study and collaboration opportunities.
- Develop support systems to enable one semester study abroad by undergraduate students.
- Create an ELST network computer support strategy to assess and leverage software, internet and web-based tools, and social networking tools to support an immersive, integrated education and research environment for Woodruff School students, faculty and staff.
- Promote research excellence in innovative educational delivery and assessment
- Evaluate trajectory of renaissance with feedback from students. Inform alumni of progress and seek feedback. Assess degree of transformation of flexible programs of study and education delivery achieved, and modify trajectory as evident from feedback and lessons learned.

Years 4-5

- Assign faculty and graduate student teams to develop and flesh out details of the mapping for flexible curricular pathways through the undergraduate program.
- Target 2016 as date for unveiling of re-invention, along with strategy for continued long term evolution of the curriculum and programs of study to develop and maintain a leadership position.
- Develop tools for assessment of impact of degree program and curriculum changes on the enhancement of student performance, broadened perspectives they have gained, and added value in learning and leadership development.
- Emphasize international student experiences:
 - Establish partnerships with premier research institutions worldwide for one semester collaborative research exchange of graduate students.
 - Create a Woodruff School student scholar exchange program.

Metrics for Measuring Success – Objective 2

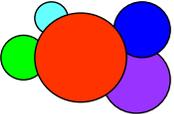
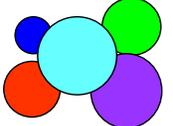
- Burdell Center established and constructed.
- Re-designed academic program of study designed by end of Spring 2012 that meets program flexibility and degree customization targets.
- Initial set of ELST theme courses developed and offered by Spring 2013.
- Student-to-student mentoring program in place and functioning well by Fall 2011.
- Implement strategy of doctoral students and adjunct faculty as instructors as part of program and curriculum re-design, along with strategies for sharing instruction of undergraduate courses across the CoE.
- Assessment tools applied for broadened measures of student performance.
- Conversion from pilot program to fully re-designed curriculum and flexible program(s) of study in new academic model achieved by Fall 2016.



Mapping Strategic Objectives onto the Institute Plan

These two Woodruff School strategic objectives map extensively onto the elements of the Institute plan, as summarized below.

Mapping to Institute Strategic Plan Themes

- **Be the Most Highly Respected Technology-Focused Learning Institution in the World** 
 - **Sustain and Enhance Excellence in Scholarship and Research** 
 - **Cultivate Fundamental Characteristics of Innovation, Entrepreneurship and Public Service in our Graduates** 
 - **Expand Our Global Footprint to Ensure that We are Graduating Good Global Citizens** 
 - **Relentlessly Pursue Institutional Effectiveness** 
- } Georgia Tech
-
- **ELST Institute** 
 - **Renaissance in engineering education** 
- } Woodruff School