Engineering and Design Opportunities at William & Mary

Condensed Summary

August 2016

The charge as outlined by Provost Halleran to the Ad Hoc Committee for Engineering and Design Opportunities at William & Mary was to explore and “find ways to give our students opportunities to become conversant with the tools, programs, and methods” deployed within the fields of engineering and design, to become familiar with “design thinking,” and to “feel comfortable when working in design studios or entrepreneurial incubators.” The committee’s recommendations for relevant engineering opportunities are described in the full report.

The committee believes separation of theoretical activities from activities that result in the rendering of a workable solution is artificial and detrimental. The committee believes that W&M, as a premier liberal arts university with a strong research culture, is well positioned to build a distinctive engineering enterprise that leverages the strengths of a liberal arts education.

Engineering and design activities already are being done across W&M. The report recognizes these activities and the concomitant competencies that have been developed. The report describes a plan to integrate them and to add needed activities to complete coherent and comprehensive engineering and design experiences for students. The program identifies engineering elements that address important societal shifts caused by a growing flood of data” and describes emergent approaches to design and engineering that require science and engineering to be integrated with humanities, arts, and business. Integrating engineering “maker” activities with computational models and other design tools allows our graduates to take on topics of societal import as competent practitioners.

While the integration of engineering with the strong liberal arts background at W&M will improve the student experience in a variety ways, the report focuses on enhancing future employment for our graduates by providing skills and perspectives valued by many employers. The program provides formal curricular content to balance W&M’s current strengths in theory with opportunities for rendering solutions using engineering and design techniques.

The program allows students who are not seeking technical positions to learn technical and critical thinking skills to participate in these important processes. For technically-oriented
students, the program further provides paths to acquire deeper technical skills. Apart from industry’s need for such skills, documented in the proposal, we recognize that inclusion of engineering in a liberal arts education is integral to reshaping the world, and therefore is required to allow our graduates to be fully informed citizens.

The report aggregates activities into five “pillars.” The first three pillars, Science, Humanities, and Arts, echo the new COLL curriculum which is now the basis of the W&M general education curriculum. The fourth pillar, Business and Entrepreneurship, provides very important support for all of the other pillars, and serves as a highly desirable outlet for students in engineering studies across the entire university. The fifth pillar, Infrastructure, builds the tools, spaces, and resource centers, especially various maker spaces, computational and communication resources, centers for learning design, media, and the liberal arts, and a center for large-scale Data Visualization. A brief summary follows:

**Science Pillar**

- **Data Science**
  - Initiative identified 16 educational units, programs, and centers whose work revolves around “big data” and computation, with multiple pathways for undergraduate, master’s, and doctoral students to acquire data science credentials. Studies in Data Science could include coursework toward interdisciplinary undergraduate degrees might also serve other areas of the curriculum, or lead to certificate, or to a Ph.D.

- **Applied Engineering Physics and Design Science**
  - Pathway for students to earn a B. S. degree in Engineering Physics and Applied Design with faculty from the Physics Department, the Applied Science Department and the Raymond A. Mason School of Business. Leverages the firm foundation that W & M offers in pure and applied science, with laboratory experiences for bridging science with applications of modern technology.
• Bioengineering/Synthetic Biology
  o Pathway to pursue integrated coursework in undergraduate bioengineering/synthetic biology along with M.S. and Ph.D. program tracks in Applied Science. The proposed undergraduate curriculum contains many COLL courses for independent studies (including COLL 400) and for Computational Biology.

• Autonomous Systems, Devices, and Robotics
  o Expertise in Autonomous Systems especially Underwater Vehicles (AUVs), underwater Remotely Guided Vehicles (ROVs), unpiolated land and aerial vehicle technologies.

Business and Entrepreneurship Pillar

• Design and Deliver
  o Undergraduate design experience for students qualifying for COLL 400 status in various disciplines. Provides online programming, prototyping, and electronics modules that can be redeployed across many internal William & Mary programs, as well as in outreach programs, with pathways to entrepreneurship and business incubation. Could be configured as a concentration through 12 credit hours of course work.

• App School
  o Spaces and programs to develop various applications for smart phones, tablets, or other devices, with curricular content (COLL 200 or COLL 400) to encourage students to create viable software products.
Humanities and Arts Pillar

- Equality Lab: A Space for *Digital Scholarship*
  
  - The Equality Lab is a center for a multitude of creative and “maker” activities offering COLL 400 experiences in pedagogic game development and other activities.

- Arts: Engineering Foci
  
  - Pathway for undergraduate students who have relied on the Interdisciplinary Studies program, or double majors, to construct programs in Digital Gaming and other areas.

- Sustainable Design
  
  - A program to blend better approaches to habitat, materials, and a cradle-to-cradle philosophy of community, energy, and environment.

- Art Conservation
  
  - Laboratory experience for restoring art and artifacts, and using advanced technical means for uncovering and preserving material culture.

Infrastructure Pillars

- Maker Spaces
  
  - IP-free spaces outfitted for rapid prototyping of electrical, mechanical, computer-assisted, controlled or autonomous device (object) construction. Maker spaces are currently being implemented or expanded in Small Hall, ISC, Morton, Andrews, ARC, Mason, and School of Education.

- Center for Innovation in Learning Design
  
  - This center (in the School of Education) provides for innovation in K-12 education and teacher candidate training using, among other techniques, design thinking. The center will aid teachers in designing learning content based on problem-solving.
• Center for the Liberal Arts
  o This Center provides support and coordination for many of the new features of the Arts and Science COLL curriculum in a physical space that could be centrally located in Swem to support curriculum design in engineering programs.

• Central Data Visualization Lab
  o Large-scale development lab comprised of hardware and software for visualizing high-dimensional data sets and the analytical output from computational efforts with geographic information systems (GIS), modeling and simulation, and predictive algorithms based on big data.