CULTURE, OPERATIONS & PARTNERSHIPS

Enable Digital Learning & Research

Enable Digital Learning & Research (IT operations)

Executive Summary

SEAS is well positioned to take advantage of opportunities in both the academic and research spaces. These opportunities offer the promises of greater productivity, efficiencies, innovation, and world-class teaching. In both spaces, the strategic direction has two major fronts. The first is availability — we have the capability and opportunity to make available to our instructors and researchers tools that they can take advantage of to achieve excellence in their academic or research missions. The second is support. Our instructors and researchers deserve the institutional support in the form of training, education, and continual development that are needed to improve the quality and effectiveness of our academic offerings and the strength and repute of our research output.

In the academic space, the focus will be on *digital learning*. The goal is to enhance student engagement via greater inclusion of digital learning technologies, and improve student outcomes with evidence-based refinement of curricula. It is also important to be more effective in the use facilities for more active and collaborative learning with telepresence, lecture capture, and application delivery technologies. This can happen through must increased access to and awareness of these resources, and the establishment of programs that provide support and professional development to instructors and enable them to be effective in using these tools and facilities.

In research, the focus is on research *engagement*. The goal is to increase access to the computational resources needed by researchers. This is to be accomplished through a combination of investing in the specific needs of Engineering and integration into existing and upcoming University resources. These resources must be expertly supported, and SEAS must engage with the University and other schools to improve computational research capabilities across the board. A professional development program for all researchers should be established to ensure the quality and rigor of our research processes and procedures, as well as introduce our graduates to the type of structured methodologies they may encounter later in their careers.

By examining its current structures and assumptions, the School of Engineering & Applied Science (SEAS) is well-positioned to take advantage of opportunities in both the academic and research spaces. These opportunities offer the promises of greater productivity, efficiencies, innovation, and world-class teaching.

Digital Learning

Enhance Student Engagement

Digital learning encompasses any technology-enabled tool or instructional practice to enhance the student experience. The technologies that enable education online are relatively mature, and the pedagogical benefits are widely established. Course management systems are commonplace, and evidence-based pedagogical approaches for taking advantage of these technologies are readily available. Student response and online course management systems enable data-driven refinement of academic offerings, as well as consistency of experience across all of a student's classes. Telepresence technologies have also become increasingly stable and accessible. Finally, the rise of ubiquitous computing means a preponderance of students have access to one or more devices capable of enabling instant collaboration with others regardless of physical location. As our curricula and pedagogy develop, digital services and resources must be included as a supplement to residential classroom instruction and a foundational strategy for professional education.

Effective Use of Space

Telepresence technologies can overcome the barrier of physical presence, allowing for education and collaboration to happen any time or anywhere. Lecture capture – either of live classes or pre-produced instructional videos – allows students to view and review information at their convenience and allows instructors to dedicate class time to guided problem-solving or other active-learning approaches. Specific experiences, such as complex demonstrations, guest speaker presentations, or a tour of off-site facilities, can be recorded and reused indefinitely. Also, the ability to review live classes has been shown to be a particular boon for non-native English speakers. Application delivery technologies — allowing students to utilize their own device to access complex engineering applications — release dependent classes from the confines of static computer labs, or from being on campus at all.

While digital classroom technologies hold the promise of eliminating the constraints of physical space or fixed schedules, it remains vital to provide spaces for collaboration or "creative collision" with faculty and with other students. As the curriculum adjusts to make better use of digital classroom technologies, the traditional class time can be held in less traditional (for Engineering) class spaces. In hand with the Teaching Center and other schools, we should take the initiative on bringing classrooms across Danforth, especially the East End complex, up to our own standards on how a flexible educational space should be provisioned. As our facilities layout changes due to new construction or changes in how existing spaces are used, we should look for every opportunity to mix in collaborative spaces. This is most important for the East End complex — the extra effort must be made to draw students in to where the research is being performed and to promote a sense of 'belonging' to the extended Engineering community.

Increase Access and Awareness

Many of these technologies are already available to SEAS students in some form or are in development:

- The Teaching Center provides access to student polling devices, SMART boards, document cameras, and other resources to facilitate flipped classroom and active learning models.
- WashU maintains Blackboard, a course management system, which provides a common interface for collaboration and management of student academic portfolios. A project is underway to choose the next iteration of this service.
- WUIT hosts several options for telepresence and lecture capture, including Skype for Business, Adobe Connect, and Blackboard Collaborate.
- The Sever Institute has begun development on digital content creation capabilities within Engineering.
- Engineering IT is executing a program to change from static computer labs to bring-your-own-device-centered application delivery.

Existing resources need to be identified, catalogued, and advertised much more actively to our faculty and instructors. Active projects should become integral parts of the resultant efforts of the strategic plan and be efforts of partnership between technologists and educators. In both graduate education (particularly the Sever Institute) and undergraduate education (the proposed Engineering Science major), we have a clear opportunity to integrate these technologies into the foundational structure of the curriculum. With a concerted effort, we can gain support for wider implementation of technology-enhanced instruction school-wide.

Improve Faculty and Student Support

Education is a process, for both the student and instructor. Integrating digital learning into our curriculum can only succeed with faculty and instructors who can fully leverage the tools. Engineering must grant each of its instructors (faculty, staff, or student) the education, training, and continued support required to judiciously transform the curriculum to utilize these new technologies and facilities.

Acceptance and integration of digital learning into Engineering's curricula will require continual governance. Many of these efforts are operating independently, and better outcomes will be realized if these projects are part of a cohesive plan. As part of the strategic plans for our undergraduate and graduate curricula, leaders in educational and technological innovation in the school, or focused experts employed for the purpose, must be empowered to both kickstart the fundamental changes needed to our academic, technology, and facilities operations and continually refine our processes against new methods and resources. To achieve this goal, this governance group should:

- Formulate and maintain a full catalog of educational and support offerings for pedagogical development of curriculum and the integration of technology, using the best resources and example programs available within and beyond WashU. Where Engineering finds gaps in these offerings, be it capability or capacity, it should be ready to close those gaps by providing its own expertise.
- Create a professional development plan for current and new faculty. Each instructor should have the knowledge of, the opportunity to, and the support required to integrate these technologies into their own curriculum where appropriate.

- Provide mentors, whether staff or faculty, to provide expert advice and guidance, and to build a knowledge base of best-practices, lessons learned, and experimental concepts.
- Expect a minimum level of discipline and rigor regarding the organization and presentation of classes with regards to digital course management and related technologies. Base expectations set now reduce later threats, make our academic offerings more flexible to future innovations, and ease collaboration with other academic units.
- Construct and govern a comprehensive view of facilities for instruction and collaboration. A minimum standard for instructional technology should be established for Engineering, and each available space tiered according to capability. Additionally, each class must be tiered according to its needs, so that the current and future scheduling and capacity needs can be met.
- Interface with and influence other WashU groups and projects to ensure Engineering's needs are met or exceeded. The next few years are a critical time for technology changes within the university, and Engineering must actively involve itself in these projects.

A successful implementation of digital learning finds our students participating and collaborating online, over interfaces common to all their classes, and in and out of class hours. Low barriers to communication find a greater rapport between instructors and students. Providing cross-disciplinary education within the school is more consistent and achieves better results due to the use of best-of-breed modular units, and Engineering education is easily portable to non-Engineering majors.

Eliminating physical barriers allows guest lecturers from academia and industry or guest students from classrooms around the globe. The Professional Education program can meet its students on their terms, providing point-of-presence education. Promising high school prospects can join programs or audit classes from their homes. Classes traditionally trapped in computer labs can now be held anywhere, enabling more dynamic and active learning situations.

New faculty receive a compete catalog of resources and support options, enabling them to use these technologies effectively their first day in the classroom. Our instructors have the ability and confidence to integrate the best examples of digital learning in their particular courses. A comprehensive support program and governing body ensures each instructor has the opportunity to provide an engaging curriculum that will transform our graduates into lifelong learners, wherever their careers may take them.

Research Engagement

Part of the historic culture of the university and SEAS has been one of isolation – independent and duplicative efforts reinventing common services. The university as a whole is changing these habits, and many of our peer institutions have overcome these limitations. New initiatives at the university level aimed at providing shared services for research offer an opportunity for the School to change the way it engages in research utilizing computational and instrumentational resources. Gaps in the availability of resources across the School have been noted. Additionally, there are mismatches in expectations in experimental rigor and research discipline, as well as asset and data management. The university is beginning several initiatives in this space, and Engineering should be prepared to meet these requirements.

Increase Access to Computational Resources

Through the Office of the CIO, WashU has implemented or launched several proposals to bring about better offerings in the research computing space. The Washington University Research Network (WURN) aims to

bridge the Danforth and Medical campuses together with a fast, independent network connection, as well as a more direct onramp to Internet2. A proposal to provide a multi-petabyte research storage system, with full archival capabilities, has passed the approval stage. Initiatives to formalize a research computing offering are beginning. WashU has agreements with several cloud vendors. Engineering must contribute to these efforts and leverage these resources to its fullest extent. Common university services for research greatly reduce the friction encountered when collaborating with other schools and departments within the university — issues of data storage and transfer, access, and authentication are largely eliminated.

For many years Engineering IT has offered a computational cluster service to all researchers within SEAS and collaborators outside SEAS. This heterogeneous cluster, a mix of EIT and grant-funded equipment, has served as an internal model of the advantages of common infrastructure. This model should be officially defined and expanded, taking advantage of upcoming university resources to build a foundation for Engineering computational research.

The combination of a solid common core and an Engineering-focused resource will then allow individual researchers to expend their funding more intelligently on their own extraordinary needs. Those expenditures can be tied, where possible, into the common offerings of SEAS and WashU, enhancing by addition the core services and multiplying the investment of single researchers. The availability of the resources aids the application and eventual awarding of grants, as funding agencies will take note that Engineering and WashU are taking appropriate steps to enable their researchers to function well and apply grant funds where they make the most impact. This existing baseline will allow Engineering to provide resources for new initiatives more flexibly, whether for research centers, undergraduate research programs, or other exploratory efforts.

Common infrastructure begets common interfaces, and researchers will be able to flow among various computational offerings with little resistance – concentrating on the implementation of their research rather than the operations of equipment. The state of our software licensing for many key applications in research is fragmented, and should be normalized to broad school needs — it is unnecessary for researchers to compete amongst each other for limited resources. This infrastructure combined with expert support greatly enhances Engineering's ability to attract and retain the best and brightest researchers — an incoming faculty member will be "ready to run, day one" on the research Engineering brought them here to do.

Developing and maintaining this service will require continual governance. A cadre of computational research and technology experts should be empowered to:

- Determine baseline requirements for the service based on current activities, polling for unmet and unknown needs
- Establish a framework for a sustainable offering that integrates existing local and WashU computational resources, and provides the flexibility and customizability to respond quickly to Engineering needs
- Provide support, documentation, and training for working with all levels of the service

- Annually review service implementation for capacity, capability, and appropriateness vs. available WashU resources
- Interface with other university schools and departments to drive the development of further computational and instrumentational resources at the university.

Define Research Methodologies

Hand-in-hand with the aforementioned service developments come university initiatives designed to codify data management and classification strategies university-wide. Additionally, more granting agencies are requiring data management plans, including archival and sharing of results. The process and procedure of obtaining grant funding will also become more important, as funding is expected to become more competitive, particularly from federal sources.

The foundation of Engineering's competiveness for the best researchers, largest grants, and most promising students starts with research quality. The rigor of the research done – proper documentation and data management, efficient management of personnel, projects and assets, agile navigation of the grant process, and high ethical standards – must be ingrained and reflexive.

A professional development program for researchers, including faculty, postdoctoral associates, students, and laboratory personnel, should be defined and continually curated by an expert committee, with the intent of establishing a baseline competency and confidence in:

- Grant proposal writing and the application process
- Data management – recording, managing, and protecting
- Asset management and protection
- Project, time, and personnel management
- Research ethics

These programs should include current and future university offerings, supplementing with higher standards for Engineering where advantageous to do so. Introducing our researchers to these concepts will repay itself in greater results. Additionally, our students will be more prepared to adapt to process management programs later in their careers, having been exposed to, and expected to execute on, these same concepts.

A successful implementation finds our faculty able to concentrate their funding on the particulars of their research needs rather than reinventing infrastructure from scratch. Researchers with low or mid-sized requirements may find themselves able to omit equipment purchases entirely; and no person or group will find themselves lacking due to the "feast or famine" cycle of grant awards. New faculty or interdisciplinary initiatives can be quickly implemented.

The execution of the research mission — from faculty investigations, graduate and PhD thesis completion, or undergraduate research efforts — are supported by a solid professional foundation. Data management processes ensure experimental repeatability; project management procedures aid the successful completion of a grant's lifecycle. Our graduates, armed with experience in these concepts, are able to quickly adapt to the *systéme du jour* of any industry or academic environment they find themselves in. The reputation of our school will follow in the excellence of our research and graduates.