School of Computing & Information (SCI)

Proposal

March 7, 2016

1. individual(s) initiating the proposal
    a. Dean Ronald L. Larsen (School of Information Sciences)
    b. Professor Taieb Znati (Chair, Department of Computer Science)
2. responsibility centers wherein the changes will occur
    a. School of Information Sciences
    b. Dietrich School of Arts and Sciences
3. name of academic unit to be created
    a. School of Computing & Information (SCI)
4. schools and departments affected by the proposed change(s)
    a. School of Information Sciences
    b. Dietrich School of Arts and Sciences, Department of Computer Science
5. date of the proposal
    a. March 7, 2016

6. Rationale:
    a. The rationale for the proposed new academic unit, specifically explaining:
        i. its relation to the current mission and goals articulated in the long-range plans of the University, the responsibility center, and/or the department,

The new academic unit directly supports two of the principal drivers espoused in the "Plan for Pitt – Making a Difference Together, Academic Years 2016 - 2020" (see sidebar).

The new academic unit is designed to directly or indirectly support the university's strategic goals. These goals are inserted for reference throughout this proposal in banded quote boxes, noting the strategic goal (and its number) extracted from "The Plan for Pitt."

> "The Plan for Pitt"
> *Drivers*
>
> **"Partnering for Impact:** We will facilitate internal collaboration to enrich the interdisciplinarity of our academic endeavors and enhance operational efficiency; and actively pursue engagements with private, public, government, and international partners on strategic initiatives."
>
> **"Harnessing Information:** We will transform the scale and impact of our activities by harnessing information in pursuit of grand challenges. This will drive innovative approaches to research, student learning and development, community and alumni engagement, and operational excellence."
>
> http://www.pitt.edu/sites/default/files/Strategic-Plan-Presentation.pdf

        ii. the external and internal environmental influences or trends justifying the creation of the new academic unit.

On April 10, 2015, Provost Beeson met with the faculties of the School of Information Sciences and of the Department of Computer Science in the Dietrich School to invite them to develop a proposal for a new unit that will incorporate both faculties into a single academic and administrative unit. This request was motivated by the widely held belief that our institutional strength in this increasingly important area of inquiry could be enhanced through a structure that allows for greater integration and coordination of both the research and academic programs.[1]

"In talking with the faculties, I asked that they take a broad look at the University's strengths, opportunities, and needs in this area and develop a proposal that will significantly advance our efforts by consolidating academic programs, capitalizing on

[1] Email from Provost Patricia Beeson to Council of Deans, 4/10/2015 2:16 pm

existing strengths, enhancing collaborations, and creating an intellectual hub for computing and information sciences at the University."

The examination that followed revealed an emerging new era of computing which requires understanding and applying computing and information in the *context* in which it is being used. With the pervasiveness of computing and digital information, *computing & information* has become and will be even more interwoven with disciplinary domain areas. Domain scientists and educators require sophisticated understanding of what computing can provide, and computing scientists and educators need a deep appreciation of the requirements of the application domain.

"Strategic Goal 3: Strengthen Communities"
"Increasing the economic impact of our work through technology transfer and commercialization efforts and leverage impact through collaboration and coordination with other institutions and government agencies" "Increasing the impact of research by focusing on key global themes that draw on expertise from across the University and build on our traditional strengths in language and culture"      "The Plan for Pitt – Making a Difference Together, Academic Years 2016-2020"

Context and Enablers of a New School

Computing has impacted nearly every aspect of our lives. Its potential to drive technological innovation and fuel scientific discoveries is undeniable and widely recognized across numerous scientific disciplines and critical sectors of our society. Computing enables the integration of computational thinking and data-intensive discovery into a range of natural, physical and social fields to explore new approaches and develop efficient solutions to a wide range of grand challenges critical to our lives. The integrative approach to problem solving, enabled by computing, has ushered in a paradigm shift not

only within, but also across, academic disciplines, triggering a rethinking of how research in essentially every discipline is conducted and how knowledge can be acquired.[2]

The confluence of computing with diverse academic disciplines is increasingly leading to new approaches to interdisciplinary research, gradually paving the way for a range of shared knowledge bases. The resulting research ecology enables discoveries in one discipline to contribute to advances in other disciplines, which in turn create opportunities for improved knowledge in the original discipline. Although hard to predict a few years ago, the transformative impacts from the adoption of computing on numerous scientific, engineering, humanistic, and artistic fields are evident. This trend will undoubtedly continue, shaped by the pace of technology changes, emerging social trends and increasing human coupling with and dependency on computing and information technology. The new school proposed for Pitt aspires to facilitate and accelerate computing and information-fueled discovery and creativity throughout the university. This will necessarily require the forms of creative discourse that follow from intense interdisciplinary and interpersonal interaction and collaboration.

"Strategic Goal 2: Engage in Research of Impact"
"Position the University to participate in large research collaborations through investments in shared core facilities; strategic recruitment; and partnerships with industry, government, and other institutions" "Expand our computational capacity, human and physical, to meet research needs across a broad range of disciplines into the future" "Extend the impact of our research through application to practice, policy development, and commercial translation"      "The Plan for Pitt – Making a Difference Together, Academic Years 2016-2020"

Research Collaboration and Community Partnership for Scientific Progress and Innovation

Sustainable university-wide efforts and practices to bring together and integrate existing and yet-to-be-recruited scholars to foster a multidisciplinary culture driven by proactive

[2] See, for example, The Fourth Paradigm: Data-Intensive Scientific Discovery

critical thinking and the capacity to create new knowledge for scientific breakthroughs and problem solving in a wide range of domains is essential to our society. Active collaboration across the university and with industrial, cultural, and community partners is critical to our goal of fostering entrepreneurship and innovation, and to facilitating technology transfer across scholarly domains, as well as to commercial and social sectors. Understanding the need, the potential impact, and how the derived knowledge contributes to the vision and goals of each partner is critical for a successful collaboration. This requires approaches that foster the establishment of strong communication, understanding, and trust between the new school and its partners. Face-to-face meetings and frequent, informal interactions are viewed as essential to facilitate effective collaboration, in both directions. To this end, the School will seek to:

- Support collaborative research activities and industrial, cultural, and community partnerships. We envision close collaboration not only with the Innovation Institute and key university partners (e.g., the School of Medicine's Department of Biomedical Informatics), but also rich engagement with visiting scholars, researchers, entrepreneurs, and industrial partners. The objective is to enable the collective thinking, managed coordination, and spontaneous communication critical to fostering creativity and building shared knowledge.
- Build programs to accelerate innovative uses of computing and information throughout the university and to transfer technological discoveries through the Innovation Institute to foster the creation of companies and related entrepreneurial ventures among faculty and students.

"Strategic Goal 4: Build Foundational Strength"

"Transform information infrastructure to expand our reach and better support recruitment, research, learning, and operational efficiency"

"Enhance our ability to partner both internally and with public and private partners locally, nationally, and globally"

"The Plan for Pitt – Making a Difference Together, Academic Years 2016-2020"

7. Description

The goal of this proposal is to create a new academic unit (the *School of Computing and Information*) that will become a center of gravity for scholarly activities related to computing, interpreted in the broadest sense and as inclusively as possible to include all aspects of computer science, telecommunications, information science, archives, and library science. The new school will provide an environment enabling larger scale computing and information-related research, thus leading to more (and larger) research grants, more influential papers and better training of undergraduate and graduate students. Having well recognized research groups in unique and futuristic areas will benefit the entire university by enabling large interdisciplinary research projects, since computing and information technology are becoming pervasive themes in almost all aspects of the sciences and humanities. An anticipated consequence of the development of this new school is that more and more highly qualified students will choose to study at Pitt as their first choice because of its excellent research reputation.

Research Theme: Contextually Situated Computing

Computing and Information Science (CIS) research and reach are largely about everything that we do as a society, whether in science, business, government or individual lives, that involves computing and information technologies (e.g., programming languages, databases, information systems, information management, algorithms, computer processors, operating systems, networks and the like). It is a cliché, perhaps, to say that "computing is everywhere," but this statement is resoundingly true today. The entwinement of computing in society and our physical world is having a profound effect on the disciplines. Interdisciplinary CIS research is no longer "computing in support of an application domain;" it is about allowing the domain to influence CIS and vice versa. This substantial transformation currently underway will transcend the simplistic notion of interdisciplinarity. The change is that CIS is becoming contextually situated; the disciplines are no longer on their own, nor just standing alongside a domain in interdisciplinary study. The disciplines are directly embedding intelligence (through computing) within the context of the problems they are trying to solve, for example: understanding and analyzing data; managing a situation for safety, privacy and security; discovering new insights from context; automating tasks in the home; improving responsiveness and quality of health care and medical treatment; creating interactions of device and data as one, etc. One way to think about this notion is to visualize swimming in a sea of data, trying to make sense of it all and getting more out of it for the betterment of society and deeper understanding of the world. As disciplines, we must remove technological silos and insular research and education efforts to lead the placement of computing within the context of its use.

An emerging example of this ***contextually situated computing*** (CSC) is tetherless augmented reality (as embodied in Google Glass, Apple Watch, etc), which encompasses much of computing and information science advances to enable something new. These devices put the user directly "in the data," sorting through it to understand and learn to assist the individual (for comfort, safety, entertainment, etc.) and to benefit society (e.g., coordinating and guiding disaster response). Of course, a device like Google Glass is not just a "consumer device," but also an enabler to create novel opportunities, such as recording and analyzing images, geopositioning data, and interpreting past behavior to discover something new and to thereby improve situational awareness. Tetherless virtual reality brings together most of CS and SIS into one very complex infrastructure, including machine learning, data management, security and privacy, human-computer interaction (HCI), embedded systems, high-performance computing, networking, software engineering, and on and on. It also involves seemingly unrelated, though vital, areas such as industrial design and consumer fashion. Numerous other examples arise in many domains, such as medical devices, robotics, and autonomous vehicles, among others.

CIS research and education in the new school will become more attuned to context, in addition to addressing the specific character of individual technologies. This requires rethinking how we approach research and education. In research, we need to consider the relationship of innovations to the end capabilities required by computing within context. For instance, in computer systems architecture, there is a trend of specialization, where a computing system is tailored to a domain. In big data analytics, deep learning is emerging as an important new trend. New algorithms and computer architectures can be built to more efficiently apply deep learning, and thus allow more data to be analyzed for improved scientific understanding and discovery from the analyzed data. These examples illustrate connection between machine learning, computer systems architecture, and data analytics. By themselves computer systems architecture researchers would be unable to develop the techniques to more efficiently apply deep learning. The same can be said for the others: there is a symbiotic relationship between all three of being in-situ to one another. The CS and SIS undergraduate and graduate curriculums need to bring forward concepts behind contextual situation. Students need to be educated to become computational thinkers, creating new technologies by incorporating contextual and the end goals of computing, rather than being only technologists. This touches again on all computer and information science areas, e.g., databases, security and privacy, algorithms, operating systems, compilers, software engineering, and also technology in society. New curricula must embrace relevant emerging research areas, such as data analytics. New contexts and how they influence the way we create new computing systems, design and use them should be an integral part of the new curriculum. Students also need to learn how to cross boundaries, interacting with people outside their discipline, understanding domain problems, and synthesizing concepts and knowledge. Like many topics, learning to span

boundaries involves both concepts and skills that can be taught. Other aspects that come to the forefront of CSC, include computing ethics, governmental policy, and societal affect.

Contextually Situated Computing – More than a Vision, Beyond a Brand

N**ew scientific discoveries and innovations increasingly lie at the intersections of traditional disciplines; information and computing technologies (ICT) often serve as the bridge between these disciplines.** Pitt's School of Computing and Information (SCI) will focus on research and education leading to innovative solutions to complex problems in computer and information science and engineering domains, driven by requirements and challenges in such key areas as healthcare, national security, and personalized education. In this emerging era of computing and data-intensive discovery, we envision a new school that will become the recognized center for *contextually situated computing,* building on an open curatorial culture facilitating longevity and trust in the records that are produced.

As the broad stroke direction for SCI research and education, contextually situated computing can influence scholarly research, education, and discovery throughout the University. It will enhance other disciplines' ability to leverage expertise in computing, accelerating mutual progress to achieve more impact than could be done separately. It will require new ways to enable effective and direct interaction between SCI programs and domains. It will also impact how we educate students, favoring, for example, explicit integration of field experiences and multidisciplinary projects. SCI research and education programs will be crosscutting between academic and research units at the University of Pittsburgh, facilitated by creative incentives and mechanisms to enable deep collaborations.

- The School will become the intellectual hub for interdisciplinary research, teaching and outreach activities in **computing and information**. It will build on existing synergies to create a critical mass of faculty in several research areas and foster collaborations across and between constituencies in research and innovation.
- The School will consolidate and enhance its existing programs and develop new multidisciplinary programs, focused on fundamental knowledge, insights, and skills from other domains to educate outstanding students and next generation scientists in information and computing technologies.
- The School, in collaboration with the Innovation Institute, will facilitate and nurture partnerships with relevant industry, cultural, and community organizations. Facilities and processes will be designed to foster sustained collaboration between

these organizations and Pitt, supporting innovation and the transition of discoveries and inventions into real values to society.

Emerging Themes

As a "north star" for the School, Contextually Situated Computing (CSC) provides a direction for a wide range of research and collaboration within and across disciplines and domains. The strategy is to focus on building core strength and gaining national visibility in selected crosscutting areas. The selection of these areas is motivated by the potential for innovation and social impact, the ability to leverage faculty strengths and existing synergies between constituencies in CS, SIS and other schools and healthcare institutions for immediate faculty engagement in multi-disciplinary research and innovation, and the relevance of these areas to the University's strategic planning and priorities. Taking into consideration these objectives, the School will strive for preeminence in its research and educational programs and worldwide recognition in the following three strategic areas**:**

- **Connected Life, Health and Medicine –** Harnessing the unique opportunity to gather, analyze and synthesize data from a variety of sources, coupled with the ubiquity of powerful networked sensors and mobile computing devices, creates unprecedented opportunities for interdisciplinary research across the areas of medicine, social and behavioral sciences, and computing to enable next generation health systems that are agile and cost-effective, capable of delivering high-quality personalized healthcare. We will leverage our existing strengths in machine learning and data mining and explore emerging data-driven technologies, such as the Internet of Things (IoT), to fundamentally alter the way patients' activities are tracked and how information, augmented with intelligence, is collected to identify choices and inform decision making in next generation healthcare systems. Advances in this area will require catalyzing new connections and fostering interdisciplinary research directions.
    - **Relevant Areas:** Cyber-physical Systems, Security and Privacy, Data Management, Machine Learning, Natural Language Processing, Human-Computer Interaction, and Data Stewardship.
    - **Potential collaborators:** the School of Medicine, the Graduate School of Public Health, and the Swanson School of Engineering, with the Innovation Institute serving as a facilitator of partnerships with organizations such as UPMC Enterprises and the Pittsburgh Health Data Alliance.
- **Synergistic Computing in Education –** As the importance of computing continues to increase, significant roadblocks still remain that prevent full integration of computing into both the education and training of next generation students, teachers and workforce. Despite significant advances in the use of information

technology to improve the efficiency and effectiveness of teaching, our knowledge of how students learn and the role that teachers and the broader community play in the practice and delivery of education and training at all levels is still limited. While the institutional objectives and setting may differ, computing has the potential to transform the way we teach and learn, in ways that adapt to different learners and contexts. The overarching goal of this research theme is to transform the way we learn and the way we teach, driven by a fundamental knowledge and understanding of what methodologies are effective, why they are effective and the circumstances in which they are effective. Driven by the promises of Big Data and data science, we will harness the different extensive knowledge and expertise available at the University of Pittsburgh to explore new effective learning strategies that not only engage, but also adapt to the educational needs and pedagogical requirements of both the individual and groups of learners. We will train teachers to harness the ubiquity of computing and power of information technology to equip students, in different settings and different levels of education, with the skills required to establish themselves and remain current in their future careers. We will develop intelligent computational models to better understand and make accurate quantitative predictions about how learners behave and how they react to different kinds of learning and practice experiences. This knowledge will enable new forms of education, new pedagogies for teaching online or on mobile platforms, innovative tutoring systems that understand and engage students like a teacher would, and new personalized learning environments for specialized education and training for different sectors of our society.

  - **Relevant Areas**: Artificial Intelligence in Education, Machine Learning, Computing Education, Pedagogy.
  - **Potential Collaborators**: LRDC, CIDDE, School of Education, dB-SERC, EERC, Health-related organizations.

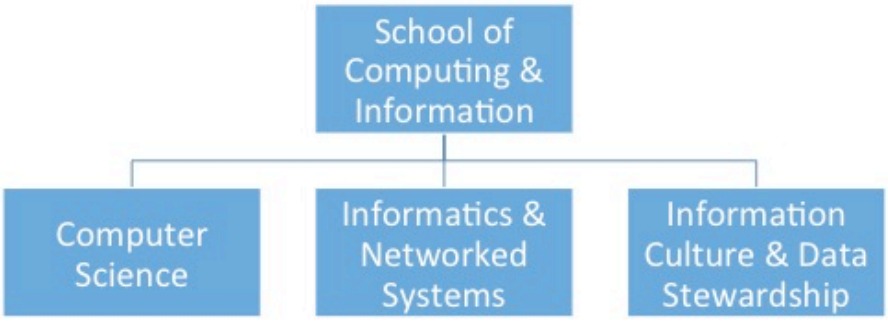
- **Computing at the Extremes –** Scientific challenges, particularly those that hold the greatest opportunity for significant impact and transformative technologies, involve systems and processes whose realization requires not only rigorous design approaches and methodologies, but also transformative thinking at the cutting edge of our understanding of computing and information systems and the complex social, economic, and legal context in which they operate. New extreme computing paradigms have emerged that hold promise for effective solutions to these challenges. The potential of extreme-scale computing to achieve several orders of magnitude increase in computing power is paving the way to quantum advances in areas of science and technology. Similarly, the emergence of the Internet of Things is enabling massive numbers of connected sensors and smart devices to collect and disseminate, at an unprecedented scale and resolution, a broad array of data, anytime and anywhere, fundamentally altering the way we seek knowledge and

address challenges. Unleashing the full potential of computing at both extremes requires holistic data- and compute-intensive approaches to understand context at scale and create actionable, situational knowledge critical to the development of effective solutions commensurate with the nature and requirements of the underlying application domain. Whether the goal is to revolutionize healthcare and our treatments of infectious diseases, enable the next generation of smart cities for sustainable urban growth, or create intelligence- and data-driven security approaches for critical infrastructure protection, breakthroughs can only be achieved through collaborative multidisciplinary research in computing and its underlying technologies, driven both by deep disciplinary capabilities and interdisciplinary conversance. Paramount in these collaborations is the role of the humanities and the social sciences in achieving better understanding of how computing and data science exist in the social ecosystem, to ensure consistency with laws and regulations and to preserve individual privacy and civil liberties.

- **Relevant Areas:** Nonvolatile Computing, Energy Harvesting, Algorithms, Systems, Networking, Computer Architecture, Data Storage and Management, Information Retrieval, Machine Learning.
- **Potential Collaborators:** Electrical and Computer Engineering, Industrial Engineering, Physics, Statistics, Mathematics, PSC, Biological Sciences, Biomedical Informatics, Bio-Informatics.

a. A detailed description of the proposed new academic unit:
   i. its specific components,

The School of Computing & Information (SCI) will be led by a Dean and will initially consist of three departments: *Computer Science*, *Informatics & Networked Systems*, and *Information Culture & Data Stewardship.* The Dean of the new school will appoint the chairs of the departments based on recommendations from the faculty in each department.



ii. a detailed chronology of steps to be taken to implement the change over time.

The proposal will be reviewed by the Dietrich School PBC and Council, and by the School of Information Sciences PBC and Council during the spring 2016 term, and is expected to be submitted to the university for consideration by August 1, 2016. The proposal will be reviewed during the fall term by the University Council on Graduate Studies (UCGS), the Provost's Advisory Committee on Undergraduate Programs (PACUP), and the University Planning and Budget Committee (UPBC). Following the review of these groups, the proposal will go to the Provost for review and approval during the fall 2016 term.

The administrative restructuring supporting the new school is to be conducted during the spring term of 2017, enabling the school to be formally established on July 1, 2017 (the beginning of FY 2018), with the first cohort of students matriculating in the new school for the fall term of 2017.

iii. Requirements for admission to the program, and a projection of the availability of qualified students for the program.

The initial requirements for admission to programs in the new school will be identical to existing requirements for these programs in the Department of Computer Science and the School of Information Sciences.

"Strategic Goal 1: Advance Educational Excellence"

"Enhance the curriculum through innovative, discipline-based approaches to teaching and learning and appropriate uses of technology to enrich the on-campus learning environment"

"Expand access to master's and professional education through innovative joint degree programs, online master's and professional programs, and new opportunities for students to earn both bachelor's and advanced degrees in five years"

"The Plan for Pitt – Making a Difference Together, Academic Years 2016-2020"

The departments in the new school will continue to offer the current academic programs of SIS and CS (undergraduate, Masters, 5-years combined BS/MS, Ph.D. degrees, and Certificates of Advanced Study). In the future, the new school anticipates developing a set of additional interdisciplinary certificates, specializations, and degrees in collaboration with other Pitt schools. The Computer Engineering degrees, the Intelligent Systems degree and the Computational Biology degree are three current examples of such interdisciplinary degrees. These programs will be maintained after the creation of the new school and will provide a model for the development of others.

We seek to build a set of excellent educational programs that address the ubiquity of computing and information in the modern world, and educate next generation students, with a focus on the knowledge and analytical skills needed to address complex compute- and data-intensive problems critical to our society. The programs will cover the technology spectrum from makers to users and from science-oriented to the human-centric, preparing students for working in industry as well as continuing to further their education and participate in research in the realm of contextually-situated computing.

The opportunities presented by advances in ICT are magnified by expanding and enhancing the educational pipeline, from primary education through society's lifelong learning needs. President Obama, in his 2016 State of the Union address before Congress, noted that the US should be "offering every student the hands-on computer science and math classes that make them job-ready on day one." He then followed up by announcing a $4B *Computer Science for All* initiative.[3] The SCI anticipates collaborating with organizations, including the School of Education and LRDC, to develop programs to prepare teachers for this expanded role.

Undergraduate education presents another set of challenges, where the difficulties of implementing multidisciplinary programs are acute, despite the growing evidence of the need for a new breed of students with insights and skills from diverse domains and the ability to engage in coordinated collective problem solving. To address this challenge, the SCI will leverage existing BS programs (from CS and SIS) and seek to build a set of exceptional educational programs that address the ubiquity of computing and information in the modern world. The programs will cover the technology spectrum from makers to users and from science-oriented to human-centric programs.

- Existing CS and IS undergraduate will continue, albeit in a modified and improved form.

[3] See FACT SHEET: President Obama Announces Computer Science For All Initiative

- **Certificate programs** will be created that focus on computing and information competencies necessary to enhance the student's career and education goals.
- **Interdisciplinary programs** will be designed, supported by an integrated, temporally-interleaved curriculum, built around courses from the computing and the application domain departments. Domains of interest range from data analytic areas such as biology, chemistry, economics and social sciences to more content-creation areas such as English composition, art, film and theatre arts.
- Current CS and IS BS/MS programs will be expanded to include selective domain-specific computing and data-analytics topics, developed in collaboration with the domain departments

Undergraduate Education

It is anticipated that all undergraduate students will have the opportunity to benefit from curricula offered by the new School, ranging from enrolling in degree programs to taking individual service and elective courses. In addition, as the School matures and develops more interdisciplinary programs with other departments, undergraduate students will find additional opportunities for specialized computing and information education.

A seminar course is envisioned that will offer to selected students an introduction to the array of different paths available to them and make sure that all students who graduate from the new school have a minimum level of core competencies in areas such as:

- **Programming**. The new School will provide classes, courses, programs, and related events to engage the creativity and motivation of students at an early stage, informed by similar efforts at institutions such as Harvey Mudd College and Harvard University.
- **Data management** (e.g., data structures, databases). The significance of informatics and data analytics is impacting essentially every academic discipline at a phenomenal rate. Understanding the construction and implementation of data centric systems is increasingly relevant to both academic and professional success.
- **Mathematical foundations** (discrete math, statistics)
- **Communications** (writing, speaking). Students need to develop the skills to write professional documentation and be able to work effectively in team environments (e.g., Agile-based management structures). Employers are also expecting students to have strong listening, presentation and overall communication skills.

Students taking this seminar would have an opportunity to sample the field of study of computing and information so that they can begin the process of analyzing their interests, skills and abilities and match themselves to opportunities that lie on a continuum. The

spectrum of available opportunities ranges from focused, technical, mathematical subject areas to project management, decision-making, data science, and digital consulting.

1. including new and special characteristics of the program, type and level of instruction, new courses to be developed or syllabi of existing courses, sequencing of courses, areas of specialization, comprehensive examination sample questions, likely thesis/dissertation topics, multi-disciplinary aspects if any, and other requirements for completing a degree or certificate in the program.

Three undergraduate pathways are envisioned:

- **BS in Computer Science** – mathematically rigorous, laying the foundation for exploring advanced topics such as 3D graphics, Machine Learning, etc. Computer Science students study solving problems using computational methods, notably those that could be practically implemented by machines. (The CS department currently offers this degree.)
- **BS in Information Science** – application of technology to problems in business, education, human-centered computing, and networking. The emphasis on people, information, and technology allows the IS major to integrate both technical and human aspects of design. The IS student will develop an understanding of not only the system, but also its impact, by studying its usage, ethics, dynamics, and social consequences. (SIS currently offers this degree.)
- **Interdisciplinary BS** – strong foundation in computing and information while simultaneously gaining expertise in a domain discipline.

There exists a profound opportunity to create interdisciplinary programs that reflect both the realization that computation and information are universal ideas that cross many disciplines as well as contributing to the emerging research brand of *contextually-situated computing*. As part of the new school, we expect to engage learners who are not just interested in computing for computing's sake, but also those who wish to use their education in computing to solve domain-specific problems in fields from the sciences, to the humanities, to medicine and beyond.

One way to do this formally is by the introduction of a curriculum, referred to here as 2+X, where two years (coursework equivalent, not necessarily calendar time) of computing and information education is completed, along with two years of domain-specific courses that serve to give an appropriate breadth and depth to the student's understanding.

Two current undergraduate programs at Pitt may already be able to be formulated in terms of a 2+X model:

- Computer Engineering (Computer Science + Electrical & Computer Engineering)
- Bioinformatics (Computer Science + Biology)

New programs that may be candidates for such a structure include (but are not limited to):

- Digital Humanities
- Computational Science (where "Science" is replaced with Physics, Chemistry, etc.)
- Health Informatics

Graduate Education

A successful graduate program serves two populations. It contributes to the state of the art by advancing research directions and by training future researchers and educators. It also serves to educate professionals in the skills necessary to advance their careers. The graduate and professional programs of the new school seek to do both with a set of excellent degree programs that reflect the needs of the individual programs as well as foster interdisciplinary research and skills for academia and industry.

Existing MS and PhD programs in computer science, library & information science, and Telecommunications will continue to be offered by the new school, modified by their respective faculties to reflect similar credit requirements. Existing joint degree programs with GSPIA (MS) and Computer Engineering (PhD) will, likewise, continue.

Faculty in the new school anticipate developing new programs that leverage the unique advantages of the University as identified in its strategic plan (e.g., big data, security, personalized education, urban informatics, medical informatics, …). A number of interdisciplinary graduate study opportunities exist on various levels, including new PhD programs, new professional MS programs, new specializations of existing programs, and new certificates.

Candidate areas that are based on existing faculty strengths include:

- **Privacy and Security** (IS-Tele-CS-LIS)
- **Big Data – Data Science** (IS-CS-LIS-Stat)
    - Also Big Data in Biomedical Informatics
- **Data Analytics**
- **Data stewardship/management** (LIS-IS)
    - Includes Data Management/Data curation, Data engineering, Data Movement, Legal Issues, Explaining the Data (Data Journalism)

- **Cyber-Physical Systems - Internet of Things** (CS-Tele–LIS)
    - Includes cloud computing, Big Data, and mobile computing
- **Technology and Society – Informatics and Society** (IS-LIS)
    - Includes social computing, urban informatics, engages Law, Business

Additional candidate opportunities that are more interdisciplinary and involve broader engagement with other units include:

- **Urban Informatics** (GSPIA, Social Work, UCIS)
- **Geomatics** (Geology)
- **Public Health – Health Informatics – Clinical Informatics** (GSPH, SHRS, SoM)
- **Computers and Education** (School of Education, LRDC)
    - CS Education, Big data in education
- **Natural Sciences** (Biology, Physics, Chemistry)
    - Includes high performance computing and big data
- **Digital Humanities** (English, Art, Music)
    - Includes text mining
- **Knowledge Management, Competitive Intelligence** (Bus, LIS, IS)
- More programs with **Engineering**
    - Security and manufacturing (ENG)
    - Sustainability (CS-ENG)

v. Availability and qualifications of faculty to support the program.

The faculty of the new school will be initially composed of tenure stream and non-tenure stream faculty with appointments in the Department of Computer Science or in the School of Information Sciences.

1. Additionally, for a new or expanded research master's or Ph.D. degree program the following should be supplied: examples of ongoing research and mentoring, evidence of investigators/co-investigators on grants or non-grant research proposals, faculty resumes including citations of articles by faculty in peer-reviewed/competitive journals over the last five years, and when relevant, evidence of interdisciplinary research/teaching collaboration.
    a. Not applicable – no new or expanded graduate degree programs are included in this proposal.

vi. Impact on students enrolled in existing programs. If students will be transferred to new programs, how will their prior work be credited?

All students currently enrolled in degree programs offered by the Department of Computer Science or the School of Information Sciences will be grandfathered into the new school and given an option to switch their major to the new school.

vii. Tuition and student support.

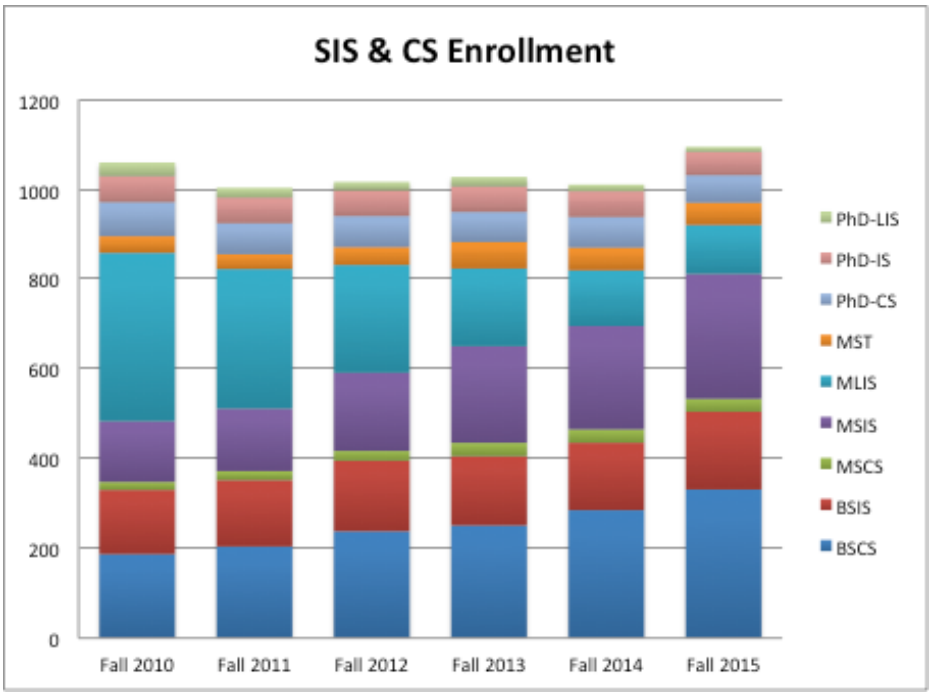
Tuition for the 2015-16 academic year is shown in the following table. Beginning with the 2017-18 academic year, the tuition for Computer Science students matriculating in the new school will be raised to the same level as students from the School of Information Sciences.

Academic Year 2015-16 (2 terms)	Full-time In-state Tuition	Full-time Out-of-state Tuition
Department of Computer Science	$17,292	$28,058
School of Information Sciences	$18,626	$30,312

Student support services from the current Department of Computer Science and the current School of Information Sciences will be moved to the new school, as will scholarship and financial aid resources, with the exception of those scholarships that are exclusively available by design to students in the Dietrich School of Arts & Sciences.

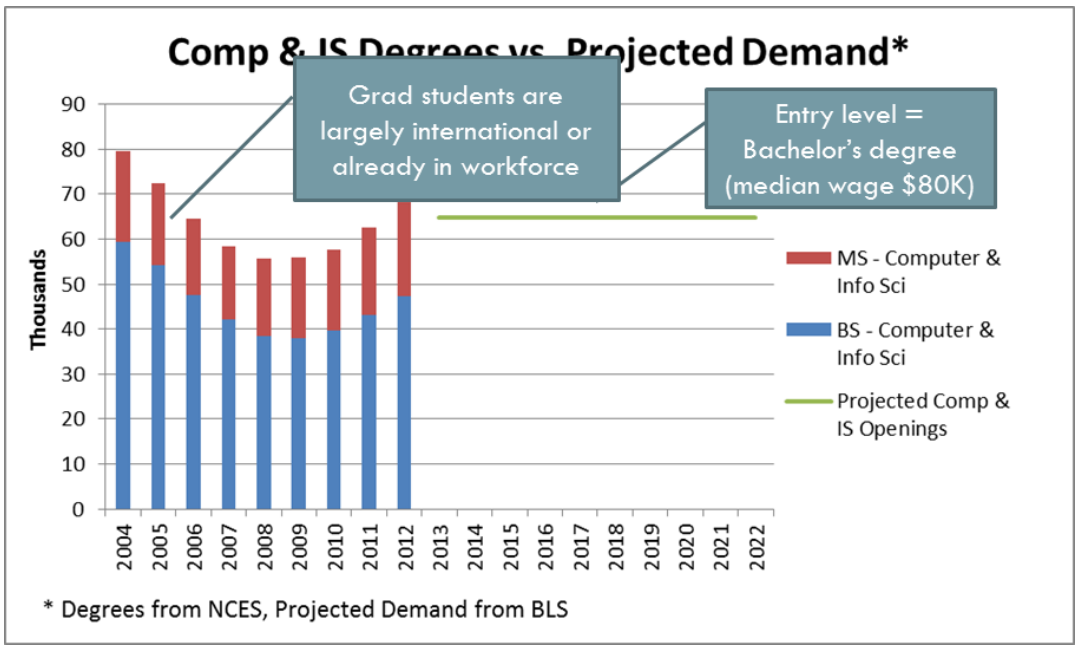
viii. Projected enrollments, student credit hours, and degrees to be granted over each of the first five years of the new academic unit.

The following chart summarizes the enrollment in SIS and CS degree programs since 2010. The SIS undergraduate enrollment has gradually been growing, from 143 in 2010 to 173 in 2015; during that same period, the number of undergraduate CS majors has increased from 187 to 331. The Masters enrollments tend to shift among programs over time. Since 2010, enrollment in the MLIS program has declined from 375 to 109, reflecting a nationwide downturn driven largely by economic factors impacting traditional libraries and their employees. In SIS, this decline has been at least partially offset by increases in the MST and MSIS combined enrollment from 172 to 328. PhD enrollment has decreased from a total of 164 (76 in CS and 88 in SIS) to 124 (61 in CS and 63 in SIS) in 2015. The 2015 numbers are expected to remain relatively stable for the undergraduate program throughout the first five years of the new school. We can anticipate that graduate enrollment, particularly in the Masters programs, will remain stable in years one and two following the creation of the new school. Interest in the undergraduate majors is expected to increase gradually as students become increasingly aware of the value of the newly created programs and focus on the emerging trends of contemporary computing and information science on their career prospects. We can anticipate that the third year may launch a gradual growth trajectory (~5 - 10% per year) through the fifth year, as the reputation of the school grows and confidence is gained among students and employers.

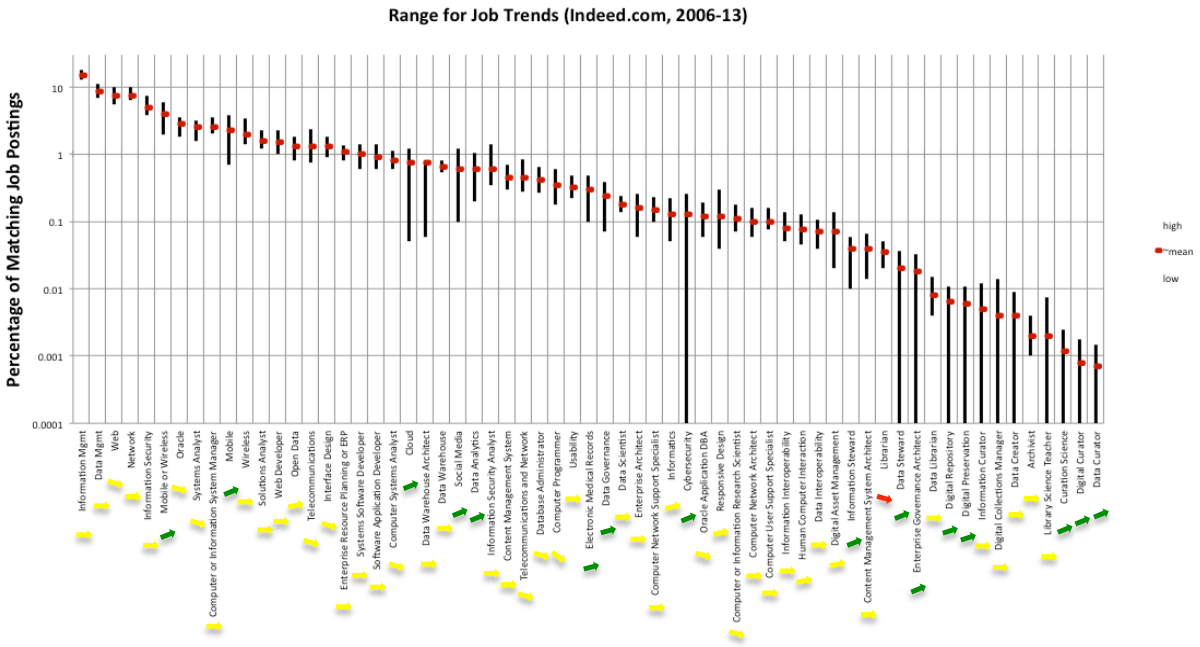


ix. Documented employment opportunities for graduates of the program.

Ten-year employment projections for entry-level positions in computing and information sciences from the Bureau of Labor Statistics estimate a demand for about 64,000 new and replacement employees per year. Graduation statistics from the National Center for Educational Statistics document a production rate in the US of about 48,000 new bachelors' degrees in computer and information sciences.



The employment picture for graduates with an MLIS degree is rather different. Eight year trending data for job placement advertisements on Indeed.com reveal a drop in demand for traditional librarians, and a large variety of new and emerging jobs requiring MLIS skillsets in other sectors.



x. Student and faculty affirmative action plans for the new or expanded academic unit.

The new school's diversity programs will be guided by Pitt's overall strategies for affirmative action. Both the Department of Computer Science and the School of Information Sciences have supported very active diversity initiatives that impact all faculty, staff, and students. The CS department, for example, has had a long and productive relationship with the National Center for Women & Information Technology and SIS has an ongoing A.W. Mellon Foundation funded diversity program called the iSchool Inclusion Institute to introduce undergraduate students from underrepresented populations to opportunities in the information professions. These sectors of the overall population are underrepresented in the computer and information science professions, and will continue to be a priority issue for the new school. Programs fostering diversity in SIS are coordinated through its standing Inclusion Committee; the committee has recently focused on issues such as training select staff and establishing safe areas for counseling LGBT individuals.

xi. The aspirations of excellence for the unit, and a discussion of how this would be achieved and measured.

National rankings inevitably attract the attention of students, faculty, and administrators. Despite much criticism, US News & World Report rankings, for example, are widely read. The CS department at Pitt is small by national standards, ranked by USN&WR at 52, tied with IU Bloomington, RPI, and Rochester. According to the 2014 Taulbee Survey, the average tenure-track faculty size per US CS department is 27.4, an increase from 26.2. The LIS program in SIS, which is an average-sized program of its kind nationally, is ranked 10, tied with Drexel and the University of Maryland. Consolidating CS and SIS into a new school will produce a relatively modest-size school of about 50 faculty, and is being designed to align with University strategic priorities and yield greater opportunities for collaboration on larger research projects that engage domain researchers in areas such as health care and education. Clearly there is an ambition to raise our publicly visible national rankings, as well as to improve more rigorous and quantitative comparative measures reported in Academic Analytics.

b. A statement of availability of required and elective courses to allow students to graduate within the published program length. A 4-year degree map should be provided for each major.

No immediate changes are contemplated for required and elective courses, so the course sequences and degree maps currently available to students of Computer Science and the School of Information Sciences remain intact. Students should notice no change in their ability to graduate within the published program length.

c. The short- and long-term effects that the proposed change(s) will have on other University programs.

Short-term effects will be minimal on other University programs, and likely limited to students in the Dietrich School of Arts & Sciences, who will simply experience their elective courses that had previously been taught by CS faculty in the Dietrich School now being taught by CS faculty in the School of Computing and Information (SCI). Most CS majors will still enter Pitt as freshmen in the Dietrich School and will then need to transfer to SCI when they declare their major. Long-term effects are expected to include the development of interdisciplinary degree and certificate programs in collaboration with other units on campus who choose to integrate computing and information knowledge and skills more deeply into their curriculum.

i. This should include an analysis of the impact that the proposed change(s) will have on programs and services such as increased or decreased demands for courses, loss or addition of students, the need for additional student aid, Library, or computing resources, etc. An analysis of the impact on space resources, including office, laboratory, and classroom space, must be included.

No immediate impact is anticipated on programs or services as a result of this proposal. The Computer Science Department will continue to deliver courses available to Dietrich School of Arts & Sciences students, as it currently does, and in the same numbers. Courses offered by the School of Information Sciences to students not majoring in SIS programs will continue to be available, and in the same numbers. No additional student aid is requested; no additional library or computing resources are required. No immediate impact on space resources is anticipated. This proposal is designed to align existing academic resources to provide increased performance and leverage, rather than to propose immediate changes in the scale of those activities.

8. Evaluation
    a. A description of a quantitative and qualitative evaluation procedure to assess the attainment of the objectives of the proposed change(s) including outcome criteria and a time frame for completion.

Learning Outcomes Assessments (LOA) for each degree program in the Department of Computer Science and the School of Information Sciences are currently conducted annually, per university policy. These will continue in their current form. Other forms of routine evaluation include:

- The 7-year accreditation of the MLIS program by the American Library Association
- Annual data submissions from SIS to the Association for Library and Information Science Education (ALISE), providing a longitudinal comparison of SIS programs to peers
- Annual data submissions from both SIS and the Department of Computer Science to the Computing Research Association for their Taulbee survey of PhD granting programs, providing another source of longitudinal data on which to assess Pitt's programs against peers and competitors

In addition to these ongoing and routine data analysis and reporting processes, the new school will be producing a 5-year strategic plan in accordance with Pitt requirements. This plan will align the new school's aspirations with the strategic directions of the university and will be updated annually to report progress and refine goals, objectives, resource allocations, and plans. The school will also conduct an in-depth organizational structure and progress review during its fifth year of operation, assessing the achievement of short term goals and the progress toward long term goals, both quantitatively (e.g., enrollment,

external funding, research productivity) and qualitatively (e.g., collaborative programs developed, relationships with industry).

9. Impact
    a. A detailed analysis of the impact of the proposed change(s) on staff and faculty personnel for the first three years of its operation, including information about the hiring of new staff and faculty and/or reassignments of existing personnel.

The faculty and staff currently assigned to the Department of Computer Science and the faculty and staff currently assigned to the School of Information Sciences will comprise the initial faculty and staff for the new school. The current dean of the School of Information Sciences will be stepping down from that position at the time of the formation of the new school and (ideally) the arrival of a new dean to lead the school. The search for a dean for the new school will be initiated during the summer of 2016, with the new dean to be in place at Pitt during the summer of 2017.

SIS will have at least three open faculty positions at the time the new school is launched, one of which is the Doreen E. Boyce Chair in Library and Information Science, with a reasonable expectation that retirements will release three additional tenure stream lines during the first three years that the school is established. The Computer Science department currently has three open tenure stream lines, thus the new school, at the time of its launching, will have the opportunity to hire a new dean and at least six faculty, with more opportunities to follow rather soon. This is expected to provide opportunities for cluster hiring of faculty to fill priority areas of strategic importance identified in the new school's strategic plan.

10. Resources
    a. A three-year budget showing the impact of the proposed change(s) on the budget of the units affected by the change, including:

There is no projected net impact on the three-year budget as a result of the changes proposed in this document. The resources currently allocated to SIS will be transferred to the new school, as will the resources that the Dietrich School of Arts and Sciences allocates to the Department of Computer Science. The budget and sources shown below for the new School reflect the combined resources of the current School of Information Sciences and the Department of Computer Science.

i. A budget for each of the affected budget units.

DIRECT EXPENDITURES			
	AY 2018	AY 2019	AY 2020
T/TS current faculty (44)	$5,100,000	$5,100,000	$5,100,000
Open TS faculty positions (4)	$400,000	$400,000	$400,000
NTS (14) + part time faculty	$1,400,000	$1,400,000	$1,400,000
Open NTS faculty positions (1)	$75,000	$75,000	$75,000
Faculty summer support and start-up pkgs	$200,000	$200,000	$200,000
Staff (33)	$1,700,000	$1,700,000	$1,700,000
Student workers	$200,000	$200,000	$200,000
Fac/NonFac Fringe	$3,000,000	$3,000,000	$3,000,000
GSA/TA/TF	$1,200,000	$1,200,000	$1,200,000
GSA/TA/TF Fringe	$600,000	$600,000	$600,000
Fellowships (CS)	$110,000	$110,000	$110,000
Operating	$700,000	$700,000	$700,000
Intelligent Systems Program Mgmt	$25,000	$25,000	$25,000
Financial Aid	$3,800,000	$3,800,000	$3,800,000
02 Budget Total	$18,510,000	$18,510,000	$18,510,000

ii. Sources of funding available to support proposed expanded or new programs.

DIRECT REVENUES							
		AY 2018		AY 2019		AY 2020	
		In-State	Out-of-State	In-State	Out-of-State	In-State	Out-of-State
	Tuition Rate	$18,626	$30,312	$18,626	$30,312	$18,626	$30,312
SIS Enrollment	Fall term UG FTE	100	75	100	75	100	75
	Fall term Masters FTE	80	20	80	20	80	20
	Fall term PhD FTE	5	60	5	60	5	60
CS Majors	Fall term UG FTE	200	130	200	130	200	130
	Fall term Masters FTE	5	25	5	25	5	25
	Fall term PhD FTE	5	55	5	55	5	55
Tuition Revenue		$7,357,270	$11,063,880	$7,357,270	$11,063,880	$7,357,270	$11,063,880
Total Projected Tuition Revenue		$18,421,150		$18,421,150		$18,421,150	
		CS	SIS	CS	SIS	CS	SIS
Endowment Income		$5,500	$130,000	$5,500	$130,000	$5,500	$130,000
Gifts		$52,000	$125,000	$52,000	$125,000	$52,000	$125,000
Sponsored Research		$2,700,000	$1,900,000	$2,700,000	$1,900,000	$2,700,000	$1,900,000
Total Projected Revenue		$23,333,650		$23,333,650		$23,333,650	

iii. A summary of financial increases, savings, or reallocations anticipated as a result of the proposed change(s).

No financial increases, savings, or reallocations are anticipated as a result of the changes proposed in this document.

b. Non-financial requirements or savings in areas such as space, facilities, or equipment that are anticipated as a result of the proposed change(s).

For the immediate future, existing space, facilities and equipment assigned to the Department of Computer Science and to the School of Information Sciences are to be

reassigned to the new school. Neither additional nor reduced requirements are anticipated for the new school as a result of the changes proposed in this document. The Department of Computer Science will remain hosted in the fifth and sixth floors of Sennott Square building.

11. Consultation
    a. A list of the faculty groups and relevant administrators who were consulted,

- Provost's Office
    a. Juan Manfredi
    b. Laurie Kirsch
    c. Michelle Amato
- Dietrich School of Arts & Sciences
    a. Dean's Office
        i. N. John Cooper
        ii. Michele Colvard
    b. Department of Computer Science
- School of Information Sciences
- Medical and health: DBMI, Public Health, Pharmacy
- Education: LRDC and School of Education
- Office of the Vice-Provost for Research: Don Shields and Mark Redfern
- Engineering: ECE, Industrial Engineering (CEE, Mascaro, and CMI invited but didn't make the meeting)
- CoE program (undergraduate and graduate directors, chair of ad hoc ECE committee on the CoE program)
- Humanities: Slavic Languages, Studio Arts, Linguistics,
- Natural Sciences: Biological Sciences, Neuroscience, Pittsburgh Supercomputing Center
- Social Sciences (Nov 24): Social Work, GSPIA, Economics, Political Science
- Business and Law (date TBD):

    b. A list of the external consultants who contributed to the development of the proposal,

i. Zachary Lemnios, VP of IBM Research
ii. John King, Dean Emeritus and Professor, University of Michigan School of Information
iii. Harry Bruce, Dean, University of Washington Information School
iv. Clifford Lynch, Executive Director, Coalition for Networked Information
v. Brewster Kahle, Director, Internet Archive
vi. Richard DeMillo, Dean Emeritus, Georgia Tech School of Computing
vii. Tom Kalil, Office of Science and Technology Policy, Executive Office of the President

viii. Bobby Schnabel, Dean Emeritus, Indiana University and Executive Director, Association of Computing Machinery
ix. Farnam Jahanian, Provost, Carnegie Mellon University (pending)
x. Andrew Moore, Professor, Carnegie Mellon University
xi. Christine Borgman, Professor, UCLA
xii. Gregory H. Leazer, Department Chair, UCLA
xiii. School of Information Sciences Board of Visitors
xiv. Three members of the Dietrich School Board of Visitors
    1. Alfred Moyé
    2. Keith Schaefer
    3. Deborah Gillotti

c. A summary of their comments on the proposed change(s),

Each of the consultants spoke to the significance of this proposal and of its potential to significantly advance Pitt's capabilities and reputation. Those who met with the Provost also observed the very substantial commitment expressed by her to establishing a new school that advances computing & information research and education, and also engages actively with industry and the Innovation Institute in new entrepreneurial ventures.

THIS BIG EFFORT WILL PAY OFF IF IT LEADS TO SOMETHING NEW AND EXCITING.

John King, University of Michigan

Several consultants focused on the organizational structure for the new school, expressing a range of options and opinions. A member of the SIS Board of Visitors (Charles Isbell, GaTech), Harry Bruce, and John King urged caution about establishing departments, citing the administrative overhead and costs associated with multiple departments. They suggested creating a school with no departmental structure. Upon careful consideration of their recommendations, we noted that in each of their situations, their schools had started with a relatively small set of

FORWARD-THINKING AND COLLABORATIVE EFFORTS TO DEVELOP INTERDISCIPLINARY SYNERGIES AMONG FACULTY ARE CRITICAL TO ACHIEVING THE STRATEGIC GOALS OF THE NEW SCHOOL

Clifford Lynch, Coalition for Networked Information

faculty and grew over time to their present size, greatly facilitating a non-departmentalized structure. None of them had engaged in a process of merging pre-existing academic units into a new one. Bobby Schnabel and Richard DeMillo also pointed out the importance of a departmental structure in establishing disciplinary identity, specifically in computer science. Balancing the set of recommendations from all consultants on this issue, the initial structure of the school will have three departments, accompanied by a sunset clause that mandates that faculty revisit and reconsider the organizational structure during the school's fifth year.

In other reflections on organizational structure, consultants commented on the importance of identity, and particularly on preserving essential elements of stakeholders' strengths while enabling the emergence of new synergies that would establish the new school's reputation and identity. John King, in particular, noted that this endeavor is much more fundamental than simply reorganizing existing units under a new umbrella, emphasizing the necessity of thinking very strategically about long term goals and aspirations. Zachary Lemnios elaborated on this idea, observing that collaboration and partnership with industry that is focused on common goals and mutual understanding can be a significant and substantial feature of the new school's long-term future.

Several consultants picked up on the university's strategic planning goals, opining that the new school should take this opportunity to focus its research on a relatively small number of large, long-term challenges that would involve multi-disciplinary teams. Two areas identified were personalized education (in collaboration with the School of Education, LRDC, and possibly others) and personalized healthcare (in collaboration with the School of Medicine, GSPH, SHRS, Nursing, Pharmacy, and possibly others).

> CREATE INNOVATION ENGINES TO ACT LIKE "THINK TANKS" FOR INVESTIGATION, INNOVATION, AND EXPERIMENTATION
>
> Richard DeMillo, Georgia Tech

The necessity to build a strong and distinctive undergraduate program also attracted substantial attention from the consultants. Several consultants (notably John King) observed that admitting students into the new school at their time of matriculation at Pitt, or shortly thereafter during their first year on campus, will position the school to deliver a rich and comprehensive curriculum tailored to and evolving with the rapidly advancing computing and information technologies demanded by employers and impacting society as a whole.

d. A statement from the Planning and Budgeting committees of the Dietrich School of Arts & Sciences and the School of Information Sciences.