

The Future of Information Technology and Implications for URI

Technology Change over the Next Ten Years

Technology over the next five to ten years (2012-22) will be radically different with great improvements in increasingly shorter time spans as it becomes more personalized, more customized and more customizable. Self-service and self-publishing are increasing as is the functionality, ease of use, and diminishing size of technology devices. The usability of technology will increase as will the simplicity of interfaces and perhaps even become integrated biologically. These capabilities will come with an increase in the complexity of the devices. Just as automobile engines are no longer within the capabilities of the home “shade tree mechanic,” technology will be complex to troubleshoot and integrate, much of it becoming a “throw away” product like basic calculators today when they stop working. The integration of technologies will expand, including communications, computing, audio, video, handwriting and speech recognition, facial recognition, virtual keyboards and virtual screens, while becoming much smaller and more powerful.

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Bandwidth ... is already growing geometrically.”

Interfaces will improve to where speech and handwriting recognition will be virtually flawless. Devices the size of today's smallest phones will have projection capabilities permitting viewing on virtually any screen size desired as well as through glasses and contact lenses. Computers with the power of today's supercomputers will be available for access from small mobile devices.

Large databases (video data alone is doubling every two years) will require unprecedented collaborations, storage, compute power, archiving, and analysis. The ability to use, create, manipulate, and integrate large amounts of data will become an essential component of research in the 21st Century, requiring investments in staff and software with that special emphasis to assist domain scientists.

“...technology is improving geometrically.”


Cloud computing will seamlessly provide much of the necessary compute resources (CPU, memory, and disk storage) as needed. Everyone will expect to access whatever computing and technology they require, wherever they are, whenever they need it.

Bandwidth to access applications in the cloud and to access the Internet is already growing geometrically and will continue to grow, becoming an even more important part of the IT infrastructure in higher education. All areas of higher education will experience this growth, but especially research computing as more and increasingly larger data sets will be stored in the cloud. With the growth of video and large data sets in the humanities and social sciences, this bandwidth requirement will not be limited to the sciences alone.

Some of the specific technologies that will be available (and even be mature) will include three-dimensional virtual reality, large-scale three-dimensional printing, and services such as virtual home visits from family doctors.

Managing technology will become substantially more challenging. Technology will be outdated almost as soon as it's implemented and support of multiple platforms will become increasingly complicated, making decisions more challenging. Smart phones represent the future of the personalized, customizable, increasingly powerful and expanding functional world of technology and a shift in ownership to the user of mission critical technology. Also, supporting and integrating these devices into the institutional services and software are essential for stakeholders and clients to allow for the greatest productivity. Requisite software on the mobile device is not owned by the institution but by the individual. Keeping up with the changes in this technology and the new ownership issues it presents will be a serious challenge for institutions and is the precursor to future challenges of institutional management of technology.

Many stakeholders already lack the time, interest, or aptitude to learn to use the full capabilities of the technology already available to them. The good news is that the newer technologies will become easier and more intuitive to use. Unfortunately, however, that typically drives greater complexity behind the scenes, making implementation, integration, maintenance, and support more difficult. In addition, there is likely to be a transition period lasting several years during which the technologies will appear more confusing and complex to many before they become easier and more intuitive.



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Specifically regarding educational technology, online learning (especially at a distance) will mature, improve, and serve a far greater number of people. Distance learning will become especially useful for continuing and post graduate education while online education is becoming continuous education and just-in-time learning, and require a solid framework of high level skills and theory.

The delivery of instruction and the role of faculty is also changing dramatically. More and more course content will be delivered online so students can proceed at their own pace based on mastery of the material using examples and learning styles that are customized to their specific needs. As with other technologies, online learning will make learning more customized, focused on individual needs and background, as well as permitting access anytime, anyplace when it is most convenient for the student. Students will be able to learn at their own pace focusing more time on concepts they find difficult and moving quickly through material they understand easily. The idea of an entire class moving lock-step through course material at the same pace will become a quaint concept, not unlike the one room schoolhouse of the past. Textbooks will

eventually be replaced with interactive learning experiences that patiently and comprehensively guide each student individually through the requisite material. Faculty will be heavily involved in constructing online courses (not necessarily designing them) to ensure that the course content and assessment measures meet the standards of their institution and discipline. Course material will include content that is open source, commercial, as well as some that is institutionally and individually designed (sometimes by students). Faculty will ensure the material meets the institution's standards in terms of scope, substance, and credentialing.

In addition, faculty will be able to use time previously devoted to lectures to focus on the more complex and integrative aspects of the course along with one-on-one and small group interaction with students that will add greater value in face-to-face instruction formats. Faculty at research institutions will find more opportunity to integrate coursework with their research and the research of their students, linking classroom material to research in ways never before possible when learning was delivered almost entirely through lectures. Finally, faculty at traditional institutions will also be able to focus more on mentoring their students, helping them to find appropriate careers and advanced education as well as leading and guiding student to additional international and internship opportunities.

The number of students, credit hours, and revenue generated from traditional students at traditional institutions, however, is limited by the size of the campus and the real physical limitations on how many students can be serviced in any given physical location. Opportunities for significant growth in students, credit hours, and revenue for traditional institutions of higher education will be in the continuing education arena, particularly online distance learning. Not every institution will be able or interested in taking advantage of this growth opportunity but well-managed institutions will at least consciously consider the pros and cons of distance education and decide what is best for the institution from an educational, financial, and cultural standpoint.

These changes will come quickly and will, for a time, be disruptive and present a serious adoption challenge. Stakeholders may feel lost and overwhelmed by the constant barrage of change and new opportunities. Many may feel paralyzed by the sheer magnitude and frequency of change. Some may never fully adapt and never take full advantage of these advances. Nonetheless, the technology landscape is changing rapidly and dramatically. Ignoring it will not stop it.

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Implications for URI

What then are the implications for URI and how should URI position itself for this future? It should be clear that technology will be such an integral part of the day-to-day lives of everyone that, just like great corporations and businesses, the great universities of the 21st century will be marked by their commitment to investing in and using technology effectively. The President articulated this view in his *Transformational Goals for the 21st Century*, “URI must take full advantage of the most advanced educational tools, technologies, and practices.” He also commits to creating a university where “expanding resources will support a campus-wide digital culture in which students have the most up-to-the-minute technology, equipment, and laboratory experiences...”

Based on the points made in the previous section, there are some fundamental technologies that will be an integral part of the future that successful institutions of higher education will need to support. These technologies include online learning, infrastructure, cloud and virtual computing, mobile technology, security and authentication, and streamlined services.

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Online Learning

Online learning has two aspects: online distance learning and online campus learning. URI needs to carefully explore online distance learning to determine what, if any, role it should play at URI. As noted above any significant increases in students, credit hours, and revenue can only occur in the online distance learning sphere where there are no physical limitations on expansion. Many institutions are discovering that they need to establish an independent entity, much like a fund-raising or research foundation in order to be able to focus on a mission and goals that may differ from and even conflict with those of the traditional university, especially in the formative years of online distance learning. Some analysts, such as Clayton Christensen, believe that success in this arena can be accomplished in no other way.

Other institutions have already established independent online distance learning entities that can move more quickly and are not bound by the same rules as traditional universities. It is important to be aware of that model even if it is not adopted at URI because those entities are the competition URI faces should we decide to deliver online distance learning.

In terms of online *campus* learning, faculty will explore new means of delivering course content and URI should consider pilots that explore new ideas in delivering instruction. Encouraging faculty exploration needs to include removing obstacles and disincentives such as required time in traditional classrooms, focus on seat time, and traditional length semesters. Faculty in these pilots will also need support from expert staff and a “tiger team” of administrators who can quickly smooth the way and remove obstacles. Pilots with the greatest

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chance for success will be those with low risk, high gain possibilities where neither students nor faculty are particularly well served currently and that do not threaten existing traditional offerings. In the area of online distance learning, academic certificates might be good prospects. Another good pilot might be a masters degree program that is on the verge of elimination due to lack of majors. If sufficient new students can be found online, departmental faculty could be highly motivated to create an online distance learning alternative if it will save their program. Ultimately, online distance learning will be a financial decision for the university.

In the area of online campus learning, an example of a low risk, high gain, and low threat pilot might be repeat courses. Developing a completely online repeat course that is self-paced and mastery-based may fit these criteria. Many university resources are expended teaching the same entire course to students who have already taken the course at least once before. In many cases, students don't really need to repeat the entire course but primarily need to focus on the part with which they struggled. A fully online course that allows students already familiar with the material to progress at their own pace based on their mastery of the material could be an ideal pilot for delivering campus learning online. Faculty would be able to spend more time to greater effect helping students with the material the student is struggling with rather than on delivering the entire course just as they had done the first time. Once faculty are familiar with putting together such a course, its success (or failure) will equip them to realistically think about using this approach in courses other than only those being repeated.

URI should carefully explore both campus and distance online learning and decide how the university should proceed. Once the decision is made and specific goals established, it is essential to allocate the resources necessary to carry them out. Whatever URI decides to do, it should evaluate online campus and distance learning intentionally based upon the financial, cultural, and educational impacts and benefits to the university. To simply ignore online learning and allow it to merely evolve without direction or support will not be very different from deciding neither form of online learning has any place at URI.

Infrastructure

As in most endeavors, success requires one to be fundamentally sound. Infrastructure, including legacy applications, operations, and networks must be reliable and up-to-date before exploring new applications. Successfully integrating new technologies will depend upon a robust infrastructure.

Infrastructure includes the wired and wireless networks that will be the foundation for all data communications in the 21st century. These networks are made up, not only of the fiber and access points, but the switches and routers that move the data; maintenance of the hardware and software involved; and the staff required to plan, upgrade, monitor, troubleshoot, and operate this infrastructure. The same is true for legacy applications and operations. Basic, mission-critical business operations from billing and payroll to registration and financial aid need to be reliable, accessible, secure, and use modern business processes and easy-to-use interfaces.

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These systems must be as easy to use as purchasing items on the web. Students, faculty and staff

will expect no less. More importantly, less than that standard will mean wasting faculty, student, and staff time. Improving the productivity of faculty, staff, and students will permit those personnel resources and energy to be applied elsewhere in ways to help URI prosper. Likewise, the hardware and software devoted to these systems must be maintained, along with investing in the staff required to keep them operational, responsive, reliable, and productive.

Cloud and virtual computing

Expertise and experience in cloud and virtual computing will become essential for effectively allocating technology resources. Knowledgeable staff will have to determine the right mix of local, regional, national, and international computing and communications resources. Once cloud technology matures, local hardware would ideally never fall below 80% utilization. Instead, hardware should be purchased from the cloud to accommodate the cyclical times when spikes in use require additional resources. Some of those resources could be acquired from collaborative partners using the same hardware. Eventually, some computing resources might best be acquired exclusively from the cloud (such as student Gmail is today at URI). All cloud computing solutions will require security as well as integration with campus and other cloud-based computing resources. For example, most cloud offerings will require some form of authentication to ensure users are legitimate and have access to the appropriate information and applications. In other cases, different cloud-based systems may have to communicate with each other or with the URI student, financial, or HR/Payroll databases. Integrating these requirements should not be overlooked as an essential part of cloud computing.

The local cloud would include virtual servers (and eventually even desktops) that are much more cost effective than individual physical servers spread throughout the campus. It is already more effective to provide most campus servers in a centralized data center that is secure, power efficient, supported close to 24x7, with emergency battery backup and generators than haphazardly locating them throughout campus. In addition, in a virtual server environment, the necessary CPU, memory, and disk storage can be purchased and provided dynamically, as needed much more cost effectively than local purchases in which the institutional investment in CPU, disk, and memory cannot be shared when they are not being used. Better yet, fewer system administrators are needed to administer virtual servers (especially security patches) and they can be deployed within hours instead of days and weeks to purchase, receive, and install physical servers. Finally, centralized servers can be part of the data center backup, security, and archive procedures, ensuring the integrity and safety of data stored on URI servers.

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URI should develop incentives for those units purchasing servers to centralize them in a virtual environment. One way to do that is for any office planning to purchase a server to first fully price it as they normally would according to the required CPU, memory, and disk space desired. ITS will then offer to deploy that same server configuration virtually within 24 hours at 10% less cost (or, alternatively, deliver 10% more CPU, disk or memory for the same price). This approach will provide ITS with the ongoing funding stream necessary to not only purchase the requisite hardware, but to hire the support staff required to manage and maintain the central server environment. This model will also

permit colleges to purchase future server capacity with end-of-year money that can then be used in whatever future capacity the unit decides such as for application servers, virtual desktops, virtual computing labs or research computing.

Eventually, desktops should be provisioned in this fashion leading to the eventual transition to the small mobile device that will be able to perform like a desktop when needed. Initially, public computing facilities with a limited set of software applications are good candidates for virtual desktop infrastructure (VDI) technology. While virtualizing desktops is more complex due to the customization of personalized computing environments, there is much more unused CPU, memory, and disk capacity to be captured and made available for such applications as research computing, for example. The URI community will eventually expect full access to all technology wherever they are and whatever device they use. That capability will require virtual computing.

Mobile Technology

Successfully deploying, integrating, supporting, and managing mobile technology will be an important key to the future. Not all of it will be owned or managed by URI, such as personal tablets and smart phones, as noted above. Integrating this technology with the computing and communications resources a 21st century university will require to thrive, will present a growing challenge for staff. Due to the personal ownership of mobile technology noted above, universities (especially public ones) will be challenged to manage, purchase, support, and integrate applications and devices. Purchasing University apps for personally-owned mobile devices is already a challenge. Solving this problem will be a key challenge to successfully using mobile technology to its full potential and that will be vital to a successful 21st Century university. All technology will one day flow from a personal mobile device. URI has already made important strides in supporting mobile devices although the emphasis has been primarily on student use. Faculty and staff use of these devices will become an important next step for URI to explore and support.

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Security and Authentication

If mobile technology is the key to the future, security and authentication will be vital to its success or failure. As devices grow smaller, become more personal and more capable, accessing more applications with greater power, security of these devices becomes paramount. Individuals' entire professional and personal lives will be accessible through these devices. In addition, many university employees have access to sensitive information stored in thousands of student, faculty, and staff records.

URI must ensure that mobile devices and especially the information to which they have access are secure and not easily stolen - either physically or virtually. In addition, authentication of who has access to what technologies and data will also be essential for success in this mobile technology world. It is important for URI to join consortia like Federated ID where students, faculty and staff will have access to appropriate technology and data determined by their role at the University. Staff will be critical in maintaining these roles in order to keep URI a trusted member of the community. The University will need to find a way to invest in and maintain the changing faculty, staff, and student roles in much more reliable and sophisticated ways than it has in the past. URI should recognize the importance of matching the increasing security challenges of the 21st Century technology world with appropriate levels of staff and resources dedicated to addressing these challenges to mitigate the substantial liabilities these risks will increasingly present to the university.

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Streamlined Services

Technology should be used at URI to streamline services and business operations. For example, creating and filling new positions must be quick, efficient, and error-free. That will be a substantial change for URI but if the institution is to be successful and thrive in the rapidly changing world it is entering, it must be nimble and responsive by filling positions quickly and efficiently. Given the size of URI and Rhode Island, this responsiveness could easily become one of our greatest strengths. URI and RI should be able to move more quickly and efficiently than much larger States and more cumbersome universities.

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Of similar importance will be the efficient acquisition of new technologies. Institutions that cannot react quickly to the appearance of new technologies will be at a distinct disadvantage. Technology will change so quickly that institutions will be best served by acquiring the latest technology just when it's needed, not six or ten months afterward due to a cumbersome acquisition process. Otherwise, the University will be purchasing increasingly outdated, more expensive technology. Some of these streamlining changes require changes at the State level, (and URI needs to work simultaneously with the State to gain those efficiencies whenever possible), but much can be done at URI to speed up the hiring and acquisition processes.

Institutional purchases of technology in the future will best be made only when the technology is absolutely needed and ready to be used. Institutions with bureaucracies that require a long lead time for purchasing will be at a distinct and growing disadvantage. The acquisition process must be streamlined to avoid early obsolescence. In addition, URI should be careful in its technology planning to avoid continually buying the latest, state-of-the-art technology risking a merry-go-round of technology purchases that are never fully implemented or used and which the University community cannot assimilate, forcing them to move to a new technology before they have been able to learn to use the old one.

Finally, business process engineering is crucial to URI becoming a 21st Century (some would say, late 20th Century) institution. It is unacceptable that so much of URI business is still conducted with typewriters and on paper. That should have changed last century. And, while automating business processes is important, re-engineering the workflow and systems in the process is crucial. Just automating what was designed for a paper environment 100 years ago will not provide the level of productivity enhancement and cost savings that re-engineering these processes will accomplish. Those systems were designed to accommodate the limitations of paper processing. While many systems are locked into antiquated State requirements, many are under the control of URI. It is these processes that URI needs to re-engineer and stop using the excuse of an outdated State bureaucracy. Change will be difficult but essential for URI to become the institution it aspires to become.

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