Final Report

Strategic Planning Committee for Innovation in Technology and Information

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EXECUTIVE SUMMARY

With the Plan for the Class of 2000, Wake Forest radically changed the nature of teaching and learning on campus and showed the world the capability of technology to enhance learning. While the use of technology greatly enhances many classes on campus, we have not yet approached the full potential of technology in teaching and scholarship. The investment we have made in technology and its support positions us well to revolutionize learning and scholarship in the coming decade. Our vision is

> *Five years from now, Wake Forest University will be internationally recognized as a leader in the identification and use of technologies to develop an innovative teaching and learning environment that enhances and strengthens learning, intellectual development, and analytical skills. Wake Forest faculty will be creative and collaborative thought leaders in applying and integrating information and communication technology in the development of pedagogically sound learning environments and in the discovery of compelling new avenues for creative and scholarly inquiry. Wake Forest students and graduates will be recognized and celebrated as leaders of their generation with an uncommon ability to discover, discern, evaluate and apply information and communication technology.*

The students who arrive on campus today are different from those of 1996. Most are digital natives, having been raised in a world where information is abundant, immediate, and easily searchable. Many are accustomed to using multiple media and channels to communicate, plan, and construct knowledge. Aware of the power of such tools, they expect the tools to be exploited in their courses. Yet some of our students arrive having had limited access to these tools. These students experience pervasive technology for the first time after they arrive on campus, and only through those technologies that the university provides. The "Digital Divide" is real and must not be allowed to prevent any Wake Forest student from reaching his or her full potential.

Our vision demands that our students experience the right applications of the right technologies, guided by faculty with the commitment and understanding of how to use them appropriately and effectively. Teaching well is challenging. We have a faculty that is committed to teaching, but we must recognize that commitment alone is not sufficient to being effective in teaching this new generation of students. This is especially true of teaching with technology, where faculty have seen fewer examples of good teaching. Therefore we must **establish a strong Instructional Design capability along with a Digital Innovation Center to provide a world-class environment in which to model, research and apply best practices in technology-enhanced pedagogy.** This must include a commitment to continual investigation of new applications and technologies and their use for teaching and scholarly work. It must include superior support services and appropriate learning spaces that support collaboration and video conferencing. **We must provide encouragement, incentives, and rewards for faculty** to

invest their time in course redesign We should bring back the STARS (Student Technology AdvisoRS) program, one of the most effective vehicles we have seen on campus to encourage effective use of technology.

The university should establish a Future Technologies Group with responsibility for coordinating support for innovation in academic technology. Under the direction of the Associate Provost/CIO and drawn from the Information Systems, the Instructional Technology Group, the ZSR Library, and the Teaching and Learning Center, the FTG will provide a forum for communication among these groups. The coordination provided by the FTG will mean that the university will derive the full benefit of their complementary skills. The FTG group will support the work of the Committee on Information Technology and provide the committee with needed research on new technologies and development as appropriate.

Video technology is entering a new era of quality, ease of use, and ubiquity. Even limited discussions with faculty have uncovered a number of academic applications that may transform student learning, collaboration, and the sharing of faculty expertise. Therefore**, the university must build on the WFU/Cisco relationship through the Wake in Motion initiative.** Telepresence can bring experts from around the world to our students. WebEx removes barriers of space to collaboration. For the first time, high quality recording is affordable and dissemination of video is easy, opening new paradigms for sharing of information.

With improved collaboration and telecommunication tools, the walls of the classroom no longer need confine class interaction. Therefore, we must **begin planning programs to use online and distance education in thoughtful, focused ways, consistent with the Wake Forest mission, to establish and maintain close personal relationships between faculty and students.** We must identify best practices in e-learning and empower our faculty to enhance traditional classes with online components, as some of them are already doing. We should pilot e-learning courses to identify how distance learning can be done in a "Wake Forest way," with personal relationships and intense engagement of faculty and students. To enable this engagement, we must invest in next generation videoconferencing and the robust network that video and rich media require.

The power of computers is just as transformational for research. The power of computing for modeling, analysis, design, and even art opens new horizons. Therefore, we must **invest in discipline-specific exploration of new technologies in order to provide a world class environment where technology enables creativity, pursuit and creation of scholarly activity, and expression of knowledge.** We must provide faculty the computing tools and resources to be productive scholars. We must embrace opportunities for and recognize the legitimacy of immersive environments and digital publication.

Further, we must **provide a level playing field for faculty and students, both graduate and undergraduate, with equal access to technologies required for scholarly inquiry, collaboration, and participation in innovative learning activities.** This requires that we provide students and faculty with capable hardware and professional software. The laptop program continues to play a central role, but emerging technologies and the use of cloud computing resources will expand our choices for meeting these requirements.

Libraries evolved as repositories of books and journals, with responsibility to preserve, index, and provide access to these works. In the future, journals and books increasingly will be accessed electronically, and information increasingly will be found in large data sets and diverse media. The implications include

- A decrease in demand for physical space to house printed collections;
- An increase in demand for physical space for information users;

- An increase in demand for information services;
- An increase in demand for technology infrastructure

Therefore we must **transform Wake Forest libraries as the cultural center of the campus, serving as a physical and virtual locus of innovative research, collaboration, and discovery with respect to digital information and digital media.** This requires that we make more efficient and selective use of physical collections, digitizing wherever appropriate. We must increase emphasis on digital literacy through contemporary tools and techniques, social learning, and interaction. The library must serve as a key evaluator of ethical use of information assets and the primary resource for preservation and management of digital media. We must invest in collaborative people spaces, including proper support for the activities that happen in those spaces. We must attract and retain library faculty and staff to support and lead this transformation.

The programs, people, and infrastructure we have in place uniquely position Wake Forest to do extraordinary things with technology in the coming decade. Our model of providing standard laptops allows faculty to incorporate applications into their courses far more easily than at nearly any other institution. A strong corps of ITGs supports the faculty well in these efforts. Excellent library staff have the expertise to support innovative uses of academic technology. Talented and committed Information Systems staff support and extend technology on campus. Faculty employ and often pioneer exciting and effective uses of technology. Our robust network infrastructure provides the foundation necessary for the use of rich media and video conferencing.

With this foundation and with institutional commitment, Wake Forest can expect to produce students who are better educated and who are prepared to be leaders in collaboration, creativity, and influence through their lives. We can expect to enhance the scholarship and creative work of our faculty. We can expect to be more effective in our mission of *Pro Humanitate.*

I. VISION STATEMENT

Five years from now, Wake Forest University will be internationally recognized as a leader in the identification and use of technologies to develop an innovative teaching and learning environment that enhances and strengthens learning, intellectual development, and analytical skills. Wake Forest faculty will be creative and collaborative thought leaders in applying and integrating information and communication technology in the development of pedagogically sound learning environments and in the discovery of compelling new avenues for creative and scholarly inquiry. Wake Forest students and graduates will be recognized and celebrated as leaders of their generation with an uncommon ability to discover, discern, evaluate and apply information and communication technology.

II. CORE VALUES

In performing its mission and pursuing its vision through the effective use of information and communication technologies, the University will

- Preserve close student-faculty relationships
- Ensure opportunities for scholarly research and creative expression for faculty and students (both undergraduate and graduate)

- Emphasize and enable international/global exploration and service
- Ensure a diverse and inclusive learning and work environment
- Require the highest moral and ethical standards of conduct for all members of the institution

III.IMMEDIATE RECOMMENDATIONS

1. DEVELOP A STRONG INSTRUCTIONAL DESIGN AND ASSESSMENT CAPABILITY

- Hire an instructional design staff to meet the needs of the entire campus including the professional schools.
- Introduce Instructional Design as a field to the WFU campus through well-publicized programming.
- Continually assess demand for instructional design resources and expand as necessary.
- Hire or repurpose university resources to assist faculty with assessment of innovative teaching strategies, data collection, and publication of results.

2. ESTABLISH FUTURE TECHNOLOGIES GROUP TO COORDINATE SUPPORT FOR INNOVATION IN ACADEMIC TECHNOLOGY

Under the direction of the Associate Provost/CIO, this group should include representatives from Information Systems, the Instructional Technology Group, the Teaching and Learning Center, and the ZSR Library, building the unique skills of each of these areas into a capability that exceeds the sum of its parts. This group will provide a forum for communication among all those providing support for academic technology. The coordination provided by the FTG will mean that the university will derive the full benefit of their complementary skills. The FTG group will support the work of the Committee on Information Technology and provide the committee with needed research on new technologies and development as appropriate. Critical success factors for establishing this innovation capability include:

- Clearly defined and supported process for proposal, approval, timely funding, and evaluation of pilot projects
- Established criteria and a defined process for expanding successful pilots to more general use
- Collaboration with interested faculty and students on research and development of emerging technologies
- Communication back to members' areas to ensure knowledge sharing, strategic alignment, and full support for innovation without duplication of effort
- New or repurposed university resources dedicated to logistical support, scholarly assessment, and publication of results of pilot projects
- Recognition of this work as a strategic priority within each area to ensure that a high value is placed on support of innovation
- Process to address academic technology questions posed by the Provost, CIT and ITEC and inform them of coming technology trends

3. BUILD ON THE WFU/CISCO RELATIONSHIP THROUGH THE WAKE IN MOTION INITIATIVE

- Deploy Cisco Digital Media Suite for delivery of live and on-demand digital media over the wireless network.
- Establish ongoing skills development for faculty in pedagogical uses of video.
- Provide video conferencing and rich collaboration tools to provide off-campus students, and those traveling on behalf of the university, the ease of spontaneous discussions enjoyed by students on campus. This may include a site license for WebEx, which would place Wake Forest at the forefront of pervasive application of these technologies.
- Support ongoing development of WFU YouTube channel, **http://www.youtube.com/wfuniversity**.
- Deploy TelePresence on campus for delivery of course content; partner with existing TelePresence sites for career development and student interviews; consider TelePresence for overseas houses.
- Employ Cisco Fellow to focus on acceleration of faculty adoption of collaborative video technologies in the classroom.
- Deploy Flip cameras and develop plans for making them available for faculty and student projects.
- Provide media training and facilities for faculty to participate in national news conversations via the use of CISCO collaborative technologies.
- Bring remote experts and scholars "into" on-campus classes.

4. IMPLEMENT PLAN FOR ONLINE LEARNING

Begin planning programs to use online education in thoughtful, focused ways, consistent with the Wake Forest mission, to establish and maintain close personal relationships between faculty and students.

- Develop, encourage and support the augmentation of traditional courses with online technologies and investigate the potential of online education; recommend an ongoing organizational structure.
- Organize a group of interested faculty and staff that would meet to discuss issues related to online learning.
- Incorporate blended use of technology into established face-to-face courses. Provide instructional design, training, support, and production services to assist faculty with blended instruction.
- Identify a department or interdisciplinary group to pilot a distance learning course, perhaps for use by students abroad or in summer session. Assess the program to determine how this course compares to traditional classes offered on campus, and use this course to make recommendations about the place of online learning/distance education at Wake Forest University.
- Pilot programs for alumni, executive business programs, internships or graduate courses using online/distance methodology.
- Recruit faculty with expertise in high-quality online learning, and utilize these faculty members in guiding and mentoring Wake Forest University faculty in online learning. Provide case examples of how online and distance education can be done well.

5. ESTABLISH A DIGITAL INNOVATION CENTER

- Establish a facility to be used by faculty, students, and staff collaborators, equipped with new technologies for experimentation.
- Include space for collaborative work with emerging technologies as well as resources for working with remote collaborators.
- Provide staff with technical support to enable collaboration and innovation in technology.
- Provide production services to support faculty with media and course materials, website building, video creation, and digital assessment tools.
- Promote teaching with technology and provide instruction on the pedagogical value of new technology.

6. ESTABLISH A SYSTEM OF INCENTIVES, REWARDS, AND RECOGNITION FOR FACULTY INNOVATION WITH TECHNOLOGY

Wake Forest must remain on the cutting edge and forefront of new technology. We should be early adopters and be willing to embrace the unknown. One way to achieve this is through pilot programs, another is to provide reward and recognition for success in those pilot programs. This should include:

- Seed grants such as summer technology program to encourage innovation (e.g. the Provost's recent call for proposals)
- Teaching release for course development, particularly with online/distance courses
- Recognition for technology innovation in faculty evaluation and merit system
- Re-establishment of STARS or similar program, to support faculty-student collaboration on technology

IV. STRATEGIC GOALS

To provide the foundational support for these recommendations, a number of strategic goals need to be in place to position Wake Forest University as a national leader in this area. Some of the goals listed below indicate continued support through existing programs.

1. TEACHING, SCHOLARSHIP, AND CREATIVE ACTIVITIES

Provide a world-class environment to model, research and apply best practices in technology-enhanced pedagogy, and to enable the pursuit and creation of scholarly activity and expression of knowledge.

A. Provide superior technology support services to faculty and students through:

- Technology service desk
- Instructional design
- Technology training
- Production services

B. Design and build learning spaces that promote creativity and collaboration; remodel existing spaces to achieve this goal.

- Flexible learning spaces for classes, group work, and study
- Replace outdated furnishing in existing classrooms with furnishings that offer flexibility in arrangement
- Digital technology studios for innovation and collaboration
- Teleconferencing facilities to support online technologies and collaborative work on the Reynolda campus as well as in international houses

C. Establish a digital publication unit to share Wake Forest scholarship with the global community of scholars, including:

- Books
- Journals
- Multimedia
- Student works

D. Invest in new technologies in support of scholarship and creativity:

- Visualization software
- Modeling and simulation software and immersive technologies
- Communication and collaboration tools
- Symbolic mathematics software
- Digital humanities support
- Digital media and the arts software and tools

2. LIBRARY

Transform Wake Forest libraries as a cultural center of the campus, serving as a physical and virtual locus of innovative research, collaboration, and discovery.

A. Embrace digital information and digital media as formats of record.

- Eliminate print journal format as publishers make electronic versions available.
- Utilize Scholarly Communication Librarian to promote open access model for journal publishing; seek campus-wide faculty mandate.
- Actively seek e-book partners and collections; collaborate with Future Technologies Group in conducting pilots with e-book readers (See recent report from Ad-Hoc Textbook Committee).
- Partner with other campus entities to invest in print-on-demand technologies such as Espresso Book Machine.

B. Make efficient use of physical collections by keeping heavily used print collections onsite and move lesser used materials to nearby offsite storage when permanent digital access is not assured.

- Discard print journal volumes for which permanent digital rights are assured.
- Move print equivalent of e-journal volumes to university storage when permanent digital access is not assured.

- Collaborate with Association of Southeastern Research Libraries' shared storage initiative for print journals.
- Continuously evaluate print monograph collection as digital equivalents become through Google, Internet Archive or other sources.

C. Invest in library facilities by creating more collaborative people spaces, including additional services for students and faculty.

- As collections move offsite or become digital, seek opportunities to incorporate additional student service functions within ZSR for one-stop shopping.
- Renovate entire Reynolds wing for increased student satisfaction.

D. Digitize unique materials to share with global community while preserving the original cultural artifact.

- Seek grants to fund digitization of unique elements of Baptist Historical collection and other materials that are unique to Wake Forest.
- Improve environmental conditions for rare book and archival collections by replacing heating, ventilation and air conditioning systems.
- Conduct outreach to share rich archival and manuscript collections with external scholars.
- Build galleries and modern reading rooms to showcase valuable and unique primary material.

E. Increase emphasis on digital literacy through contemporary tools and techniques, social learning and interaction.

- Be the first place on campus for those looking for assistance in the location, access, organization, understanding, evaluation, and creation of digital information.
- Stay at the cutting edge of academic use of social networking technologies.
- Provide individual assistance to those looking to communicate and work more efficiently within the digital environment.
- Consult with faculty on the creation of digitally based assignments and with students on the production of these projects.
- Consult with faculty on the production of digital scholarship and assist as resources allow; consult with students looking to establish an online digital identity for their field.
- Consider information literacy course as core undergraduate requirement.
- Work with faculty to incorporate information literacy principles into existing courses.

F. Establish library as key evaluator of ethical use of information assets.

- Incorporate ethical evaluation of information into all information literacy opportunities.
- Utilize Scholarly Communication Librarian as expert advisor in intellectual property rights for all media.

G. Seek creative solutions to maximize use of open source solutions and hosted/cloud services.

- Participate in open source community to develop a fully functional open source integrated library system.

- Seek most flexible and lowest cost solution for server operations, including cloud technology.

3. FOUNDATIONAL INFRASTRUCTURE

Provide a world-class technical environment for scholarly inquiry, collaboration, and participation in innovative learning activities.

A. Client Hardware and software (currently expressed in the laptop program and the standard load):

Provide a level playing field for faculty and students, both graduate and undergraduate, with equal access to technology.

- Continue providing equality of opportunity through hardware distribution and software availability to all students.
- When considering new classroom tools provide a strategy for equal access across the student body.
- Provide training and support for faculty and students with less experience and familiarity with standard software.
- Continually evaluate the use of cloud-based and thin-client-based services for our students to extend or replace existing capabilities.

B. Telecommunications and networking

- Continue to invest in robust connectivity to support scholarly research and computation and to enable exploitation of cloud computing.

C. Authentication and Authorization

- Undertake a comprehensive identity management effort to properly support collaboration within the university and with researchers at other universities.
- Engage data custodians in the university's business offices in proper coding strategies for faculty and administrators with faculty status.

D. Data storage:

Digital assets are being produced by Wake Forest Faculty and students at a pace unheard of ten years ago. In addition to the digital preservation capabilities previously recommended, we must provide infrastructure to meet the growing storage requirements for these massive, dynamic data artifacts on our own systems or in the cloud.

- Provide infrastructure and resources for supporting increased storage needs for digital assets.

V. BACKGROUND

1. 21ST CENTURY LEARNERS: WAKE FOREST UNIVERSITY'S CURRENT AND FUTURE STUDENT BODY

As far back as 2001, the noted futurist, Marc Prensky, declared that in regard to the decline of education in the US, "we ignore the most fundamental of its causes. Our students have changed radically. Today's students are no longer the people our educational system was designed to teach." Prensky describes today's students as Digital Natives who are the first to have grown up encompassed by and using technology (Prensky, 2001). Prensky further hypothesizes that the ubiquitous computing environment, in which the Digital Natives are immersed, has changed their brain structures and consequently has changed the cognitive processes of today's students. These learners populate our classrooms while legions of future students "go native" with faster, more accessible, more innovative, and more ubiquitous computing tools, many of which are available on handheld devices with 4G connectivity... starting as early as kindergarten.

A 2009 Pew Internet & American Life Project survey examined the use of technology by Digital Natives and found that 94% of teens are online. Most teens have Internet access at home or at school, with 89% accessing the Internet from home and 77% from school (Zickuhr, 2009). Teens rely on technology to communicate. Electronic personal communication is a favored activity, with 85% of teens communicating through channels such as text messaging, sending email or instant messages, or posting comments on social networking sites (Zickuhr, 2009). Further, teens and college students are more likely than any other generation to create content for the Web. 55% of teens and 60% of Generation Y create social networking profiles, and 28% of teens and 20% of Generation Y create blogs (Jones and Fox, 2009). In both cases, these age groups outnumbered other demographics. Students often learn to navigate many of these tools and technologies on their own, without guidance from teachers. Students enter college with varied understandings of appropriate and ethical uses of technology, often depending on their former school's curriculum.

While technology tools and resources change rapidly, the technology experiences Digital Natives have in pre-kindergarten through high school American classrooms is not consistent across the country. As a matter of fact, there are many schools incapable of providing access to high speed Web-based resources due to lack of bandwidth and costs for service. The eRate, once designed to offset costs of Internet access and service, has not kept up with the costs of faster connections delivering images, video, and audio resources to schools. Server-based data transmission between schools and district offices compete with online remediation, rich video-based instructional materials, and Web-delivered mandatory testing. The demands of accountability often supersede access to contemporary and engaging online experiences for students–most frequently in lower socioeconomic status schools and schools struggling to meet adequate yearly progress. It is not just access to bandwidth that generates roadblocks for access to 21st century technology; teachers and administrators also contribute to the digital divide, as well. All instructional personnel must be provided with adequate and regular technology training and professional development in order to support the changing needs of 21st century learners. That is not currently the case in many American pre-college educational environments.

On the other end of the educational spectrum, many students experience a wide range of technologies and technology-enhanced instruction every day. Whether delivered through a toy or an Xbox at home, a virtual

environment in a science classroom or through communication and collaboration with peers and experts via Skype or a Smartphone, a large portion of American youth are wired up for most of their waking hours. They may wear bar-coded IDs at school that track their presence on the school grounds, their parents may monitor grades that teachers post regularly on a secure server, they may participate in video-conferencing with scientists, scholars, and experts around the world, they may work collaboratively to solve problems set within an interdisciplinary videogame, they may conduct research using archives around the world, they may design videos and podcasts to share on the school television station, and they may attend a virtual high school or supplement their face-to-face education with online learning experiences. But, they most certainly will be facile and capable of adapting to new technologies with which they are presented.

Today's students are modern hunters and gatherers of information, but they may not be discriminating in what they select. They may also not understand legal ramifications of their behavior with technology tools, they might be entertained by using technology inappropriately, and they might not be respectful of people and property that, to them, appear distant because they are not tangible or they are unable to comprehend the ramifications of their behaviors. They are facile users, but they are children and adolescents.

Although schools, districts, and states may have expectations for technology performance and behavior for students and teachers, there are guidelines at the national level that outline what should be addressed in pre-college schools or what American school children should know by graduation. Because most schools and school libraries take advantage of eRate funding, they are required by federal law to filter Internet access, although the schools and districts are able to select the filtering tools they choose to purchase. Once students enter college, they will have access to more of the Internet without having been taught how to filter it on their own, resulting in a deficit in information literacy skills. Also, in order to receive eRate funding, each school must have an updated technology plan that includes an Acceptable Use Policy for students and teachers. Within the next year, all states will be required by law to integrate Web safety instruction into the curriculum, but how that happens will also be under the purview of individual schools and districts.

Standards tend to drive curriculum, and there are national standards outlining what students and teachers should know and be able to do regarding technology. The International Society for Technology in Education released the first set of student technology standards in 1999, the first set of teacher technology standards in 2000, and the first set of administrator standards in 2002. All standards were recently updated in 2007 (students), 2008 (teachers), and 2009 (administrators). The main shift was toward active use of technology to facilitate development of 21st century learning and away from mastery of technology skills and applications. Another major contributor to educational change relating to technology is The Partnership for 21st Century Skills, an advocacy organization whose focus is to ensure that educational curricula reflect skill development appropriate for the 21st century. Made up of educators, business leaders, and policymakers, the partnership developed a Skills Framework to communicate what skills are necessary for competing in the 21st century workforce and to outline how these skills can be woven into traditional content coverage. Information, media, and technology skills are a critical piece of the Framework. Both sets of expectations represent the ideal and provide benchmarks by which success toward achievement can be measured. The challenge for achievement ultimately returns to educational institutions, educational leaders, and financial support to provide resources and professional development to help teachers and administrators ensure that all students in the US are able to master curriculum and technology expectations upon graduation. For many students, this is not a problem. It is definitely a challenge for many others.

There is another group of students entering Wake Forest University's classrooms. Prensky referred to this group as Digital Immigrants. Many faculty and staff members are members of this group as well. Prensky defines Digital Immigrants as, "those of us who were not born into the digital world but have, at some later point in our lives, become fascinated by and adopted many or most aspects of the new technology" (Prensky, 2001). He continues to explain that though Digital Immigrants learn and adapt to new tools and information channels, "they always retain, to some degree, their 'accent,' that is, their foot in the past" (Prensky, 2001). This "accent" is comprised of the actions that indicate that new tools are secondary to older ones acquired by the individual. Examples include printing email, turning to the Internet after other news sources, or using a manual to learn a new tool rather than assuming the technology will teach the user how it works.

Students entering Wake Forest University come from many different backgrounds. Most traditional undergraduate students are Digital Natives, entering with a new set of experiences, expectations for their education, and ways of approaching the world. Others are graduate students who will likely find themselves as part of a classroom comprised of both Digital Natives and Digital Immigrants. Further, as Wake Forest University works towards a more diverse student body, the community might begin to recognize more of a digital divide in the technological experiences and training that students have than we have experienced in the past. The rest of this report will discuss the direction Wake Forest University will need to take to both meet the needs of Digital Natives as well as to help Digital Immigrants and those with fewer experiences with technology learn to navigate and impact this new information environment.

2. WHAT IS THE NEXT STEP THAT WILL KEEP WAKE FOREST ON THE FOREFRONT OF USING TECHNOLOGY FOR LEARNING - LEVERAGING OUR STRENGTHS FROM THE LAPTOP INITIATIVE?

The laptop initiative propelled Wake Forest to the forefront of using technology for learning in the late 1990s by creating a superior technology environment that continues to provide value today. What is not clear is a specific technology strategy for the future. While laptops themselves have become a commodity, the fully tested and integrated software load that we provide to all students at no cost remains a differentiating factor for the university, ensuring that students and faculty have access to the software and computing capabilities needed for learning and research. The laptop is no less valuable as a vehicle for these capabilities than it was several years ago, but other changes in the technology landscape may offer new opportunities to continue providing the initiative’s benefits.

Four components are essential to leverage technology for learning:

- Software applications
- Devices that support these applications
- Infrastructure required to support the applications and devices
- People with the expertise, commitment, and responsibility to fully exploit these technologies

SOFTWARE APPLICATIONS

As noted in the 2009 CIT report on the laptop program, the academic value of the program lies in the extensive suite of applications that are available to all students and faculty. The application installations have been thoroughly tested and work reliably for every student.

Augmenting the software available on the standard load are those applications available to students and faculty through departmental efforts, through the virtual computing resources provided by the Computer Science department, and through the research computing cluster. In many cases, the laptop acts as a client to access these discipline-specific or computation-intensive resources on powerful servers.

These applications are seamlessly woven into classes across disciplines. However, awareness of the variety and capabilities of these applications is not pervasive among faculty or students. Discussions of software and its applications to student learning are shared through workshops hosted by the Teaching and Learning Center and Z Smith Reynolds Library, but these workshops do not reach enough faculty. Since the end of the STARS program, progress has been uneven.

DEVICES

The computing device is not the most important aspect of the university's technology strategy, but it is the most visible. In the mid 1990's, the laptop was an obvious next step beyond the desktop for providing access to applications needed for teaching and learning. The only limits to be set for this trend were price and power. Today, the next big technology client is less clear. We can see different, sometimes competing, needs and preferences. Users want, at least some of the time and for some purposes:

Mobility. Students and faculty find themselves using every available opportunity to get their work done, wherever they are. As shown by the popularity of smart phones and applications, and also illustrated by those of us who will not travel without our laptops, it is clear that we want our computer with us all the time. Implied in the concept of mobility are requirements for ubiquitous high speed connectivity, ubiquitous access to our data, ubiquitous access to applications, and long battery life.

Input/Output: Large displays, full-size keyboards, and touch displays. Cell phones and subnotebooks have illustrated both the advantages of touch screens and the disadvantages of small keyboards for input tasks. Similarly, they have illustrated the output display limitations of small devices. For years, those working with complex spreadsheets, graphics, and video editing have sought the largest displays their space and budget can accommodate. The rapidly advancing capability and use of online collaboration tools expands this need to include room for collaborative workspace and video.

Processing power. Many applications now used by students and faculty require serious computing power. Among the more demanding are video editing, some kinds of statistics, modeling and simulation.

Mobility

The overwhelming desire for mobility has driven expanded use of smart phones and smaller alternatives to laptops. The functionality of personal digital assistants (PDAs) is now incorporated into smart phones such as the iPhone, Android, and Windows Mobile devices. Smart phones continue to evolve in functionality and ease of use. The input and output limitations of first generation smart phones have been mediated somewhat in current and emerging models, pervasive high-speed Internet connectivity has become readily available, and the number of applications for these phones increases daily. Video capture and display features are now incorporated into many cell phones. The Flip camera offers high definition in a cell phone size package. However, these devices fall short of meeting most of the other user preferences: computing power, efficient input for serious writing, and large displays for collaboration and multimedia tasks. Furthermore, unlike the laptop, they are not effective as clients for access to external systems that could provide the computational and other capabilities required for scholarship. Yet the ready availability of handheld mobile devices for information seeking, data collection, reading, content creation, class participation, and collaboration is compelling. We have lessons learned from our previous mobile device efforts on which to base new evaluations, as well as continuing successful mobile phone use by students in our Education department. The current pace of innovation in the market may lead to significant leaps in functionality that we should be poised to exploit.

Mobility can also be achieved through various kinds of subnotebooks, which offer a user experience closer to that of the laptop without its weight, size, and cost. Screens are typically 7 to 11 inches, and keyboards are generally smaller than standard. Most fall into one of two categories filling different market niches:

- **Netbooks** are low priced, low power devices, principally intended for use with the Web. They often use similar processors to cell phones. As such, they are not capable of handling processor- or graphics-intensive applications. Their range of applications may be expected to expand by the emergence of cloud computing, offering online storage and applications. They might also be used as clients for campus computing resources.
- **Ultramobile PCs** look very much like netbooks, but they have more powerful processors, graphics cards, and larger and higher performing hard drives. They have all the size advantages of netbooks, without the performance compromises. They share with netbooks limited keyboard and display size. While netbooks are lower cost than conventional laptops, ultramobile devices command a price premium, often twice the price of laptops.
- **iPad-type devices:** The iPad was recently introduced with much fanfare, and competing devices are already on the horizon. Functionality in these devices is currently limited but will increase as the popularity of the form factor demands. As with other emerging technologies, it is too early to assess the likelihood that a device of this type could replace the laptop.

Input-Output

As is the case with mobility, recent innovations in input and output technologies offer new possibilities for academic use. The blurring of the distinction between computer monitors and consumer high definition television displays means that large high resolution displays are increasingly affordable. A 46 inch 1920x1080 display is now about the same price and less weight than a 17 inch 1024x768 monitor of a decade ago. It is brighter and will last longer. Two additional trends that are worth watching are ultrathin flexible displays and ultracompact

projectors. Organic light emitting diode displays are inherently thin and can be fabricated as flexible devices. We may see fold out displays that give even netbook-size devices full 17 inch displays, and large displays that roll up in a tube the size of a long pen. Laser diode technology is leading to ultracompact projectors. In December 2009, LG introduced a cell phone that includes an integral projector. The large display of the future may be a projected image. Video projectors continue to get brighter, quieter, higher resolution, and lighter.

A very different technology is the basis of e-book readers. Conventional wisdom is that to replace the book, a device needs to have very long battery life, numbering in days. Only one display technology supports that at present: e-ink. E-ink (as seen in the Amazon Kindle), consumes extremely low power except when the image changes. E-ink has the additional advantage of being a reflective display, and is just as readable in bright sunlight as in normal light. However, images on e-ink displays can change very slowly, and are not suitable for video. Thus we see dual-display devices introduced in just the past few months, combining e-ink and conventional displays in a single reader. Innovation continues at a startling pace.

The rapid evolution of computers and displays brings both joy and frustration. Joy because of all the things these devices let us do (many of which we had not even imagined a few years ago), and frustration because no single device meets all of our wants and needs. We want mobility, but we need larger and larger displays for some work. Small size and light weight are incompatible with large screens and keyboards.

Processing Power

Some applications used by students and faculty today push the limits of the university standard laptop. Even daily tasks such as creating reports or completing academic assignments can now demand greater processing power than in the past. Historically, reports and papers were text-only because that is what was possible and affordable. With the advent of powerful personal computers and printers, photographs and figures were no longer only the province of professionally published articles and books. Video and audio are increasingly appreciated for both real-time communication and for additions to or replacements for essays, reports, and the like. Wake Forest faculty find that for some topics, online lectures are more useful to students than live lecture. This year for the first time the standard laptop includes a Web cam.

A very different model of meeting the need for processing power is represented by the thin client technologies. Thin clients have very little processing power of their own, and have no internal storage. They may consist of a keyboard, display, graphics processor, network adapters, and just enough processing power to allow the device to act as a remote keyboard and display for a computer typically sitting in a server farm. Other thin client models have no keyboard and display of their own, but allow for connections to these peripherals. Thin clients are less expensive than laptops, but the servers they access are far more expensive. Today the advantage of thin client's lies in ease of support and security, not cost. They suffer the additional limitation of being useless when they are without a high speed network connection.

The Device of the Future.

In this dynamically changing environment, it is difficult to anticipate what gadget or gadgets we will be using in five years, much less ten. No one wants to carry a cell phone, a laptop, an e-book reader, a still camera, and a camcorder, and even the combination does not give us the display size we want.

Will there be a single successor to the laptop in five years? The Committee does not yet see an alternative that meets all these seemingly conflicting needs, but we do see glimpses of how these advances may align to change the way we work.

It is instructive to look back to 2002, when IBM introduced the Meta Pad. The Meta Pad was a family of devices built around a small nine-inch rectangular module that was in fact a full-fledged computer, including processor and hard drive, but without any input or output capability. Slipped into a compact display, it became a personal digital assistant (PDA). Inserted into a laptop shell, it was a full fledged laptop. Placed in a desktop device with ports for keyboard, monitor, printer, and additional devices, and it became a desktop computer. There was even a "wearable" configuration. A beautiful concept, it allowed one to have access to a full Windows XP computer and personal data in the configuration that was most appropriate at the moment. Expensive and ahead of its time, it never caught on.

One can imagine a fully, or at least partially, converged device: a cell phone with enough power for complex calculations; a built-in display or projector with enough brightness and resolution to provide an ample replacement for a large monitor; a high quality collapsible keyboard communicating wirelessly, which is already available. Physical challenges will have to be overcome for such a fully converged device to reach fruition, mostly related to display size, demands for power, and the need to eliminate waste heat.

The university cannot wait for a single "winner" among the different devices or we will be years behind. These varied devices each represents a foundation for new and better ways of enhancing learning. Our faculty need to explore the power of these technologies now, and begin enhancing the experience and learning of the current generation of students. The expertise we develop in online collaboration, rich media, and improved pedagogy will position the university well for whatever software or device comes next.

INFRASTRUCTURE

Cloud computing and storage will play a role in some future applications. E-mail and calendaring applications for students at Wake Forest are already moving to the Web, and basic office applications are now available as Web applications. This trend will continue, but it is too early to predict whether the cloud will be cost effective for processor and disk intensive applications, thereby reducing the need for serious computing power in the local client.

Advances in video conferencing are revolutionizing the nature of collaboration. The most dramatic such technology is manifest in Cisco TelePresence. Advances in video compression, display resolution, and easy to use interfaces make video conferencing all but indistinguishable from an in-person meeting. The potential exists for bringing students together, for providing access to remotely located experts, and for collaboration. A TelePresence facility located on campus and at each of the overseas houses would open valuable opportunities to enrich the learning of our students on campus and abroad.

Cloud computing and video will require that we have a robust campus network and high speed connectivity to the Internet. To stay on the forefront of using technology for education, the university must ensure that we continue to advance our network infrastructure and Internet connectivity. At the same time, we must undertake an identity

management effort to stay in step with our peer institutions in support of faculty and student research collaborations and to pave the way for cross-institutional collaboration.

It may be that changes in infrastructure will be the answer to some of the device challenges, such as that of the need for large displays. Perhaps that will happen by a change in the expectation of work spaces. Rather than making large displays mobile, large displays may instead become ubiquitous. Just as we now expect to find wireless everywhere, we may soon expect access to a large display everywhere. Hotels are already deploying HDTVs that are in fact high quality computer monitors. We may choose to provide a pair of HDTVs or HD monitors in every residence hall room as part of our campus computing infrastructure. We must begin thinking in creative new terms, exploring new possibilities.

PEOPLE AND EXPERTISE

The final challenge in leveraging technology in learning is achieving in our faculty a pervasive understanding of the capability of technology and the best practices in instruction with and without such technology. Teaching well requires more than commitment; it requires knowledge of pedagogy. This is even truer of teaching with technology, where faculty have been exposed to fewer examples of effective teaching. Indeed, the best uses of technology in teaching are being invented now.

The next step, then, is creation of a group such as the recommended Future Technologies Group to jump-start and support active research into the use of single or multiple technologies to provide the rich technology environment that earned the university its reputation as a leader among liberal arts institutions. Responsibilities of this organization should encompass research, following and even forecasting the evolution of information and communication technology, assessing the market readiness of new technologies, and supporting faculty in conducting pilots and assessments of promising new technologies. We must create an environment that encourages innovation with technology, and supports and encourages sharing and dissemination of such innovation.

Of utmost importance is the level playing field with respect to technology resources that the laptop initiative has provided for our students over the years. As the university's student population becomes more diverse, it is even more important that we continue to provide the technologies that are required for learning and research so that no student is at a technological disadvantage due to personal economic circumstances. The principle of technology equality for all students and faculty must be preserved in considering new technologies for adoption.

3. WHAT WILL THE ACADEMIC LIBRARY LOOK LIKE IN 5 YEARS? IN 10 YEARS?

Academic libraries have evolved for hundreds of years in their quest to meet the needs of their users and to preserve the world's knowledge. As the academy has changed, so has the library. Recent trends that have affected all facets of higher education include the rise in interdisciplinary research, collaborative work in all fields, and an increase in research that involves teams of faculty, undergraduate and graduate students. Future trends will include a greater reliance on large data sets and the expression of new forms of knowledge through technology and multimedia. All of these trends will have profound impact on peer review and the tenure and promotion process as well as on publication formats and therefore on the academic library of the future. Pundits across

higher education have wondered publicly about the future of scholarship and the future of libraries. What will be the final product of scholarship? Will it continue to be publication in a small set of journals or a print book from a recognized publisher or will it the process itself? Will print go away? Will there be anything tangible left to preserve?

Libraries serve all their users, including those in fields of knowledge where the rate of change is rapid and those where scholarship remains tied to traditional formats. Academic libraries also serve students who want their information to be visual, shared, and immediate. The successful academic library will respect the differing information needs of all who depend on it and provide the products of scholarship in all the ways they are expressed.

The implications for the library of the future are thus:

Decrease in demand for physical space to house printed collections: Differentiation in academic libraries used to be based on the size and scope of their collections. In the Google age when the bulk of the scholarly record will be digitally available to all, differentiation will occur on how effectively libraries use digital collections and information technology for the benefit of their users, and how they preserve and make available their special, rare, and primary materials. This means that the inexorable rate of growth for libraries in numbers of volumes and square feet has already slowed and will eventually reverse. Networks of libraries are cooperating to preserve shared print volumes of journals for which permanent archival digital rights have not yet been secured so that each individual library does not need to maintain its own copy. The crystal ball on the digital equivalent of books is less clear and less immediate. As the Committee deliberated this past year, the legal settlement between Google and the publishers who sued them over copyright infringement for digitizing their books without permission took several surprising turns and remains unsettled. Google's early momentum to digitize all the books of all time has slowed due to considerable legal resistance. However, in the long run there is little doubt that academic information will become digital, journals will get there before books, and the sciences will transition faster than the humanities.

Faced with this digital future, responsive libraries will begin to remove lesser-used materials to offsite storage and eliminate redundant print materials from the collection. This is happening in academic libraries across the U.S, including those at Wake Forest.

Increase in demand for physical space for information users. The notion of “library as place” has been at the forefront of discussion in academic libraries for a decade. When outside experts were predicting that academic libraries would become obsolete and die, the reverse happened. Academic libraries across America are filled with students, affirming the library as the academic heart of the campus as much it ever was. For example, the Z. Smith Reynolds Library is experiencing a 38% increase in attendance this year over last. College students are social creatures. They choose to learn in a supportive environment where they can seek assistance if they need it. Wake Forest students typically like to study independently but surrounded by their peers. They, like their counterparts in universities across America, want a comfortable place to spread out their books, laptops, food and drink always within reach of an electrical outlet. They want natural light in the day and they want to stay up late at night. They want services close by that can help them succeed in their studies and academic careers.

Libraries that recognize and meet the needs of students for functional and attractive learning spaces will be successful in making themselves the center of learning on their campuses. This will require a consistent investment in the physical infrastructure of libraries as learning spaces to keep them fresh and inviting.

Increase in demand for information services: The third component of the successful library of the future is an enhanced level of service. The central role of the library will always be in guiding users to find, evaluate and use information appropriately and ethically, independent of the physical format. Academic libraries such as those at Wake Forest define themselves by the success of their users. In order for faculty and students to be successful, they turn to libraries for help with research, access to print and digital collections, advice on publishing and intellectual property rights, examination of primary materials, and use of technology for the acquisition and expression of knowledge. Demand for formal and informal course work in the information literacy field will continue to grow. ZSR's own experience has seen the growth of the Lib 100 program from three to fifteen sections per semester and the expansion of the beginner course to higher level courses for majors in four areas.

Faculty and students will continue to turn to libraries for help in learning how to apply the latest technologies to their work. The Z Smith Reynolds Library pioneered the use of social networking tools at Wake Forest, incorporating blogs, wikis, Facebook, Twitter, and Flickr into the classroom environment. ZSR is currently investing in digital video infrastructure and expertise in anticipation of its explosive growth in education. Libraries that embed themselves deeply into the fabric of the academic environment will become critical partners in the teaching and learning experience.

Increase in demand for technology infrastructure and expertise: As academic information continues the transition from print to electronic, the demand for technology infrastructure will grow, just as the physical infrastructure will decline for printed material. Physical archives will become digital archives and space needs will become acute for digital storage just as they once did for physical storage. Some libraries will turn to off-site cloud computing to meet heavy demand for cost-effective, reliable digital space. People who work in libraries have been accustomed to constant change and will need to continue to adapt to new technologies as they evolve. Libraries were early adopters of Web technology to the point that the majority of library collections and services are now delivered via the Web. Most recently, libraries adopted video and social networking tools before most other campus units. The rate of change will continue to accelerate as the emphasis on large data sets grows and new models of collaborative digital scholarship transform entire fields of knowledge.

These changes will mean a different kind of workforce than libraries employed in the past. Libraries like ZSR have begun to employ instructional designers, Web developers, metadata specialists, open source programmers, scholarly communication experts, and digital curators. There will be no clerical positions left in libraries. Every position will be involved with technology and its application to academic work. Whereas academic libraries used to have twice the number of support positions for each librarian, the library of the future will see closer to a 1:1 ratio, a state that ZSR has already reached.

4. HOW WILL STUDENTS AND FACULTY ACCESS INFORMATION IN 5 YEARS? IN 10 YEARS?

For a long time information was scarce, expensive, and difficult to locate. Information was contained in physical documents that required significant resources in the time to produce them, the energy to distribute them, and

funds to purchase them. This information environment gave rise to a long and stable period in information access based in hierarchical organizational systems. We have witnessed a radical shift in how information is produced and accessed in the past few decades, and this change is likely to continue to evolve at a rapid rate. Now information is plentiful, cheap, and easy to find. However, instead of easing the information seeking process, this new information environment has increased the challenge of finding quality information and the best sources in a sea of all available information and misinformation. Further, it has become more difficult for organizations to collect institutional knowledge as we witness an increase in the diversity of types of publication opportunities available to faculty and students. The best resources still take the most time to create and have significant costs despite a general expectation that all information should be free. While there is plenty of "good enough" information for day-to-day needs, there are still challenges associated with finding and selecting the highest quality information for academic research.

Today's information environment is shaped by many factors. Knowledge creation and distribution has sped due to computing resources and the Internet. People receive information through multiple channels, from traditional scholarly publications to email discussion lists to blogs to Twitter feeds. Boundaries between professional and personal time, work, and communication are fading. In addition to these changes, communication is becoming more open. For example, people routinely post works in progress, whether as streaming video or photos of construction project, the beginnings of research ideas in blog posts, or preliminary research findings in research communities such as SSRN. In addition to open communication, these informal and transparent venues allow people to develop powerful voices based on contribution to the field at any point in their career and allow people to influence discourse in ways that might not have been possible before.

Hierarchy. When information was located primarily in physical documents, the organization of information was built on hierarchy. This model arose given that a piece of knowledge could only be located in one physical place. (For example, one book can only be stored on one bookshelf.) However, hierarchy had some drawbacks. Many books contain information on multiple subjects, but can only be shelved based on their primary subject area. If someone were browsing shelves in a secondary area, the user would never find the other work because the book would not be shelved there. To accommodate this, librarians developed complex systems to aid in finding materials from a number of different starting points. Card catalogs allowed people to find books by title, author, and subject. Controlled vocabularies were developed to allow users to search for books based on subject and find related topics. This hierarchical method of accessing information was created for a physical, print-based world.

Search. Early in the development of the Internet, people began applying similar methods of organizing information to Websites. Portals like Yahoo and projects like DMOZ, the Open Directory Project, were created to mirror traditional ways of finding information. However, it became clear that there was too much information for people to manually classify and organize it, and that search would be a faster way of accessing information. Search came into its own in the mid to late 1990s as Yahoo, AltaVista, and Google figured out how to index content on the Web and make it searchable. Search allows information to be stored wherever the creator chooses to store it, yet it can be found through a number of different channels. In essence, information can be found on multiple "bookshelves"—bookshelves that are created instantaneously for every search a user performs. A book on the economic impact of women in the arts would show up in searches on economics, women's studies, and art, rather than just one of the three.

Search has improved with the use of tagging and user generated content. Internet users tag information when assigning a keyword to a piece of information. For example, one might tag a multidisciplinary Website with “economics,” "women," “art,” and “interesting.” These tags provide search engines with more information about the content, and enable search to provide better results. Similarly, any user generated content, whether it is a review on Amazon, a comment on a blog post, or a photo uploaded to a photo sharing Website, enhances search results as well. Search has improved significantly over the past ten years. In fact, though it is not as precise as expert searching in the hierarchical system, for most people's day-to-day information needs it is good enough.

Search has improved to the point that it is extending to environments other than the Internet as well. Though Gmail allows users to create labels, which is somewhat like organizing emails into folders, some users forgo organizing their email since the search functionality is so accurate. Spotlight, on the Mac OSX platform, similarly allows users to search across all files and applications on their computer rather than relying on complex systems of organization. Today we are seeing the introduction of real time search as well. This search of current content was fueled by Twitter, but has been widely recognized as important with innovations in this area from Google, Bing, and Yahoo.

Push. Finally, we will consider the push environment, which is just coming into its own today. This method is recognizable by the ability of individuals to create environments in which the information they desire comes to them. For example, with the introduction of RSS, or Really Simple Syndication, users can specify specific news sources, Web sites, or journal article topics that continue to be relevant to them. RSS allows those users to create a space, either in a program or on a Website that pulls all new content related to their interest into one place for easy access. Instead of running several searches every day to catch all relevant new information, RSS allows users the ability to create a customized environment that pulls relevant content into one place so that instead of searching new information comes to them.

Push environments rely on a mix of user generated content as well as expert metadata. The ability to pull information from a relevant blog relies on the blog author's explanation of their site as well as the user's ability to find and identify the blog as useful. A database search on a topic will rely on a good original search as well as the expert created metadata.

Push entered the mainstream with RSS and some social networking sites that make use of a similar technology. The challenge in this environment is not finding information as much as it is filtering through large quantities of information. One way of avoiding this is for users to learn to craft very good searches that only return the most relevant sources.

Access. Over the next five years, most academic researchers will rely on a combination of approaches to finding information. Users must understand hierarchy to access physical library books. Anyone using Google or databases has to understand search. Those who are looking to save time and access the most current resources will have created a place to collect RSS feeds on relevant information.

However, in addition to these methods of finding information, information is available in an increasing number of ways. The Web continues to provide new types of information. Where it was once text based, we now can experience rich multimedia environments. The Web enables us to do things that used to require stand-alone technology. VOIP (Voice Over Internet Protocol) technology can enable communication in the same way phones

do. Streaming video enables television and movie viewing instead of needing a separate device for those activities. In addition to this, the Web can be accessed from a number of devices other than traditional laptops and desktops. Cell phones, video game consoles, and some eBook readers allow users to connect with the Internet. Some devices, such as the Chumby, Sonos speaker system, or digital picture frames connect with specific data on the Internet to provide content through new stand alone devices.

Mobile devices allow users to interact with information in ways unimaginable before. Standard cell phones with text messaging capabilities can perform Google searches via SMS. Basic Web browsers allow users to access simple Websites for quick questions. Smart phones with unlimited data plans allow people to have entirely different experiences. With one of these devices it is possible to stream Internet radio while running errands around town, watch your car travel along a satellite map as you drive down a freeway, and pay your phone bill while standing in line. In a few locations, you can even show your smart phone to the Starbucks barista, which can be scanned instead of your card, rendering the actual card unnecessary.

The methods and channels of accessing information are shifting quickly, and we can only expect more of these changes in the near future. It is likely that customized information environments will become more common; both created by individuals for their specific needs and automated by services offered by providers such as Google or libraries. We can expect more types of information on the Internet and more devices to hook into the Internet in order to access specific information in designated contexts. We can expect smart convergence devices that allow us to access information in ways we are only beginning to imagine today. However, in addition to these exciting possibilities, we can also expect increasing quantities of information, more information finding us at a quicker pace, and an increasing challenge of weeding through it all to find the most relevant resources. As it becomes easier for people to contribute information to the online environment or print-on-demand books, the challenge shifts from being one of having resources to purchase the best information to one of teaching those in the academic community how to filter through large quantities of information and determine which sources are reliable and which are not.

5. HOW WILL TECHNOLOGY CHANGE THE USE OF TEXTBOOKS AND SCHOLARLY JOURNALS?

Textbooks: Rising textbook prices have rendered the current textbook model unsustainable, and at the same time, the growing number of e-book readers on the market is a clear indication that interest in electronic books is increasing. Though reading for pleasure on electronic readers is becoming widely accepted, electronic textbooks have not yet evolved to meet essential criteria for acceptance by college students. In Wake Forest's own e-book study as well as in published studies, students have indicated that affordability and accessibility are essential criteria that are not being met. Textbook publishers, in an effort to protect their business model, have put both economic and technological barriers in place to meeting these criteria. Electronic textbook prices are not yet low enough to make up for the lack of the sell-back option exercised with printed texts, and a majority of electronic texts are encumbered with Digital Rights Management (DRM) that limits the student's access to the text for a specific time period or on a specific device, as well as limiting printing. Thus access to the text is either temporary or inconvenient or both. For students, these factors outweigh the searchability and portability that are the electronic text's primary selling points. Add to this the limited availability of titles coupled with the lack of standards for electronic publishing, making it virtually impossible for a student to get all or even most of her

textbooks in a format for which a single reader will suffice. Thus e-book readers become additional devices that the student must carry, along with her laptop, her cell phone, and her other textbooks.

Some faculty members are pursuing alternatives to traditional printed and electronic textbooks by assembling course materials from a variety of print and electronic sources, sometimes including selection of specific chapters from electronic textbooks. Many are understandably reluctant to take this approach because of the time, effort, and research required to assemble a collection of materials that meets pedagogical goals.

Some solutions to all these challenges are emerging. Epub, a free and open e-book standard, is the official standard of the International Digital Publishing Forum (IDPF). It is designed in such a way that the text can be optimized for multiple display devices, including laptops and mobile devices. This gives the student the convenience of accessing the text in whatever manner is convenient at the time. The Open Knowledge Foundation has created opentextbook.org, a registry of textbooks that are free for anyone to use, reuse, and redistribute. A growing number of faculty are choosing to write and license textbooks through Creative Commons licenses, on Wikibooks, or through other means that promote the use of free or inexpensive electronic textbooks. An Open Textbook Statement, supported by the MERLOT project and other efforts, encourages faculty members to sign a Statement of Intent to use materials that are pedagogically appropriate but also affordable, including open textbooks.

As a university, we must leverage both existing expertise held in people beyond our campus, and widely accepted pedagogical theory to assist faculty members in structuring their courses to use a wide array of instructional devices and materials designed to be compelling, not so much to the instructor, but to the digital natives who are now our students. Making our faculty aware of these possibilities, as well as watching the continuing developments in the e-book reader market, will help us to make wise choices for Wake Forest.

Scholarly Journals: The evolution of the cultural record from print to electronic format began with scholarly journals. For well over a decade, academic journals have been increasingly available in digital form. The movement began in the sciences, where the imperative to publish results more quickly was a powerful driver. Journals in the scientific, technical and medical (STM) community are largely owned by a small number of foreign-owned publishers. These publishers have long been notorious for overcharging academic libraries, given the inelasticity of demand that is a byproduct of the rigidly enforced tenure and promotion schemes in much of academe. The positive outcome of this publisher wealth was the capital to invest in technologically enhanced digital publishing mechanisms. Publishers started bundling packages of e-journals in addition to selling individual titles. As a result, libraries were able to provide faculty and students with a lot more e-journals by spending a little more money. The journal literature has finally reached a tipping point, where most academic libraries, including all three libraries at Wake Forest, have higher expenditures for electronic materials than they do for print. The Z Smith Reynolds Library now considers digital as the default format for journals and only subscribes to the print format if there is no digital equivalent.

E-journals have been enthusiastically accepted in the science departments at Wake Forest. The social sciences have also been persuaded by the conveniences of 24x7 remote access. Faculty in the humanities are still the least enthusiastic about the digital format but have cooperated with the movement. Students, of course, prefer digital access almost exclusively and mostly ignore the remaining printed volumes. However, not all journal volumes are available electronically. Backfiles of journal volumes continue to come online but are not universally available or

affordable. The ZSR Library maintains off-site storage for over 100,000 printed physical volumes for which it does not hold permanent digital rights.

Innovation in the journal literature no longer lies in the change in format, but in the exploitation of that format to include vast quantities of data and multimedia heretofore impossible in print. This is particularly likely in journals that are published independently from the commercial oligarchy that controls the bulk of the standard periodical literature. Changes in publishing methods of scholarship at the article level are likely to be significant in the next decade and real opportunities exist for libraries to play key roles in these changes. It is the traditional tenure and promotion model that is the biggest inhibitor of radical change in the publishing world. As long as departments maintain lists of established, traditional journals in which junior faculty must publish to achieve tenure, commercial publishers will continue to charge exorbitant rates for journals that academic libraries must purchase. The challenge is to exact systemic change in the slow-changing industry of academe. Peer review is a critical factor in traditional journals and can remain so in any new model. Professional societies should be encouraged to "take back" their journals and stop looking at them as cash cows to fund non-related activity. Libraries can partner with academic departments and individual faculty to publish niche journals electronically and include large data sets and multimedia that would be too expensive to publish commercially. These and other alternatives exist, but they must be accepted for the purposes of tenure and promotion in order to change the paradigm.

The other major change in the world of academic journals is the open access movement. For decades, librarians, faculty and administrators decried the unsustainable nature of journal prices. Finally, open access offers an alternative. Open-access literature is freely delivered on the Internet, and is free of most copyright and licensing restrictions. Open access can take place at the article level in traditional journals, or in completely open journals. Peer review is entirely compatible with the open access movement, and in fact depends on contributions by scholars in the review and editing of open work. A variety of business models exist to cover the real costs of digital publishing, including the author-pays model, institutional subsidy, advertising, or funding agency. Open access has gained significant traction in recent years. The U.S. National Institutes of Health and European Research Council now require grantees to submit their articles for posting in the freely accessible digital archives. The Harvard Faculty of Arts and Sciences voted unanimously in 2008 to allow the university to openly publish their scholarly articles in Harvard's institutional repository. A number of other faculties have followed suit. Wake Forest has established its own institutional repository, WakeSpace, and is soliciting participation by faculty scholars on both campuses. The hiring of a Scholarly Communication Librarian at the Z. Smith Reynolds Library is an opportunity to advocate for a greater acceptance of open access publishing at Wake Forest.

6. WHAT ROLE WILL COMPUTING TECHNOLOGY PLAY IN CREATION OF KNOWLEDGE IN 5 YEARS? IN 10 YEARS?

Improvements in technology – and new technologies – are powerful enablers for the creation of knowledge. Seven trends will radically change and enhance the way that knowledge is created: 1) abundant and accessible information, 2) the need for and availability of tools for extracting knowledge from information, 3) improved communication and tools for collaboration, 4) symbolic mathematics software, 5) modeling and simulation, 6) digital humanities, and 7) new, creative tools and media.

Abundant and accessible information. Historically, scholars with access to large libraries enjoyed a considerable advantage over those without such access. Knowing what has gone before is all but essential for rapid discovery. The Internet and the Web lower the cost of disseminating information, though they may not necessarily lower the price of retrieving such information. Publishers will be able to maintain high costs for access to scholarly works only as long as they are able to sustain their oligarchy over journals. Scholars create journal content, provide peer review and editing, and their institutions are then charged large sums of money to retrieve this very content.

However, in some disciplines, articles published in scholarly journals are old news. Current activity is tracked in freely accessible online archives such as http://arXiv.org. Scholars can find articles in such articles many months before they are published by journals. The Committee is optimistic that within five years, and certainly within ten, new scholarly publications will be widely available at modest cost. The biggest barrier to this trend is the role of traditional journals as scorecards for promotion and tenure.

Accompanying the explosion of information are rapid changes in the nature of search. Traditional classification schemes seem clunky and limited compared to the power of Google and Yahoo. Manual classifications are not sufficient when information is so abundant and rapidly generated.

The need for and availability of tools for extracting knowledge from information. The very abundance of information means that new tools must be used to find the meaning behind that information. Visualization tools play an important role, including three-dimensional representations of data. The mind is remarkably adept at pattern recognition, and translating information into a visual representation that unleashes that ability can be powerful. Virtual reality may play a role here. More fields will make more use of sophisticated statistics. Data mining methods are just beginning to realize their potential.

Improved communication and tools for collaboration. Many faculty choose among job offers based on the access the position affords them to scholars working on similar topics. In five years, physical proximity will be less important. Even today, some of our faculty have video conversations with collaborators abroad several times per week via Skype. TelePresence raises the quality of a video conference to a level that it is barely distinguishable from a face to face discussion.

Beyond improving the ability to converse, new tools make collaboration easier. Shared documents can be edited by multiple people simultaneously, with edits appearing to all within seconds. New tools such as Google Wave offer a new paradigm for online collaboration. With sufficient processing power and network bandwidth, discussing common documents and data will get easier and easier – and in some ways more effective than what we settle for now in face to face communications.

Data sets. Modern scholarship and instruction are highly data-driven endeavors. Digital assets produced by Wake Forest Faculty need to be stored, processed, analyzed, and communicated at a pace that was unimagined ten years ago. It is quite typical to find scholars at Wake Forest who will produce hundreds of megabytes of data per hour. It is an ongoing issue of how to best warehouse and handle these digital artifacts. This challenge extends beyond that of traditional archiving which is concerned with the finished results of research, to the management of massive amounts of raw-unprocessed dynamic data. It is difficult to provide infrastructure to meet these needs if we do not develop a clear assessment of current and future requirements and create policy for handling these massive, dynamic data artifacts.

This challenge presents an opportunity to investigate new ways to not only store data on campus, but to leverage opportunities beyond the physical boundaries of the campus in the "cloud" of the Internet. By intelligently developing our capabilities with both internal and external infrastructure, we can meet these challenges effectively.

To meet the needs of managing raw-scientific, instructional, and scholarly data, staff will be required to:

- Assess current needs and predict future needs based on various growth curve scenarios.
- Evaluate implementations of local and "cloud" infrastructure and various aggregation scenarios to provide dynamic data-warehousing for scholarship and instructional artifacts.
- Instruct, assist, and implement best practices for research artifacts such as online lab-notebooks and original-raw-research-data.
- Instruct and assist with data artifact categorization, indexing, and meta-data schema.
- Implement data deposition, access, and transfer consistent with statutory obligation, University, and granting agency rules.
- Assist scholars and students with procedures for authentication and authorization for data-mining of internal and external artifacts.
- Oversee data-safety and sanitization procedures of University held data-assets; evaluate and predict future needs.
- Collaborate with peer institutions to explore synergies and partnerships that are mutually beneficial to scholarship.

In regards to "mixed-data":

- Leverage approaches to be developed by data warehousing for scholarship and/or investigate vendors that can provide individual computing backup.
- Promote best practices in handling of mixed-data-- this includes, instructional, scholarly, communication, and personal data artifacts produced and held in offline and near-line storage by individuals employed by the University.
- Develop infrastructure, policy, and quota standards to provide individuals employed by the University access to data-warehousing on an ad-hoc or scheduled basis.
- Educate employees in regard to their obligations to handle University data assets according to policy, with special emphasis on security and privacy standards.

Symbolic mathematics software. The advent of programs such as Maple and Mathematica leverage the mathematical ability of scientists, engineers, and mathematicians. Many difficult proofs and derivations span scores of pages and can take years of work. With programs such as these, the user must clearly define the path to be taken, but the steps are carried out automatically. This means more than finishing a task faster; it completely changes the magnitude of problems that can be solved.

Modeling and simulation. While the power of symbolic mathematics software is profound, most problems do not have exact solutions. For these tasks, numerical approximations can yield accurate answers when conducted with the right algorithms on sufficiently powerful computers. This has revolutionized the aircraft industry, where design and performance are tested in numerical simulations. Our own faculty use computer modeling to help discover new drugs. Novel materials for better batteries, solar cells, and structural materials have been advanced through numerical modeling. Computer models are often faster and cheaper (and for some applications safer) than conducting traditional experiments, and can be used to guide where real experiments are needed. Techniques of

computer modeling in certain life sciences are so well developed that new specialties and programs of study and research have evolved, such as bio-informatics and bio-mathematics.

Importantly, even though computing and mathematics are behind all modeling, modeling is not limited to engineering, medicine, or other hard sciences. Modeling has applications across the modern university. Business students use process modeling and simulation to refine almost every aspect of a business and define ways and means of long-term sustainability. (Indeed, business process patents, based on computer modeling, are among the "hottest" and most valuable forms of intellectual property.) Legal scholars, economists, and political scientists use statistical and mathematical models to map the facts of a case and derive the legal rules of judicial decisions, and more strategically to show how the economic effects of a given legal rule depend on the local and global interaction of a variety of actors with the capability to evolve. Computer modeling is helping us to understand the most challenging aspect of the study of language, which is how language is acquired. In truth, computer modeling increasingly reaches the core of every academic discipline and pursuit.

Digital Humanities. The evolution of digital humanities has led to the emergence of at least two trends that impact research and teaching in the Humanities: shifting epistemologies and understandings of what constitutes knowledge, and increasing online publication of primary source material and other archived data for humanities research, teaching and collaboration. Digital humanities reflects, engages and examines the impact of technology on the humanities, and explores issues in humanities research made possible by technology, such as open access to materials, the digitization of cultural heritage materials, digital libraries, data mining, emerging modes of publication and writing, visualization, and digital reconstruction.

New creative tools and media. Digital arts began with the documentation of work and digitization of materials, but today go far beyond that. Today, digital media offer new platforms for creative expression within the visual arts, music, theater, dance, film, and creative writing. In the next five to ten years, we will see increasing use of digital media to document work done in these areas, as part of the products created by those in these fields, and in the methods of disseminating these works. Digital art, as an emerging area of work, is still being negotiated. Practitioners and scholars are still learning how to best manage these projects, developing standards for artistic products, determining how to disseminate these new types of information, and thinking about how to approach archiving and preserving content in long lasting formats.

The visual arts are impacted by new tools and interfaces. Digital artistic experimentation takes place in animation, virtual reality environments, and graphical interaction. Digital media allows for three dimensional visualization and interactive technologies as part of the artistic product. Music has also been impacted by the digital arts through new tools to enable recording as well as sound editing software. In addition to this, composing software can play works for the composer as they are being written. Synthetic instruments have been created using computing technology. Incorporating music into other art forms, digital media enables rich audio visual environments. Theater has always been influenced by technology, in special effects and supporting systems for performance. New technologies allows more to be incorporated into theater work. At Wake Forest University, we have seen the impact of digital media on dance, when three dimensional models interacted with live dancers in performance. In addition, motion capture allows dancers to continue working with a dance after its completion in new formats. The technology to record, edit, and produce video has also become much more accessible in recent years. In the area of creative writing, a Wake Forest class has explored how technology impacts writing, and many creative writers make use of the flexibility of the online environment with hyperlinked text and graphically designed interfaces.

As digital media has impacted the arts, the same technologies have impacted the scholarship that takes place around art objects. As print media declines, and online media increases, we witness a changing platform for artistic criticisms. Some in this field point out that many social media venues, such as blogs or reviews on sites like Amazon, offer more opinion and are less substantial than the art reviews of the past in scholarly journals or publications such as the *New York Times Review of Books*. However, the same technologies that may detract from critical scholarship enable new ways of discussing art. For example, Alexander Street Press offers a database of theater works that allows users to link to a specific scene or segment of video for critique or citation. Many Websites are making it easy to embed actual works into the text of another site, enabling reviewers to point to specific aspects of the work and create a multimedia experience within their review.

7. INSTRUCTIONAL DESIGN

Wake Forest University has historically provided support for the use of instructional technology. The current support infrastructure centered around the departmental ITG support, ZSR Library training, and service desk assistance was developed for the Plan for the Class of 2000. This system is unusual among higher education institutions, placing ITG support within departments to provide technology support beyond standard help desk questions, and distributing other types of support to other units on campus.

Instructional technology support often means working with software and hardware beyond the standard load, in support for specific academic needs. This work, depending on the skill level of the individual ITG or ITA, may extend to the use of technology in the classroom, and providing support for technological issues. This type of work is technical in nature, focusing on the technology requirements that faculty specify.

Instructional Design is a distinct area of work that is separate from instructional technology. Instructional Design often builds on the technologists' skill set and extends to educational theory and pedagogical design. As a profession it has its own credentials, associations, and professional development opportunities.

An Instructional Designer works with faculty to develop the pedagogy for their class. This means that in addition to understanding the technology tools that might enhance and support class work, the Instructional Designer understands good teaching principles, educational theory, and other pedagogical concepts. An Instructional Designer can do anything from work with a faculty member to improve the assessment value of an individual assignment to scaffolding a course and helping to restructure it to be better. Some Instructional Designers develop modules for classes. A typical example of this would be the creation of an online tutorial in which the Instructional Designer works with the faculty member to understand the content to be conveyed by the object, develops the assessment plan, and works with technologists and coders to develop a module the professor can then use in class.

Faculty members are expected to be experts in a number of areas: content, research methods, and instruction. They know the information students need to learn in their classes and understand how the content fits into the larger understanding of the field. With all these demands on their time, some faculty do not stay as current in recent pedagogical developments. Instructional Designers are instruction experts. The very nature of their profession requires that they stay current in pedagogical developments and educational research. These professionals can help faculty package the content in a way that is most effective for student learning.

Wake Forest University has historically focused on instructional technology, without providing instructional design support. Some ITAs have gained instructional design skills, though it is not part of their job duties. The ZSR Library

created an instructional design position in 2007, which works with librarians on instructional design issues and academic faculty on incorporating library provided instructional technology into their courses.

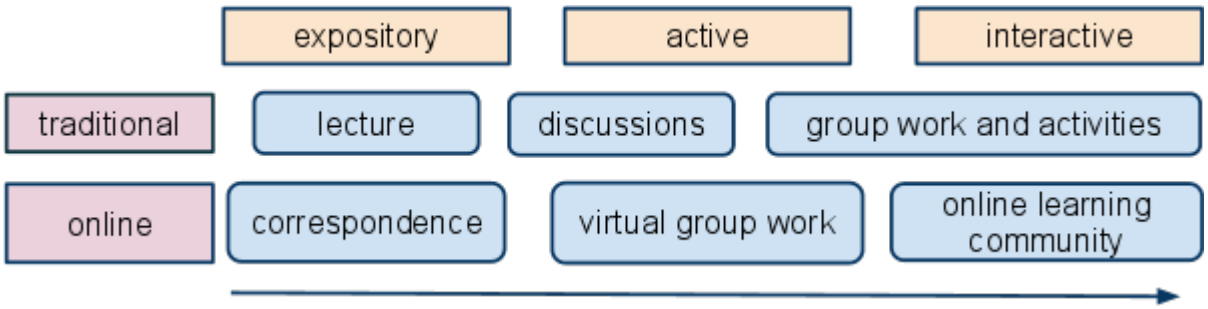
With a move to e-learning, it will be particularly important to provide instructional design support to Wake Forest University faculty. Faculty have not had the opportunity to teach in an online environment, and the pedagogical considerations can be quite different from classroom teaching. Instructional Designers with a specialty in online learning can provide some of the support necessary to enable the transition to electronic learning environments.

8. ONLINE EDUCATION

Online education can mean a number of things. At its most basic level, online learning is the inclusion of mainstream educational technologies such as PDF documents and PowerPoint as part of traditional teaching. Online education can also mean a blended approach involving more technology in a course to a hybrid class that meets in person as well as virtually. Many people associate online education with its most extreme position, the distance education class that is taught entirely online.

Throughout this report, whenever we have addressed online education, we have referred to the use of technology as a way to enhance traditional education. However, it is worth noting that distance education, as a component of online education, is a fast growing sector of higher education. Students participate in distance learning both at a distance as well as participate in "distance" learning courses at their local institution. The rise in the popularity of distance education classes is due to a number of factors. Students choose to enroll in distance learning classes due to travel costs, the lack of availability of certain courses at their own institution, the need for a flexible schedule due to family or work, or the ability to participate in class at times of day that they are best able to learn (Matthews, 1999).

Within the specific field of distance education, there is a spectrum of approaches. Some of the poorest learning environments are those online courses that are nothing more than a list of documents to read, standardized assignments to complete, and little interaction. Some of the best environments are found with skilled instructors creating a learning community with their students. These classes might make use of synchronous video, in depth discussion forums, well structured group work, and meaningfully created assignments. As with any teaching, the quality of the learning environment varies by instructor. A rich distance learning environment creates a sense of community among participants, significant discussion, and close relationships with professors.



Wake Forest University offers a personalized, interactive learning environment; any online instruction would need to mirror this method in course design.

ONLINE LEARNING AT WAKE FOREST UNIVERSITY

Enhanced Classes. Since the ThinkPad initiative, Wake Forest University faculty have shown widespread adoption of technology for teaching both in and outside of the classroom. Some examples of enhanced classes include:

- Including a course Website or Blackboard
- Using blog software as a more flexible learning management system
- Demonstrating work in a hyperlinked environment to illustrate points and concepts
- Experimenting with wikis as collaborative space for students to work
- Incorporating online primary resources or born digital documents into course material
- Integrating Facebook pages into their courses for discussion and ways to share information with students
- Creating supplemental video lectures
- Assigning video-based projects

All of these enhancements have been included in traditional courses with regular meeting times, standard methods of sharing information, and the typical information students were expected to learn. In some cases involving blogs or Facebook, the tool was designed to facilitate community among the students. In other cases, such as the video projects, the assignments encouraged the students to spend more time with the content and get more involved in the creation of their final product.

A Blended Course. Professors Earl Smith and Angela Hattery's Sociology course *Social Stratification in the Deep South* has made use of significant technology over the past two trips. Students have used blogs, Facebook, and Twitter to communicate about their experiences with those who follow along vicariously. The course has also made use of Google Maps, a wiki, and video to further document the learning process. These tools enable students to reflect on the content in formats familiar to them as well as share their learning process and outcomes with those at a distance.

Distance Education. Steve Nickles has experimented with distance education in the School of Law, making presentations to lawyers and judges through Internet audio broadcasts and teaching law students--synchronously and asynchronously--who are located around the country and world. Some of the law classes are real-time, two-way video casts. Sitting in his office on the third floor of Worrell, Nickles sees and hears the students sitting thousands of miles away; and they see and hear him and each other. These “distance” classes proceed exactly as his regular, “live” courses in the first floor classrooms of Worrell. Nickles also uses distance technologies to reverse the flow, bringing judges, lawyers and other experts to his Wake students.

In the Fall 2009 semester, the same technologies allowed Nickles and federal judges in other states to begin a judicial clerkship program for Wake Forest University law students. These students perform the same work for the judges as judicial clerks working in residence from the judges’ chambers. From a “distance,” the Wake law students access case files, annotate the judges’ dockets, write briefs, “attend” hearings and trials, and “meet” with the judges and other judicial staff on a regular basis, without ever leaving Winston-Salem. Lessons learned from such experiments will help university faculty discover those aspects and technologies of distance education and learning that bolster our traditional ways, goals, and values.

The above cases illustrate the spectrum of online learning at Wake Forest University. Though Wake Forest follows a traditional education model, many professors enhance their teaching with the use of a learning management system, traditional educational technologies such as Word or PowerPoint, discipline specific software, and more experimental technology such as social software or digital multimedia. However, when looking toward the future it will be important for us to consider the introduction of distance learning classes for our community. Wake Forest University values high faculty engagement with their students. The University believes in the value of the interaction of students with faculty and with each other. With enhanced collaborative and communications software, it may be possible to provide the richness of a Wake Forest education in an environment that is partly or mostly distance education. If the University chooses to pursue distance education, it will be important to note that teaching in an entirely online environment is a very different experience from the traditional teaching that a majority of Wake Forest University professors have developed expertise in performing, so any faculty interested in teaching a fully-online course would need additional training and support as they learn about instruction in this new environment. In addition, resources would be required to train faculty and support staff. Faculty would also need release time to create their online classes, and a period of several years to adjust to this new style of teaching.

THE STATE OF DISTANCE EDUCATION

A recent report published by the U.S. Department of Education on online learning explored four key issues:

1. How does the effectiveness of online learning compare with that of face-to-face instruction?
2. Does supplementing face-to-face instruction with online instruction enhance learning?
3. What practices are associated with more effective online learning?
4. What conditions influence the effectiveness of online learning?
   (Means, et al, 2009)

Consistently, the findings were that online learning can offer equivalent, or better, educational opportunities when compared to traditional face-to-face instruction. Some key findings from the report include:

- Students who took all or part of their classes online performed better, on average, than those taking the same course through traditional face-to-face instruction
- Most of the variations in the way in which different studies implemented online learning did not affect student learning outcomes significantly
- The effectiveness of online learning approaches appears quite broad across different content and learner types
- Blended and purely online conditions implemented within a single study generally result in similar student learning outcomes
- Online learning can be enhanced by giving learners control of their interactions with media and prompting learner reflection (Means, et al, 2009)

POSSIBILITIES AT WAKE FOREST

Distance education faces challenges at a traditional institution such as Wake Forest University. The Wake Forest culture values the rich community that has been fostered by face-to-face interactions among students, faculty, and staff. However, online learning can be used to to further that community. As such, many faculty have sought out ways to do so in their classes. Currently, faculty can turn to the Teaching and Learning Center, their ITGs, or the Library for help integrating technology into their teaching. However, an instructor looking to move their teaching into the online realm would benefit from additional resources as these units would be too taxed to support any significant shift to online teaching.

Despite these challenges, Wake Forest University also would gain some significant opportunities if it were to take this step. Students in intentionally designed distance learning classes learn well and can form close relationships with their professors and peers. In addition to this, as much of the work force moves to using Webinars and online training for continued professional development, our students would be familiar with this style of learning and better prepared to take advantage of these opportunities once they have graduated.

The most significant opportunity for Wake Forest University is in the pioneering work that the University could do in this realm of education. Wake Forest University could be in a position to define what ideal distance education looks like, similar to the way Wake Forest is defining another emerging realm: the collegiate university. Starting work in distance education at this point would mean that the University could benefit from learning the established best practices that others have determined up to this point. However, it is still early enough in the world of distance education that Wake Forest is not so far behind that it would be impossible to catch up, something that might become true if we continue to avoid participation in this aspect of higher education.

Finally, Wake Forest also has the opportunity to strengthen and advance its commitment to public scholarship. Creative use of new technologies will enhance public scholarship by providing Wake Forest faculty greater means by which to inform, educate and impact the general public as well as specifically targeted communities outside the university.

VI. CONCLUSION

As the Committee deliberated throughout the year, it became apparent that trying to predict changes in technology and information was a moving target. No one could have foreseen the changes in the last 10 years. Google was in its infancy in 1999, Facebook was created in 2004, and Twitter in 2006.The consistent theme to which the Committee kept returning was the fact that in order to be ready for the next big thing, whatever that thing might be, Wake Forest needs to invest in a technology infrastructure and environment that will enable the university to create and adapt innovative and emerging technologies wherever they are found. This infrastructure must include hardware and software capabilities, as well as physical facilities and perhaps most importantly, skilled faculty and staff to provide the guidance, training, and support to encourage innovation at all levels. The committee concluded that we cannot wait for a single "winner" or a possible successor to the laptop to emerge. These various infrastructure elements all bring value to student learning and faculty scholarship, and unless we actively explore and exploit them we will deny our current students their benefits and fall behind in understanding of the power and application of emerging technologies.

The current technology support landscape at Wake Forest is distributed across a number of units including

Information Systems, the Libraries, and the Instructional Technology Group. Lately, the Teaching and Learning Center has included technology topics in its pedagogical offerings. This distributed approach has led to a certain amount of duplication and gaps in the services available to faculty and students. If the distributed model is to continue, a higher level of coordination and communication is required. The Committee recommends formation of a Future Technologies Group (FTG) to foster coordination of academic technology support by staff in Information Systems, the Instructional Technologies Group, the Libraries, and the Teaching and Learning Center. With members drawn from each of these groups, the FTG will inform faculty and the CIT of coming technologies and respond to faculty needs and interests. The FTG will be the forum for communication and coordination of academic technology initiatives, unleashing the full potential of the skills embodied in these groups.

The Committee views the STARS program as one of the most successful vehicles used on campus for expanding the effective use of technology. It combined individual help, incentives, and a requirement to share lessons learned in a fair on teaching with technology. Whether through a revived STARS or another program, we see these elements as critical.

The Committee concludes that Wake Forest University must keep leadership in technology and information as a strategic goal with commitment at the highest levels. Universities that do not provide a rich, supportive environment enabling their faculty and students to innovate in technology and information will inevitably decline. Wake Forest must make the commitment to technology infrastructure, facilities, and staff that will facilitate and encourage an innovative teaching and learning environment and provide new avenues for creative and scholarly inquiry. Not to do so would mean a lesser Wake Forest.

APPENDICES:

1. COMMITTEE MEMBERS

Rick Matthews, Associate Provost for Information Systems and Chief Information Officer, Co-Chair

Lynn Sutton, Dean, Z Smith Reynolds Library, Co-Chair

Anne Bishop, Director, Application Development and Deployment, Information Systems

Ann Cunningham, Associate Professor, Education

Darcy Delph, Wake Forest Fellow, Information Systems

Paul Escott, Reynolds Professor, History

Jacque Fetrow, Dean of the College

Mary Foskett, Associate Professor, Religion

Daniel Hostetler, Undergraduate student

Hugh Howards, Associate Professor, Mathematics

Delphine Masse, Graduate student, Biology

Gordon McCray, Executive Associate Dean, Schools of Business

Steve Nickles, Professor, Law

Brett Noble, Undergraduate student

John Pickel, Associate Professor, Art

Lauren Pressley, Instructional Design Librarian, Z Smith Reynolds Library

Ching-Wan Yip, Instructional Technology Analyst, Physics

2. SWOT ANALYSIS

SWOT Analysis (Strengths, Weaknesses, Opportunities, Threats)

STRENGTHS

1. A technologically literate and interested faculty
2. A corps of skilled and helpful Information Technology Consultants
3. An active and expanding Teaching and Learning Center
4. A laptop for every student and faculty member with an extensive load of relevant software
5. A strong computer infrastructure and staff
6. Well-equipped classrooms
7. An established and respected Committee on Information Technology
8. A legacy of involvement in major decision-making by faculty about technology
9. Strong support among students and stakeholders for maintaining a high profile in technology
10. A history of various successful initiatives and tactics in ThinkPad initiative
11. Experience designing applications for smart phones
12. Lower cost Internet connectivity than most universities via NC-REN
13. IS reporting to the Provost helps protect the academic mission as an IS priority
14. Strong external reputation as a technology leader positions WFU for grant support
15. Unified platform makes it easy to provide campus wide services such as drive encryption
16. Capable network infrastructure
17. Innovative, skilled, and helpful library staff
18. Library resources/collections emphasis on emerging formats such as electronic journals and film/media collection.
19. Library spaces are heavily used at peak times
20. Library offers multiple ways to access services
21. LIB100/200 information literacy classes are accepted and supported by faculty and popular with students
22. Library serves a substantial role in technology training for students and faculty
23. Library is a leader in academic use of emerging technologies
24. Library consortia maximize library collections and access to information at reasonable cost

WEAKNESSES

1. Lack of a sense of urgency for undertaking new ventures
2. Limited facilities for video-conferencing
3. Tight budgets
4. Perceived mismatch between what many students need to learn and what attracts them in current technology
5. Wide disparity among faculty in skill levels, which breeds caution and timidity
6. Disparity in disciplinary openness to digital scholarship and teaching could present barrier to faculty adoption
7. Disparity in knowledge of discipline-specific applications and lack of resources to explore

8. Absence of important strategic partnerships (such as we had with IBM)
9. Sense among faculty that its role in decision-making is diminishing
10. Only limited sharing of pedagogy and lessons learned from technological initiatives
11. Lack of clarity in responsibilities and insufficient coordination of all technology support -- IS, ITGs, Library, TLC; faculty unsure of the right person to ask for the right thing
12. Demands on faculty time leave little room for experimentation with technology
13. Absence of incentives and rewards for faculty who invest time in technology
14. Absence of a program such as the STARS program means less help and fewer opportunities to share
15. Need for more support for instructional technology -- current support is inconsistent
16. Lack of institutional structures (including architectural design) to lead us where we need to go in technology
17. Not fully taking advantage of the resources we have
18. Traditional physical structures that make it difficult to teach in new, better, innovative ways. (The traditional classroom with fixed seating does not support interactive learning)
19. Graduate students lack techno-equity with undergrads
20. Lack of understanding and experience with online learning
21. Library resources/collection does not meet research needs of a major university
22. Library lacks adequate classroom, meeting, and programming space
23. Library learning spaces need updating and expansion
24. Library building infrastructure not functional: heating, cooling, plumbing
25. Library's original building design is now a barrier to effective resource organization
26. Library services are limited based on funding restrictions
27. Lack of full coordination between curriculum and information literacy program

OPPORTUNITIES

1. Chance to define educational uses of technology in a distinctive Wake Forest manner
2. Opportunity for Wake Forest to build on reputation of previous technology initiative
3. Opportunity to build on the high level of technological literacy of the student body
4. Chance to increase contacts of Wake Forest faculty with influential scholars elsewhere
5. Opportunity to reinforce dedication to teaching
6. Opportunity to strengthen tools for research
7. Opportunity for faculty to learn from skilled faculty colleagues
8. Capable network infrastructure provides opportunity for a variety of online video and online learning experiences
9. Chance to do cutting edge work in one's discipline
10. Possible cost savings depending on financial model, building on video conferencing
11. Improved service by relocation of service desk to the Bridge and unification with Library
12. Success with technology innovation can enhance academic reputation
13. Connectedness with international houses could enrich on-campus courses, seminars and meetings with international leaders/scholars/experts
14. Opportunity to deliver innovative curricula in an innovative way based on sound pedagogy
15. Opportunity to prepare students who have a thorough mastery of tools for communication and collaboration and outstanding technological skills
16. Opportunity to strengthen and maintain life-long relationships with alumni base

17. Opportunity for Wake Forest to sustain learning communities beyond graduation
18. Technological maturity sets the stage for openness to taking new directions with technology
19. Teaching and Learning Center expansion can support innovators disseminating their discoveries across campus
20. Library can create community spaces for programming
21. ZSR Library can further synergies and interrelationships with other WFU libraries

THREATS

1. Wake Forest seen as falling behind in competition for institutional leadership in technology innovation
2. Failure to sustain support for technology will result in a loss of our reputation as a technology leader
3. Financial stringency may hinder innovation and limit skilled support
4. Adapting to new uses of technology may slow the pace of scholarly achievement
5. Faculty may divide between high-end users and resisters
6. Less thoughtful use of technology may not aid intellectual development
7. Danger that any new technology effort may get lost among many other initiatives
8. Misunderstanding and lack of understanding of online education may cause us to miss opportunities to best educate our students
9. More economically diverse student body may encounter the digital divide among incoming students
10. Some disciplinary fields and external reviewers may not recognize innovative scholarship as valid "research"
11. Without the right people with the right skills spending dedicated time on where we need to go, we will miss opportunities or make bad decisions
12. The widening digital divide between faculty and science may not encourage faculty to invest the time to learn new technology and teaching methodology
13. Not recognizing how students' technological skills need to be shaped and expanded by faculty
14. Faculty not recognizing the power of new technology tools and better teaching methods and investing the time required to take advantage of these
15. Unless the library adapts collections/services/roles it may cease to be the intellectual heart of the university
16. Copyright restrictions are a threat to accessing information
17. Emergence of new information environments is a threat to the status quo; library must be prepared with collections, systems, and services to respond to new information seeking paradigms

3. RESOURCES CONSULTED

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