

## Possible Futures for the Research Library in the 21st Century

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**ABSTRACT.** *We live in a time of great change, an increasingly global society, knitted together by pervasive communications and transportation technologies and driven by the exponential growth of new knowledge. It is a time of challenge and contradiction, as an ever-increasing human population threatens global sustainability; a global, knowledge-driven economy places a new premium on workforce skills through phenomena such as off-shoring; governments place increasing confidence in market forces to reflect public priorities even as new paradigms such as open-source technologies challenge conventional free-market philosophies; shifting geopolitical tensions driven by the great disparity in wealth and power about the globe, national security, and terrorism. (Friedman, 2005) Yet it is also a time of unusual opportunity and reason for optimism as these same technologies enable the formation of new communities and social institutions, better able to address the needs of our society.*

**KEYWORDS** *library of the future, information technology, cyber-infrastructure, metauniversity*

The information and communications technologies enabling the global knowledge economy—so-called *cyberinfrastructure*, the current term used to describe hardware, software, people, organizations, and policies—evolve exponentially, doubling in power for a given cost every year or so, amounting to a staggering increase in capacity of 100 to 1,000 fold every decade (Atkins, 2003). It is becoming increasingly clear that we are approaching an inflection point in the potential of these technologies to radically transform

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knowledge work. To quote Arden Bement, Director of the National Science Foundation, "We are entering a second revolution in information technology, one that may well usher in a new technological age that will dwarf, in sheer transformational scope and power, anything we have yet experienced in the current information age." (Bement, 2007)

Rapidly evolving information technology has played a particularly important role both in expanding our capacity to generate, distribute, and apply knowledge. This technology is evolving very rapidly, linking people, knowledge, and tools in new and profound ways. It is driving rapid, unpredictable, and frequently disruptive change in existing social institutions. But since information technology can be used to enhance learning, creativity and innovation, intellectual span, and collaboration, it also presents extraordinary opportunities as well as challenges to an increasingly knowledge-driven society. And it is dramatically transforming the character and role of the research library and its host institution, the research university.

### THE NATIONAL ACADEMIES STUDIES

It was just such concerns that stimulated the National Academies to launch a major project to understand better how this technology was likely to affect the research university. (Duderstadt, 2003) The premise of the study was a simple one: The rapid evolution of digital technology will present many challenges and opportunities to higher education in general and the research university in particular. Yet there was a sense that many of the most significant issues are neither well recognized nor understood either by leaders of our universities or those who support and depend upon their activities. The first phase of the study was aimed at identifying those technologies likely to evolve in the near term (a decade or less) that might have a major impact on the research university and examining the possible implications of these technology scenarios for the research university.

The first finding was that the extraordinary pace of information-technology evolution is likely not only to continue for the next several decades, possibly even accelerating. Hence, in thinking about changes to the university, one must think about the technology that will be available in 10 or 20 years, technology that will be thousands of times more powerful as well as thousands of times cheaper. The second finding was that the impact of IT on the university is likely to be profound, rapid, and disruptive, affecting all of its activities (teaching, research, service), its organization (academic structure, faculty culture, financing, and management), and the broader higher education enterprise as it evolves toward a global knowledge and learning industry. If change is gradual, there will be time to adapt gracefully, but that is not the history of disruptive technologies. As Clayton Christensen explains in *The Innovators Dilemma* (Christenson, 1997), new

technologies are at first inadequate to displace existing technology in existing applications, but they later explosively displace the application as they enable a new way of satisfying the underlying need.

While it may be difficult to imagine today's digital technology replacing human teachers, as the power of this technology continues to evolve 100- to 1000-fold each decade, the capacity to reproduce all aspects of human interactions at a distance with arbitrarily high fidelity could well eliminate the classroom and perhaps even the campus as the location of learning. Access to the accumulated knowledge of our civilization through digital libraries and networks, not to mention massive repositories of scientific data from remote instruments such as astronomical observatories or high energy physics accelerators, is changing the nature of scholarship and collaboration in very fundamental ways.

The third finding stressed that although information technology will present many complex challenges and opportunities to universities, procrastination and inaction are the most dangerous courses to follow all during a time of rapid technological change. Attempting to cling to the status quo is a decision in itself, perhaps of momentous consequence.

More recently, the National Academies have extended this effort to involve directly a large number of research universities by creating a National Academy roundtable on information technology and research universities ("the IT-Forum") to track the technology, identify the key issues, and raise awareness of the challenges and opportunities. The IT Forum has also conducted a series of workshops for university presidents and chief academic officers in an effort to help them understand better the transformational nature of these technologies and the importance of developing strategic visions for the future of their institutions.

## THE LIBRARY AS THE POSTER CHILD OF THE IT REVOLUTION

To make these discussions less abstract, the impact of information technology on university planning for libraries was introduced in several workshops. In a sense the library has become the poster child for the impact of IT on higher education. Beyond the use of digital technology for organizing, cataloguing, and distributing library holdings, the increasing availability of digitally-created materials and the massive digitization of existing holdings (e.g. the Google project to digitize and put online in searchable format the entire holdings of major research libraries) is driving massive change in the library strategies of universities. While most of the universities in our workshops were continuing to build libraries, many were no longer planning them as repositories (since books were increasingly placed in off-campus retrievable high-density storage facilities) but rather as a "knowledge commons" where users accessed digital knowledge on remote servers. When

pressed, it turned out that the most common characteristic of these new libraries was a coffee shop. They were being designed as a community center where students came to study and learn together, but where books were largely absent. The library was becoming a people place, providing the tools to support learning and scholarship and the environment for social interaction.

What is the university library in the digital age? Is it built around stacks or Starbucks? Is it a repository of knowledge or a “student union” for learning? In fact, perhaps this discussion was not really about libraries at all, but rather the types of physical spaces universities require for learning communities. Just as today every library has a Starbucks, perhaps with massive digitization and distribution of library holdings, soon every Starbucks will have a library—indeed, access to the holdings of the world’s libraries through wireless connectivity.

In a sense, the library may be the most important observation post for studying how students really learn. If the core competency of the university is the capacity to build collaborative spaces, both real and intellectual, then the changing nature of the library may be a paradigm for the changing nature of the university itself.

Yet the participants in our workshops also raised the very serious issue concerning the preservation of digital knowledge, now increasing at a rate an order of magnitude larger than written materials. Without a more concerted effort for the standardization of curation, archiving, and preservation of digital materials, we may be creating a hole in our intellectual history. Traditionally this has been a major role of the research university through its libraries. There was a general agreement that research universities need to collaborate more on their responsibilities for the stewardship of knowledge in the digital age.

## THE FUTURE OF THE LIBRARY

Librarians have developed over thousands of years valuable methods for acquiring, organizing, archiving, and distributing knowledge in many forms—from clay tablets, papyrus scrolls, and illuminated manuscripts to books, recordings, films, and today’s multimedia digital assets. Much of this wisdom, many of these fundamental concepts and principles continue to be valued as they are applied to a digital world. The academic library has become a knowledge commons for collective learning. Beyond holding rare and unique records, today’s research library is increasingly viewed as a data repository where data acquisition, curation, organization, maintenance, and distribution have become equally important missions.

Yet not only will the knowledge assets of libraries rapidly merge in cyberspace, but furthermore through open education and knowledge

philosophies, they be increasingly accessible by anyone with Internet connectivity and augmented by powerful tools—sophisticated search engines, collectively generated and maintained Wikis, and the digital assets undergirding many of the leading university programs throughout the world. Of particular importance are efforts adopting the philosophy of open source software development to open up opportunities for learning and scholarship to the world by putting previously restricted knowledge into the public domain and inviting others to join both in its use and development (Atkins, 2007). MIT led the way with its OpenCourseWare (OCW) initiative, placing the digital assets supporting almost 1,800 courses in the public domain on the Internet for the world to use. (Vest, 2006) Today, over 400 universities have adopted the OCW paradigm to distribute their own learning assets to the world. Furthermore, a number of universities and corporations have joined together to develop open-source middleware to support the instructional and scholarly activities of higher education, already used by several hundred universities around the world (Moodle, 2007; Sakai, 2007). Others have explored new paradigms for open learning and engagement.

One of the most exciting—and controversial—efforts is the Google Book digitization project in which a number of leading libraries around the world have joined together with Google to digitize a substantial portion of their holdings, making these available for full-text searches using Google's powerful internet search engines. (Kelly, 2006) For example, over 2 million volumes at the University of Michigan have been already been digitized, with our complete 8 million volume library now projected to be online by 2010. While there are still many copyright issues that need to be addressed, it is likely that these massive digitization efforts will be able to provide full text search access to a significant fraction of the world's written materials to scholars and students throughout the world within a decade.

Open source, open content, open learning, and other “open” technologies become the scaffolding on which to build truly global universities—what Charles Vest terms the “meta” university. (Vest, 2006) As he observes, “the incredibly large scale of education world wide; the huge diversity of cultural, political, and economic contexts; and the distribution of public and private financial resources to devote to education are too great.” Instead, Vest suggests that “through the array of open paradigms, we are seeing the early emergence of a “meta university”—a transcendent, accessible, empowering, dynamic, communally-constructed framework of open materials and platforms on which much of higher education world wide can be constructed or enhanced.”

To these developments should be added other emerging characteristics of our times. We all know well the rapid propagation of mobile technology, with over 3.5 billion people today having cell-phone connectivity and one billion with broadband access. Today's youth are digital natives, members of the Net Generation, comfortable with using the new technologies for building

social communities—instant messaging, blogs, wiki's, virtual worlds, Face-Book, MySpace, Wikipedia (which even their professors use). Rather than access the vast knowledge resources provided through the open education resources movement through passive media such as books, this generation access knowledge and build social communities through 3-D virtual reality environments such as Second Life, the World of Warcraft, and Croquet in which all of the senses are faithfully replicated to enable human interaction at a distance.

Imagine what might be possible if all of these elements could be pulled together, i.e., Internet-based access to all recorded (and then digitized) human knowledge augmented by powerful search engines, open source software (SAKAI), learning resources (OCW), open learning philosophies (open universities), new collaboratively developed tools (Wikipedia II, Web 2.0); and ubiquitous information and communications technology (e.g., cheap laptop computers or, more likely, advanced cell phone technology).

In the near future it could be possible that anyone with even a modest Internet or cellular phone connection will have access to the recorded knowledge of our civilization along with ubiquitous learning opportunities. Imagine still further the linking together of billions of people with limitless access to knowledge and learning tools enabled by a rapidly evolving scaffolding of cyberinfrastructure increasing in power one-hundred to one thousand-fold every decade. In fact, we may be on the threshold of the emergence of a new form of civilization, as billions of world citizens interact together, unconstrained by today's monopolies on knowledge or learning opportunities. (Atkins, 2007; Kelly, 2006; Kurtzweil, 2005)

Perhaps this, then, is the most exciting vision for the knowledge resources such as the library and learning organizations such as the university, no longer constrained by space, time, monopoly, or archaic laws, but rather responsive to the needs of a global, knowledge society and unleashed by technology to empower and serve all of humankind.

## WHENCE AND WHITHER THE REVOLUTION

Yet today university today looks very much like it has for decades, still organized into academic and professional disciplines; still basing its educational programs on the traditional undergraduate, graduate, and professional discipline curricula; still financed, managed, and led as it has been for many years. But if one looks more closely at the core activities of students and faculty, the changes over the past decade have been profound indeed. The scholarly activities of the faculty have become heavily dependent upon digital technology—rather cyberinfrastructure—whether in the sciences, humanities, arts, or professions. Although faculties still seek face-to-face discussions with colleagues, these have become the booster shot for far more frequent

interactions over Internet. Most faculty members rarely visit the library anymore, preferring to access far more powerful, accessible, and efficient digital resources. Many have ceased publishing in favor of the increasingly ubiquitous preprint route. Even grantsmanship has been digitized with the automation of proposal submission and review and grant management and reporting by funding agencies. And, as we have noted earlier, both student life and learning is also changing rapidly, as students bring onto campus with them the skills of the net generation for applying this rapidly evolving technology to their own interests, forming social groups, role playing (gaming), accessing services, and learning—despite the insistence of their professors that they jump through the hoops of the traditional classroom paradigm.

In one sense it is amazing that the university has been able to adapt to these extraordinary transformations of its most fundamental activities, learning and scholarship, with its organization and structure largely intact. Here one might be inclined to observe that technological change tends to evolve much more rapidly than social change, suggesting that a social institution such as the university that has lasted a millennium is unlikely to change on the timescales of tech turns—although social institutions such as corporations have learned the hard way that failure to keep pace can lead to extinction. Yet, while social institutions may respond more slowly to technological change, when they do so, it is frequently with quite abrupt and unpredictable consequences, e.g., “punctuated equilibrium”. It could also be that the revolution in higher education is well underway, at least with the early adopters, and simply not sensed or recognized yet by the body of the institutions within which the changes are occurring.

Universities are extraordinarily adaptable organizations, tolerating enormous redundancy and diversity. It could be that information technology revolution is more a tsunami that universities can float through rather a tidal wave that will swamp them. Perhaps we should view the transformation of the university as an evolutionary rather than a revolutionary process. Evolutionary change usually occurs first at the edge of an organization (an ecology) rather than in the center where it is likely to be extinguished. In this sense the cyberinfrastructure now transforming scholarship or the communications technology enabling new forms of student learning and faculty scholarship have not yet propagated into the core of the university. Of course, from this perspective, recent efforts such as the Google Book project take on far more significance, since the morphing of the university library from stacks to Starbucks strikes at the intellectual soul of the university.

It is certainly the case that futurists have a habit of overestimating the impact of new technologies in the near term and underestimating them over the longer term. There is a natural tendency to implicitly assume that the present will continue, just at an accelerated pace, and fail to anticipate the disruptive technologies and killer apps that turn predictions topsy-turvy. Yet we also know that far enough into the future, the exponential character of

the evolution of Moore's Law technologies such as info-, bio-, and nano-technology makes almost any scenario possible. (Kurzweil, 2005)

In this spirit, then, perhaps we should end with a discussion that occurred with the AAU provost's workshop in 2004. While university presidents are reluctant to let speculation about the survival of the university on the table, not so with provosts, who were quite comfortable talking about very fundamental issues such as the values, roles, mission, and even the survival of the university, at least as we know it today. During this discussion it was pointed out during the 19th century, in a single generation following the Civil War, essentially everything that could change about higher education in America did in fact change: small colleges, based on the English boarding school model of educating only the elite, were joined by the public universities, with the mission of educating the working class. Federal initiatives such as the Land Grant Acts added research and service to the mission of the universities. The academy became empowered with new perquisites such as academic freedom, tenure, and faculty governance. Universities increased 10-fold and then 100-fold in enrollments. The university at the turn of century bore little resemblance to the colonial colleges of a generation earlier.

The consensus of our discussions with the provosts suggested that we are well along in a similar period of dramatic change in higher education. In fact, some of our colleagues were even willing to put on the table the most disturbing question of all: Will the university, at least as we know it today, even exist a generation from now? Disturbing, perhaps. But certainly a question deserving of very careful consideration, at least by those responsible for leading and governing our institutions.

Certainly the monastic character of the ivory tower is certainly lost forever. Although there are many important features of the campus environment that suggest that most universities will continue to exist as a place, at least for the near term, as digital technology makes it increasingly possible to emulate human interaction in all the sense with arbitrarily high fidelity, perhaps we should not bind teaching and scholarship too tightly to buildings and grounds. So too, both learning and scholarship will continue to depend heavily upon the existence of communities, since they are, after all, high social enterprises. Yet as these communities are increasingly global in extent, detached from the constraints of space and time, we should not assume that the scholarly communities of our times would necessarily dictate the future of our universities. Even in the near term, we should again recall Christensen's *innovators's dilemma*, as these disruptive technologies, which initially appear rather primitive, are stimulating the appearance of entirely new paradigms for learning and research that could not only sweep aside the traditional campus-based, classroom-focused approaches to higher education but seriously challenge the conventional academic disciplines and curricula. For the longer term who can predict the impact of exponentiating technologies on social institutions such as universities, corporations, or governments,



as they continue to multiply in power a thousand-, a million-, and a billion-fold?

To be sure, there will be continuing need and value for the broader social purpose of the university as a place where both the young and the experienced can acquire not only knowledge and skills, but the values and discipline of an educated mind, so essential to a democracy; an institution that defends and propagates our cultural and intellectual heritage, even while challenging our norms and beliefs; the source of the leaders of our governments, commerce, and professions; and where new knowledge is created through research and scholarship and applied through social engagement to serve society. But, just as it has in earlier times, the university will have to transform itself once again to serve a radically changing world if it is to sustain these important values and roles.

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