Making Knowledge Services

Work in Higher Education

By Donald M. Norris, Paul Lefrere, and Jon Mason

In 2003, *EDUCAUSE Review* published "A Revolution in Knowledge Sharing," in which we suggested that a range of emerging knowledge-focused practices and developments had the potential to enable new sources of value, particularly for higher education:

- Growing interest in knowledge sharing, peer-to-peer (P2P) content sharing, and personal knowledge management
- The emergence of pragmatic, usable "interoperability" standards for reusing content and sharing knowledge across the desktop, local networks, the enterprise, other organizations, and the Web
- Proliferation of for-fee/for-free knowledge partnerships, exchanges, infrastructures, and services, providing access to rich combinations of formal and informal knowledge networks, the Web, and traditional centralized sources of information (e.g., databases, libraries)
- Changing expectations by consumers, including students, regarding the mix of types of knowledge available to them and ways of experiencing that knowledge
- The emerging (and not always justified) view, by students and other consumers, that new and more generous rules apply to the cost, availability, and ownership of knowledge; to the consumers' part in knowledge creation and use; and to their responsibilities regarding copyright

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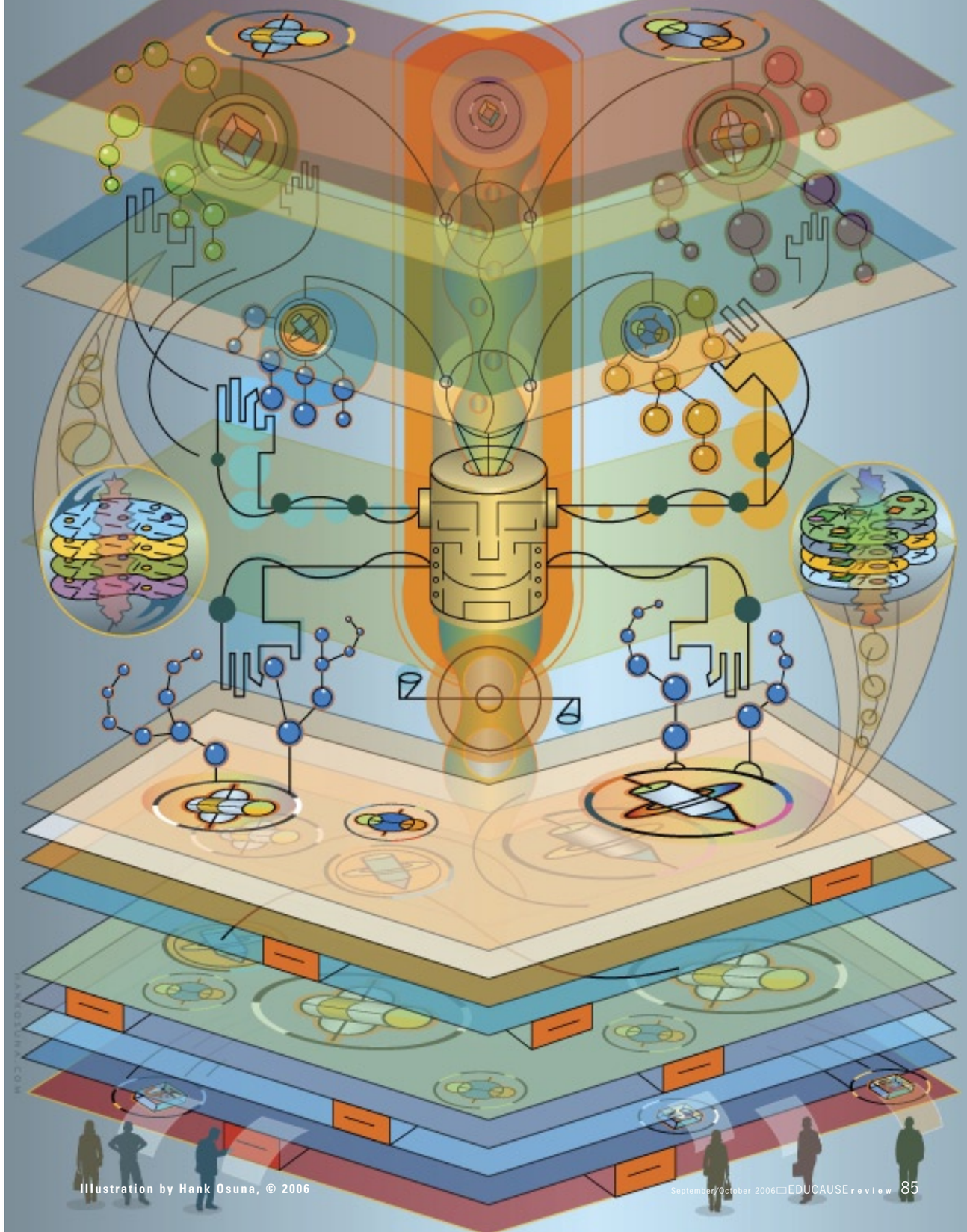

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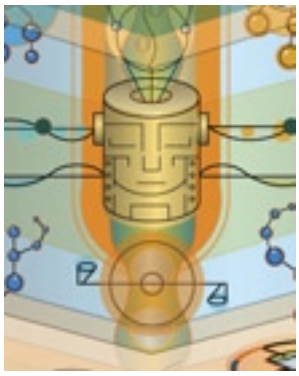


We concluded: "Taken separately, e-learning, knowledge management, and IT have failed to provide strategic differentiation for colleges and universities. But by combining the three in higher education, e-knowledge can avoid suffering the same fate if it is used to change the dynamics of institutional business practices and to create new, knowledge-based experiences, unleashing enhanced value."[1]

Over the past three years, knowledge-based practices have advanced, driving the development of low/no-cost, mass-market tools for knowledge sharing and reducing some barriers to change. The revolution we identified is taking place globally but unevenly. New investors in higher education are developing strategies to exploit the knowledge-driven value propositions. Existing institutions, anxious to maintain their position in a fast-changing world, are also taking notice. The latter are finding that past investments (e.g., in e-learning, knowledge management, and information technology) can indeed live up to the promises made for them, if knowledge sharing as we described is encouraged and used to drive necessary change in technology, services, and culture.

Knowledge Nodes, Networks, and Services

In our earlier work, we used the term *e-knowledge* to describe the many forms of knowledge and how it is shared and utilized in an extensively networked world. The term itself is not important; what it is intended to convey is.

The Nature of E-Knowledge

Several interconnected perspectives on the nature of e-knowledge must be revisited to provide the context for comprehending recent developments in and contributors to knowledge sharing and services.

Content, Context, Community

People make sense of and understand information individually and in isolation. Knowledge is developed from information in the context in which it lives, and its meaning changes in different contexts. As such, knowledge is a social construct. John Seely Brown articulated the fundamental insight that knowledge is created, understood, and shared when three factors combine: content, context, and community.[2]

Knowledge as a Thing and a Flow

Knowledge can be modeled as both a "thing" (e.g., as a resource, a state of understanding, or a rule) and a "flow" (e.g., as an expression of a relationship between the knower and the object that is known). Thought leaders have argued that this seemingly paradoxical nature of knowledge as both a thing and a flow requires that the practice of knowledge management must embrace this complexity fully if it is to deliver meaningful results.[3]

Complementarity of Tacit and Explicit Knowledge

Knowledge exists in tacit (subjective) and explicit (objective) states. Tacit knowledge is carried with us in the way we do things, as know-how. It can be revealed via processes such as mentoring or through back-and-forth, tailored explanations that occur in conversation. Explicit knowledge is shared through periodic reviews of innovations and/or discoveries, resulting in updated procedural manuals, modified goals of R&D departments, and/or databases shared by users of electronic laboratory notebooks. Tacit and explicit states are complementary and symbiotic. Ikujiro Nonaka observed, "Only when explicit and tacit knowledge interact can innovation occur."[4]

From Knowing What to Knowing If

In an earlier publication, we modeled knowledge as having seven primary concerns: who, what, when, where, why, how, and if.[5] All seven of these concerns are candidates for custom e-services. Search services such as Google already deliver rich results, but they are focused mostly on search results that relate to who, what, when, and where and not to why, how, or if, which could have even higher value to users. Specialist or niche Web sites are now beginning to specialize in "know-who" services (e.g., ZoomInfo), and plenty of Web sites provide useful "know-how" information (e.g., BusinessKnow-How). Likewise, the needs of strategic planning will likely stimulate the emergence of "know-if" services over time. In combination, such sites could help to fill the gap between knowing what needs to be done and taking action that delivers results.

Knowledge Nodes and Networks

Yet another way of expressing the duality of knowledge is by considering the nodes and networks that support it. Knowledge nodes are represented by the collections of explicit knowledge captured in knowledge/learning object repositories, podcasts, learning management systems, academic exchanges, and such. On the other hand, knowledge networks are the pulsing, dynamic social interactions that can generate tacit knowledge and accelerate the flow of knowing. They occur in formal and informal communities of interest and practice and in free-range forms in individual blogs, wikis, and social networks. As the interplay between nodes and networks develops, clusters of high value will form and disperse as needed.

E-Knowledge Commerce

Transactions based on the sharing of e-knowledge can be described as *e-knowledge commerce* when commercial interests apply. Three years ago, e-knowledge commerce was focusing on how to expand and eventually monetize the sharing of explicit learning/knowledge objects in knowledge repositories and even in cross-repository marketplaces and exchanges. Commercial progress on this front has been slow, largely due to digital rights management issues raised by publishers and holders of current intellectual property intended for sale or license. But in the revolution in knowledge sharing now under way, both explicit knowledge objects and the conversations/interactions leading to tacit insights can be exchanged for free (as part of the pervasive, emerging knowledge commons) *or* for fee. Open (freely published) content is becoming a feasible alternative to paid-for content. A case in point is the growth in popularity of community-authored material (e.g., Wikipedia). Moreover, emerging knowledge services supported by service-enabled architectures

now provide authors and readers with alternative sources of the value-added services that publishers provide to authors (e.g., validation of references, as part of the editing process). Open educational resources, made available for free to noncommercial users, are widely seen as a solution to the knowledge needs of developing countries, but they are achieving traction in developed countries as well. In addition, Creative Commons and Science Commons are also providing ways for authors to create public versions of their intellectual property, consistent with the authors' specific intent.[6] The marketplace for e-knowledge will be sorted out from the bottom up, driven by users' demands and their reactions to the emergent spectrum of e-knowledge offerings and options.[7]

Mapping Knowledge Nodes and Networks

Mapping the dimensions of knowledge and navigating to them is a core competency in dealing with e-knowledge. *Knowledge domains* are the node and network clusters where knowledge resides in particular industries, fields of endeavor, academic disciplines, subdisciplines, or even personal knowledge collections. *Knowledge repositories* are knowledge nodes that house particular collections of explicit knowledge resources and that, where appropriate, provide authorized, authenticated access to the collections. *Knowledge registries* link to the knowledge resources contained in knowledge repositories and provide directory services to them, creating value simply by providing linked access. A new generation of interoperable knowledge repositories and registries is being enabled using SCORM/CORDRA standards.[8] *Knowledge exchanges* or *knowledge marketplaces* have a higher degree of functionality and value than repositories, accumulating knowledge resources from a variety of sources and providing the processes, policies, practices, and rules necessary to support the aggregation of both supply and demand. Finally, a new generation of *e-knowledge portals* provides even greater capability to leverage knowledge nodes and networks, support e-learning, and facilitate e-knowledge.

In our earlier *EDUCAUSE Review* article, we described the constellations of knowledge nodes and networks that were then evolving to create, nurture, and array knowledge resources and experiences. Since that time, these constellations have grown more complex and pervasive. Whereas the focus in 2003 was on knowledge nodes and formal knowledge collections and aggregations, since 2003 the balance has shifted to knowledge networks and tools that have empowered individuals and communities to create, assimilate, and share content as a necessary step toward sharing knowledge. For example, community networks have formed for sharing knowledge through conversations about problems. (The Metafilter community weblog allows unstructured descriptions of problems; the Experts Exchange requires relatively structured descriptions of problems.)

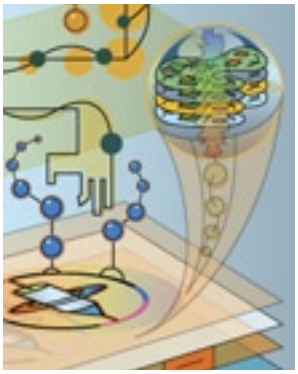


Table 1 summarizes these constellations of knowledge resources and relationships. *Vertical* collections of resources represent knowledge in a particular discipline or subdiscipline. *Horizontal* collections represent a range of disciplines or types of knowledge. We provide greater detail in the article "Mapping Knowledge Nodes, Networks, and Domains."[9]

The Nature of Knowledge Services

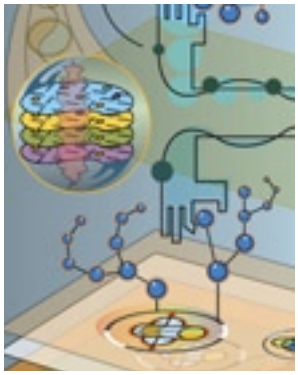
Today's trend in online infrastructure development is to deploy small, flexible applications and/or services that can interoperate with each other in a "loosely coupled" mode. This is a shift from the era of large applications whose specific IT functions were tightly bound to each other. In the current context, knowledge services perform tasks that both use and enable e-knowledge. Examples include a Google search or online authentication services. Web services are the instrument, providing protocols and interoperable interfaces that enable applications to operate seamlessly with one another; they also provide a common technological means for systems integration that all the major IT vendors now support. Developing a broader services-enabled infrastructure is the goal of organizations such as the IMS Global Learning Consortium, as well as of government-sponsored initiatives such as the e-Framework for Education and Research Initiative.[10] Defining knowledge services according to this vision is both a challenge and an opportunity. Defined thoughtfully, those services can provide a way to segue smoothly from a "single point of failure" (a large application) to any one of a range of services with equivalent functionality, created from components that use public-domain methods. This is a way to reduce the impact of newly awarded third-party patents that cut across one's core business, an ever-present threat for all users of software-based systems, from e-mail (e.g., Blackberry) to e-learning (e.g., Blackboard).

Knowledge services can be used to leverage knowledge nodes and networks to create new value propositions. At the low-value end of knowledge-based services are simple "mash-ups" such as adding Google Maps to a college or university Web site: easy-to-follow directions to the campus and bus routes are overlaid on a satellite image of the campus. A more robust and higher-value example is the weaving together of knowledge aggregation services to merge knowledge from different sources (e.g., desktop software, Web services, and social networks), thereby enhancing the value of individual tools and knowledge sources. In both cases (Google Maps and multi-source aggregation), the choice of which services to combine involves substantial what, why, and how knowledge that often is neither made explicit nor shared with users.

Put simply, the trajectory of developments in knowledge nodes, networks, and domains suggests that the balance of creative energy has shifted to open knowledge resources, individually controlled tools and practices, and community-based networks and nodes with social networking capabilities. Further, the adoption of services-enabled architectures is enhancing the capacity to blend and leverage various interoperable services in new ways. Many of these new practices increase the potential value of the knowledge created in, or available to, a college/university, its staff, and their academic disciplines. These elements come together to form the foundation for leveraging knowledge services in higher education.

TABLE 1. KNOWLEDGE NODES AND NETWORKS

NODE/NETWORK	DESCRIPTION	EXAMPLES *NATURE OF RESOURCES*
Global search registries	Search and access to the bulk of Web-accessible knowledge in the world	Google, Yahoo!, Microsoft *Global; horizontal*
Institutional or disciplinary knowledge repositories/ digital libraries	Knowledge repositories/digital libraries created by individual academic institutions or systems	**Institutional :** Ohio State University Knowledge Bank, University of California System eScholarship Repository, ARROW (Australia) *Local or regional; horizontal* **Disciplinary:** Digital Library for Earth System Education (DLESE) *Global; vertical*
Tradebooks and academic publishers	Proprietary digital libraries for tradebook and academic publishing houses; combine textbook intellectual property with other resources; many now include fledgling communities of practice	Emerald, Springer, John Wiley *Commercial; global; horizontal*
Academic content exchanges	Collections of course materials/learning objects, including validated peer reviews; also open content	IVIMEDS, JSTOR, MERLOT Open Courseware such as MIT Open Courseware (OCW) and 50 OCW initiatives in the United States, China, Japan, France, Spain, Portugal, and Brazil *Global; horizontal*
Communities of practice	Groups of practitioners who combine nodes/ networks in particular fields of endeavor to define a practice and knowledge domain	**Institutional/consortial:** The Boston Consortium for Higher Education *Administrative resources; local; vertical* **Commercial enterprises:** IBM, other commercial enterprises *Private; global; vertical* **Federal agencies:** U.S. Department of Defense, ADL Registry *Private; national; vertical* **Professional/trade societies:** Educational Research Service *E-knowledge portal; national; vertical*
Social and gaming communities of interest	Social networks drawn together to share information and build relationships; multi-player gaming and simulation	**Social networks:** MySpace.com, Facebook **Multi-player gaming communities:** Warcraft, poker and other gaming venues **Other interest-based communities:** Friendster, Flickr.com, LinkedIn, Tribe, ZoomInfo *Global; horizontal*
Individual knowledge tools, networks, and services	A plethora of tools for individuals to manage personal knowledge and networks	**Directories of personal files:** accessible by PC, PDA, other devices **Personal entertainment devices:** downloads of music, knowledge resources **Wikis:** create online resources **Blogs:** personal Web publishing system **E-portfolios:** personal record of competencies, accomplishments, knowledge resources **ASP services:** Backpack, ClientConnect, KW Professional *Global; horizontal*



The Importance of Knowledge Services

Even though higher education is a knowledge industry, colleges and universities do not leverage knowledge and knowledge services as intensively as do today's leading commercial enterprises in customer services industries. An excellent example is Amazon.com, which repeatedly refines its services to leverage its knowledge of what adds value for prospective and existing customers. Amazon moves from offering weak forms of personalization (noting that "some people who bought this book also bought these other books"), to including a community dimension more explicitly (providing peer review), to trusting known customers with access to samples of the products (allowing customers to search inside the text of a book), to identifying the things that make a book unique and are likely to be of particular interest to certain people. In general, using a world-class service from a third party is more productive than using scarce internal resources to develop and run a second-class alternative. Consequently, many educational institutions are choosing not to invest in R&D in this area; instead, they are linking to commercial suppliers such as Amazon. This releases resources that give higher education the potential to leverage its first-generation knowledge services to create new value propositions.

To illustrate, the first colleges and universities to use Google Maps (or a similar service) found that the service was a useful differentiator that enhanced their image, albeit at a micro level. But awareness of the value of a mapping service spread quickly. Now, institutions routinely have mapping services on their Web sites. Generalizing, service innovators soon get copied and have to reinnovate to stand out. One way in which innovative colleges can reduce the risk of copycat services is to exploit data not available to competitors (e.g., internal data) and then analyze that data in ways that are not apparent to competitors (e.g., using customer relationship management software to mine past interactions with applicants). Another way is to exploit external data but not reveal sources (e.g., mining unnamed social networking sites to identify students' interests that are relevant to enrollment decisions and other student life issues). Yet another way is to do both: exploit a hard-to-emulate combination of internal and external data, providing people with highly valued services.

One example of a potentially valuable service (offered by for-profit educational enterprises) analyzes patterns of college attendance, engagement, and academic performance. The service offers early and timely warning of students who are at risk of dropping out, so that intrusive, remedial action can be taken to help students maintain their career path and to enable the institution to retain students who are in good standing and to maintain enrollment-based revenues. Another valuable service helps students to maximize the grades they achieve on written assignments by introducing a formative feedback system based on a combination of "how am I doing compared to past students?" feedback (a data-mining service) and specific feedback on their draft, using an automated text-analysis service based on tools such as latent semantic analysis. Such a service would move the focus of assignment marking away from current preoccupations with spotting plagiarism.

Having identified the needs of prospective students, a college or university can meet those needs faster, better, and cheaper by combining knowledge services. Thus, an institution that receives a query about campus life might link the prospective student directly to an appropriate place in a third-party social networking Web site in order to connect the prospective student to current students or to alumni. Stepping up in complexity and value, the insitution could mine its data on frequently asked questions (FAQs) and deploy appropriate combinations of knowledge services. Suppose, for example, that its top four FAQs concern (1) the cost of air travel to the college, (2) the safety of neighborhoods, (3) the availability of part-time work, and (4) details on local events. Knowledge services could address all four:

1. *Air travel.* At least one "mashup service" on the Web links data from multiple sources (airline routes, schedules, fares) to highlight lowest-cost travel options. Extending such a service to link to new types of data would be simple (e.g., linking to data on student discounts or discounts for traveling in a group), as would allowing users to forward the details to friends.
2. *Safety.* The insitution could overlay Google Maps with crime statistics to show problematic routes or neighborhoods and also could overlay campus locations and/or add Web services links that provide discussions or the capacity to annotate.
3. *Part-time work.* The institution could utilize maps to combine location and hiring information made available by employers, employment agencies, and job-related services such as Monster.com, and it could include links to social networking sites where students can find feedback from past or present employees, including other students.
4. *Local events or local suppliers.* Information can be culled from multiple sources (e.g., RSS feeds, as well as iCalendar, iCard, and iReview microformats, which enable users of Web sites to update their own calendars automatically and to make purchases online). Enterprising colleges and universities could add that local information to their Web sites automatically via knowledge services compatible with Google, Yahoo! Local, or Windows Live.

These services would have been prohibitively expensive five years ago. Today, Web-based knowledge services reduce technical and cost barriers to innovation. Higher education can thus combine enterprise-wide technology infrastructure, knowledge-intensive services, and programmatic innovation to deliver fresh value propositions, as seen in the six examples that follow.

Example #1: Fully Leveraged Personal Knowledge Domains

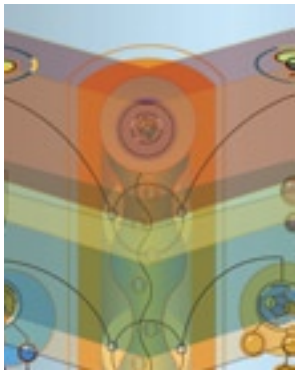
Today, most faculty manage their personal base of knowledge by combining print and digital collections of their own work and of salient work in their field.

Typically, personal knowledge management is a "cottage industry" that is personalized, fragmented, isolated, and not yet scalable. But in many scientific fields, faculty and researchers are facing an unprecedented knowledge explosion, and some see this as a harbinger of things to come in other disciplines.

Colleges and universities could address the management of personal knowledge domains in several ways. First, they could use e-services to amass examples (with proper permissions) of superior practices and personal knowledge bases. Second, they could build on the scientific and industrial contacts of their own scientists and engineers to extend enterprise information systems to integrate with those of sponsors, providing some funding support for enterprise knowledge collaboration. Third, they could make available powerful, enterprise-wide tools that reduce the effort needed for personal knowledge management.

To work effectively at scale, personal knowledge domain management would need to be accompanied by attention to human issues. Institutional policies/processes would need to provide incentives for faculty/researchers to organize, tag, and manage knowledge resources and prepare them to be shared and leveraged. This proposed knowledge ecosystem could include an e-knowledge portal weaving together an institutional repository, an e-portfolio, P2P architectures, and participation in social networks, communities of practice, and other relationships. The enterprise portal toolkit could include services such as high-level simulation and visual representation of complex data sets.[11]

Progressively and over time, individual faculty/researchers could use these knowledge nodes, networks, and services to define and shape their personal knowledge domains and map/tap their relationships to other knowledge domains of interest. Such knowledge would become part of larger, disciplinary knowledge aggregations, knowledge marketplaces and exchanges, and social networks. Faculty/researchers would also participate in formal and informal communities of practice in their academic disciplines using P2P architectures to accelerate the flow of knowledge creation, sharing, and recalibration.



Over time, artificial intelligence (AI) tools could be incorporated into personal repository/e-portfolio tools. In current prototypes, an AI-enabled agent/avatar serves as a sort of "digital clone" of an individual's knowledge domain. The agent/avatar can move about the larger knowledge domain, sharing insights about what it knows with the digital clones of other faculty/researchers and providing feedback. These practices could dramatically increase the personal bandwidth of individuals, as well as their capacity to engage in shared knowledge networking.

What are the value propositions justifying investment? Over time, the capacity to launch, manage, and leverage these personal knowledge domains could be a key differentiator for institutions attempting to attract top faculty and researchers. These personal knowledge domains would also contribute to the productivity and visibility of faculty/researchers as individuals and collectively.

Example #2: Lifelong Personal Knowledge Profiles

Today's portfolio tools represent the adolescence of what could ultimately be among the most transformative knowledge-intensive services in education. Current e-portfolio and related assessment products (and the generation of open-source portfolio tools now under development) could be leveraged to create a lifelong instrument for personal human-capital development. The capabilities of these tools can be expanded by exposing their components as knowledge services (capable of being repurposed by users through the use of mash-up services and enterprises concerned with "talent management") and by progressively adding new knowledge services. Some of these new knowledge services (e.g., benchmarking to show how many people in the job market have particular combinations of the skills represented in the portfolio) will necessarily need to be sourced from trusted and secure providers. These portfolios could link to social networks, P2P networks in particular disciplines, and other networking opportunities selected by the portfolio owner. They could be part of a substantially enhanced e-learning environment, richly supported by knowledge services.[12]

New rubrics and templates could be used to put different faces on the portfolio for different purposes. For example, a professional could use her portfolio as a lifelong record but could choose to project to the professional world only a current portrait of her knowledge domain and professional standing. The portfolio could be given a "serious myfacebook" template so that it could become the owner's "face" in her professional world—a face with a more serious demeanor than, perhaps, in the owner's MySpace.com or Facebook.com profile.

The next generations of e-portfolios could be much more closely linked to employment networks and credentialing authorities while also maximizing portability. Applying data-mining techniques to the public face of personal portals could facilitate professional advancement. In the future, these sorts of connections will be useful for initial job placement and for continuing employment progressions.

What are the value propositions justifying investment? The existence of seamless, effective workplace linkages with institutionally launched e-portfolio services could be a key differentiator in future college/university decisions. Lifelong knowledge and competency management capabilities based on e-portfolios that are easily portable across institutions could become the gold standard for prospective students considering their choices of institutions.

Example #3: Learning Communities of Practice

The first generation of online learning applications has largely digitized existing approaches to courses and has created portfolios of online and hybridized courses represented in learning management systems. The work of Carol Twigg has demonstrated that courses can be reinvented, by leveraging technology, in ways that enhance performance and reduce cost.[13] To truly transform online learning, these examples of successful, one-off innovations must be leveraged across the enterprise, combined with

knowledge service and social network technologies.

One means of achieving this goal would be to deploy P2P architecture to create learning communities associated with individual courses or degree programs. These communities would engage participation by learners, faculty, mentors, and practitioners. The community-based body of knowledge would drive all learning experiences and standards of learning in all sections of particular courses. Variations on this approach have been shown to dramatically drive down costs and improve performance (e.g., at the University of Southern Queensland, the Open University in the United Kingdom, and proprietary universities such as the University of Phoenix and Capella University) and to create highly consistent, managed educational outcomes for adult learners, at lower costs than traditional colleges and universities.[14] This approach could be used with individual institutions, systems of institutions, or consortia. Rolling this model out across institutions or systems of institutions requires a combination of enterprise systems and knowledge nodes, networks, and services.

The community of practice also could develop customizable variations of online/hybrid learning experiences that would appeal to different generations of students (e.g., Millennial, Gen X, Boomer). These variations could offer different patterns/depth of interactivity and a variety of ways of experiencing knowledge resources. Similarly, P2P architectures and communities of practice could be developed to engage students while they are off campus in study-abroad environments, co-op experiences, and other peripatetic pursuits. While traveling, learners could have access to substantial knowledge resources, social and practice networks, and a full spectrum of support services.

What are the value propositions justifying investment? Investing in knowledge nodes, networks, and services to support learning communities of practice is a substantial undertaking. Colleges and universities can afford to do so, but only if they leverage this investment purposively and dramatically to reduce costs and improve students' performance.

Example #4: Dramatically Enhanced Student Services and Success

On many campuses, first-generation, portalized Web services have been deployed to enable students to access administrative and business support processes and to "self-serve" their own solutions. Already, these solutions are yielding enhanced performance, leading to the reinvention of campus processes, practices, and policies.

Several migration paths exist for further improvement of student services and students' success in using knowledge-intensive services. Online universities have developed full portfolios of student support services dealing with all administrative, academic support, and academic services that can be deployed. The Western Cooperative for Educational Telecommunications (WCET) is developing best practices in online student services through its Center for Transforming Student Services (http://www.wcet.info/consulting/audit.asp). Once proven for online students, these sorts of knowledge-intensive tools are likely to be so effective that they will be used for all students, including on-campus, residential students.

What are the value propositions justifying investment? These online student services, analytics, and knowledge services, when coupled with the learning communities of practice described in example #3 above, can enable institutions to substantially improve student access, success, and retention. These outcomes could increase enrollments and revenues, reduce costs, and enhance institutional attractiveness.

Example #5: Master Planning for the Wireless, Retrofitted Campus

Today's automated applications for scheduling and gauging the availability of campus facilities are relatively unsophisticated. However, knowledge-intensive services have the potential to raise these functions to the *n*th order, combining mobile computing, Web services, planning/scheduling algorithms, and visualization techniques. This could require a pervasive "retrofitting" of current campus facilities in order to create new kinds of dispersed spaces and environments where faculty, staff, and students can interact. New-generation classrooms need to be available 24x7 for scheduling so that they can be used by student groups and student/faculty interactions when not formally scheduled. Moreover, new kinds of learning spaces are needed, supported by ambient technology and collaborative work spaces.

Campus facilities and master planning are being dramatically affected by these developments.[15] Planning for each new facility—especially science buildings, campus student centers, and libraries—becomes an opportunity for exploration and reinvention. New facilities are being designed to be expeditionary, flexible in both space and technology. The new planning tools integrate visualization (e.g., of the loading of facilities across a campus or of the locations and activities of all people in "public visibility" mode at that moment), modeling of current facilities utilization and productivity, new learning ecosystem requirements, and other planning parameters. They can be applied to new facilities or used to consider retrofitting opportunities across the campus.

What are the value propositions justifying investment? Deploying these tools and practices will require substantial changes in the campus knowledge ecology, analytic/modeling tools, policies and processes, faculty and staff skills, and organizational culture. The payoff is dramatically enhanced facilities utilization, the capacity to serve greater numbers of students with existing facilities and resources, and improved learning experiences.

Example #6: Demonstrated Value to Institutional Stakeholders

On most of today's campuses, knowledge resides in separate, vertical silos. This is true even for institutions using the best-available practices enabled by the current generation of executive dashboards, report writers, and business intelligence tools supported by integrated ERP systems. The interoperable knowledge services described in the five examples above have the potential to liberate the

full range of knowledge resources and the associated knowledge networks. Institutions will be able to achieve new levels of performance and productivity by leveraging these knowledge resources, using the next generation of interoperable business intelligence tools, enterprise performance management tools, customer relationship management and customer services applications, e-portfolio capabilities, knowledge domain repositories, learning communities of practice, and other knowledge services.

In this e-knowledge future, institutional planning/management processes and associated knowledge flows can be seamlessly integrated, including strategic planning, the expeditionary execution of strategy, budgeting, process reinvention and continuous improvement, accreditation, academic programmatic planning and review, and individual performance management. Goals, objectives, and performance can be measured, monitored, managed, and aligned across all planning processes. Both objective information and subjective information from assessments are integrated and managed. Accreditation reviews and follow-up monitoring of corrective actions and continuous improvement will be as easy as pushing a button. These knowledge systems will enable institutional leaders to continuously assess and report on the elements of value: outcomes, the experiences through which the outcomes are achieved, and cost. By demonstrating this value added, leaders will be able to respond more effectively to the public demand for increased accountability, greater productivity, and controlled costs.[16]

What are the value propositions justifying investment? Seamlessly integrating the institutional processes of planning, assessment, and management will reduce costs and dramatically improve the coherence of these efforts. College and university leaders will be able to align mission, goals, and performance. Most important, their capacity to demonstrate value added will serve the institutional stakeholders.

Conclusion: Making Knowledge Services Work

The ability of colleges and universities to continue to provide knowledge leadership is at risk. Information overload, increased competition, expensive investments in technologies, growing costs of energy and benefits, heavier administrative requirements, lower net revenues per student (through initiatives to widen participation), and a host of other forces are to blame. Many institutions report broken budgets, overstressed faculty, and declining morale.

Enhancing productivity and reducing costs compose an urgent imperative in higher education today.[17] One facet of the solution is to use knowledge services (and supporting technologies and systems) that deliver higher value on investments in each area of an institution's operations. But colleges and universities must do so sustainably, offering a transition from expensive legacy systems to more affordable and flexible systems based on service-oriented and component-based approaches and knowledge aggregation. The examples given above suggest several possibilities:

- Cut the costs of capturing and interpreting the data needed for the administration of teaching and research and deliver the results to all parties (faculty, sponsors, students), using an appropriate mix of available legacy systems and newer systems (including secure and vandal-proof versions of wireless and RFID)
- Create locally relevant services that embody the best features of mass-market knowledge services and that look more professional than today's campus services
- Develop unique and hard-to-copy combinations of services, based on local experience and knowledge and/or personalized to the recipient, thereby attracting more sponsors or more of the desired students and faculty
- Reduce barriers to raising income from teaching and research (e.g., through the adoption of industry-derived insights into ways in which groups can overcome information overload, can

manage and share their assets, and can collaborate more effectively)

Knowledge services are still rare in most higher education institutions. However, sufficient examples exist among commercial enterprises, proprietary higher education, and some pioneering colleges and universities to demonstrate that the conditions are right for wider trials of knowledge sharing and knowledge services. One needs only to consider the sophistication and agility of the global news syndication of agencies such as Reuters and the Associated Press.[18] The more challenging question, as Clifford Lynch has suggested, is determining "how much we are going to be able to afford to develop technologies specifically to meet the needs of the world of education and scholarship and how much we're going to have to rely on these general-purpose developments."[19]

Making knowledge services work in higher education will depend on a variety of commitments—academic, institutional, commercial, and public policy—as well as on developments in technology. Delivering on this vision will not come easily. Most expeditions in knowledge sharing/services development will likely be undertaken by a small cadre of innovative institutions and leaders who are capable of sparking fresh, transformative value propositions that will deliver the results they seek. Eventually these institutions and leaders—and their results—will influence all of higher education.

Notes

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