THE HORIZON REPORT

2009 EDITION

a collaboration between
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EXECUTIVE SUMMARY

The annual *Horizon Report* describes the continuing work of the NMC's Horizon Project, a long-running qualitative research project that seeks to identify and describe emerging technologies likely to have a large impact on teaching, learning, research, or creative expression within learning-focused organizations. The *2009 Horizon Report* is the sixth annual report in the series. The report is produced again in 2009 as a collaboration between the New Media Consortium and the EDUCAUSE Learning Initiative (ELI), an EDUCAUSE program.

Each edition of the *Horizon Report* introduces six emerging technologies or practices that are likely to enter mainstream use in learning-focused organizations within three adoption horizons over the next one to five years. Challenges and trends that will shape the way we work in academia over the same time frame are also presented. Over the six years of the NMC's Horizon Project, more than 200 leaders in the fields of business, industry, and education have contributed to an ongoing primary research effort that draws on a comprehensive body of published resources, current research and practice, and the expertise of the NMC and ELI communities to identify technologies and practices that are either beginning to appear on campuses, or likely to be adopted in the coming years. Through a close examination of these sources, and informed by their own distinguished perspectives, the 2009 Advisory Board has considered the broad landscape of emerging technology and its intersection with the academic world as they worked to select the six topics described in these pages. The precise research methodology is detailed in a special section following the body of the report.

The format of the *Horizon Report* reflects the focus of the Horizon Project, which centers on the applications of emerging technologies to teaching, learning, research, and creative expression. Each topic opens with an overview to introduce the concept or technology involved and follows with a discussion of the particular relevance of the topic to education or creativity. Examples of how the technology is being

— or could be — applied to those activities are given. Each description is followed by an annotated list of additional examples and readings which expand on the discussion in the *Report,* as well as a link to the list of tagged resources collected by the Advisory Board and other interested parties during the process of researching the topic areas. Many of the examples under each area feature the innovative work of NMC and ELI member institutions.

Technologies to Watch

The technologies featured in the *2009 Horizon Report* are placed along three adoption horizons that represent what the Advisory Board considers likely timeframes for their entrance into mainstream use for teaching, learning, research, or creative applications. The first adoption horizon assumes the likelihood of entry into the mainstream of institutions within the next year; the second, within two to three years; and the third, within four to five years.

In the first adoption horizon we find *mobiles* and *cloud computing,* both of which are already well established on many campuses — and still more organizations have plans in place to make use of these technologies in the coming months. Institutions at the leading edge of technology adoption are also already applying the two clusters of technologies we have placed on the mid-term horizon, *geo-everything* and *the personal web.* All four topics on the first two horizons are already in common use in other sectors, including entertainment, commerce, and the world of work. The two technologies placed on the far-term horizon, *semantic-aware applications* and *smart objects,* are not yet commonly found in an educational context, although research is being conducted in both areas and the rate of development seems to indicate that these topics are well worth watching.

Each profiled technology is described in detail in the body of the report, including a discussion of what it is and why it is relevant to teaching, learning, research, and creative expression. Specific examples are listed there for each of the six topics, consistent with the

level of adoption at the time the report was written (December 2008). Taken as a set, our research indicates that all six of these technologies will significantly impact the choices of learning-focused organizations within the next five years.

- **Mobiles.** Already considered as another component of the network on many campuses, mobiles continue to evolve rapidly. New interfaces, the ability to run third-party applications, and location-awareness have all come to the mobile device in the past year, making it an ever more versatile tool that can be easily adapted to a host of tasks for learning, productivity, and social networking. For many users, broadband mobile devices like the iPhone have already begun to assume many tasks that were once the exclusive province of portable computers.

- **Cloud Computing.** The emergence of large-scale "data farms" — large clusters of networked servers — is bringing huge quantities of processing power and storage capacity within easy reach. Inexpensive, simple solutions to offsite storage, multi-user application scaling, hosting, and multi-processor computing are opening the door to wholly different ways of thinking about computers, software, and files.

- **Geo-Everything.** Geocoded data has many applications, but until very recently, it was time-consuming and difficult for non-specialists to determine the physical coordinates of a place or object, and options for using that data were limited. Now, many common devices can automatically determine and record their own precise location and can save that data along with captured media (like photographs) or can transmit it to web-based applications for a host of uses. The full implications of geo-tagging are still unfolding, but the impact in research has already been profound.

- **The Personal Web.** Springing from the desire to reorganize online content rather than simply viewing it, the personal web is part of a trend that has been fueled by tools to aggregate the flow of content in customizable ways and expanded by an increasing collection of widgets that manage online content. The term *personal web* was coined to represent a collection of technologies that are used to configure and manage the ways in which one views and uses the Internet. Using a growing set of free and simple tools and applications, it is easy to create a customized, personal web-based environment — a personal web — that explicitly supports one's social, professional, learning, and other activities.

- **Semantic-Aware Applications.** New applications are emerging that are bringing the promise of the semantic web into practice without the need to add additional layers of tags, identifiers, or other top-down methods of defining context. Tools that can simply gather the context in which information is couched, and that use that context to extract embedded meaning are providing rich new ways of finding and aggregating content. At the same time, other tools are allowing context to be easily modified, shaped, and redefined as information flows are combined.

- **Smart Objects.** Sometimes described as the "Internet of things," smart objects describe a set of technologies that is imbuing ordinary objects with the ability to recognize their physical location and respond appropriately, or to connect with other objects or information. A smart object "knows" something about itself — where and how it was made, what it is for, where it should be, or who owns it, for example — and something about its environment. While the underlying technologies that make this possible — RFID, QR codes, smartcards, touch and motion sensors, and the like — are not new, we are now seeing new forms of sensors, identifiers, and applications with a much more generalizable set of functionalities.

As in past editions of the *Horizon Report,* we have again found that some topics have carried forward in one form or another from one edition of the *Report* to the next. Mobiles, a family of devices characterized by unprecedented advancement, have appeared in both of the past two editions, and appear in this edition yet

again. This year's analysis finds mobiles firmly in the near-term horizon as the capabilities of phones have continued to develop rapidly. Innovations over the last year have brought third-party applications, easy GPS, and intuitive interfaces to mobile devices, blurring the boundary between phone and computer.

Cloud computing, placed on the near-term horizon this year, has emerged as the unifying technology supporting grassroots video, collaboration webs, and social operating systems, all described in the 2008 edition. It has become obvious that cloud computing has the potential to change the way we think about computing, and even as we come to recognize how profoundly different it is, new applications that take advantage of cloud computing as an infrastructure are continuously arising. Its clear disruptive potential led to cloud computing's selection this year as a technology to watch on its own merits.

Key Trends

Each year the Horizon Advisory Board researches, identifies and ranks key trends affecting the practice of teaching, learning, research, and creative expression. The Board reviews current articles, interviews, papers, and new research to discover emerging or continuing trends. The trends are ranked according to how significant an impact they are likely to have on education in the next five years. The top trends highlighted for 2009 are presented below in priority order, as ranked by the Advisory Board.

- *Increasing globalization continues to affect the way we work, collaborate, and communicate.* Information technologies are having a significant impact on how people work, play, gain information, and collaborate. Increasingly, those who use technology in ways that expand their global connections are more likely to advance, while those who do not will find themselves on the sidelines. With the growing availability of tools to connect learners and scholars all over the world — online collaborative workspaces, social networking tools, mobiles, voice-over-IP, and more — teaching and scholarship are transcending traditional borders more and more all the time.

- *The notion of collective intelligence is redefining how we think about ambiguity and imprecision.* Collective intelligence may give rise to multiple answers, all equally correct, to problems. The notions of collective intelligence and mass amateurization are redefining scholarship as we grapple with issues of top-down control and grassroots scholarship. Today's learners want to be active participants in the learning process – not mere listeners; they have a need to control their environments, and they are used to easy access to the staggering amount of content and knowledge available at their fingertips.

- *Experience with and affinity for games as learning tools is an increasingly universal characteristic among those entering higher education and the workforce.* A recent survey by the Pew Internet and American Life Project (http://www.pewinternet.org/PPF/r/263/report_display.asp) found that massively multiplayer and other online game experience is extremely common among young people, is rich and varied, and that games offer opportunity for increased social interaction and civic engagement among this group. The success of game-based learning strategies owes to active participation and interaction being at the center of the experience, and signals that current educational methods are not engaging students enough.

- *Visualization tools are making information more meaningful and insights more intuitive.* As tools of this nature continue to be developed and used, visual literacy will become an increasingly important skill in decoding, encoding, and determining credibility and authenticity of data. Visual literacy must be formally taught, but it is an evolving field even now.

- *As more than one billion phones are produced each year, mobile phones are benefiting from unprecedented innovation, driven by global competition.* New capabilities in terms of hardware and software are turning mobiles into indispensable tools. Third-party applications, now available on several models of mobile

devices, expand their utility even further. This trend, observed in the *Horizon Report* now for some time, will continue to impact the ways we communicate and view computing and networked resources.

Critical Challenges

The Advisory Board annually identifies critical challenges facing learning organizations over the five-year time period covered by this report, drawing them from a careful analysis of current events, papers, articles, and similar sources. The challenges ranked as most likely to have a significant impact on teaching, learning, and creativity in the coming years appear below, in the order of importance assigned them by the Advisory Board.

- *There is a growing need for formal instruction in key new skills, including information literacy, visual literacy, and technological literacy.* The skills involved in writing and research have changed from those required even a few years ago. Students need to be technologically adept, to be able to collaborate with peers all over the world, to understand basic content and media design, and to understand the relationship between apparent function and underlying code in the applications they use daily.

- *Students are different, but a lot of educational material is not.* Schools are still using materials developed decades ago, but today's students come to school with very different experiences than those of 20 or 30 years ago, and think and work very differently as well. Institutions need to adapt to current student needs and identify new learning models that are engaging to younger generations. Assessment, likewise, has not kept pace with new modes of working, and must change along with teaching methods, tools, and materials.

- *Significant shifts are taking place in the ways scholarship and research are conducted, and there is a need for innovation and leadership at all levels of the academy.* A challenge cited as critical now for several years running, academic review and faculty rewards are out of sync with

the practice of scholarship. Clear approaches to assessing emerging forms of scholarly practice are needed for tenure and promotion. Students who are living and learning with technologies that generate dynamic forms of content may find the current formalism and structure of scholarship and research to be static and "dead" as a way of collecting, analyzing and sharing results.

- *We are expected, especially in public education, to measure and prove through formal assessment that our students are learning.* Data collection and mining of student information systems for such evidence is being considered as a component of accreditation, and institutions increasingly are expected to collect, manage, sort, and retrieve an expanding mountain of data related to not only learning, but the entire spectrum of their activities. Current systems are not capable of managing and interpreting real time information flows on the scale that is anticipated.

- *Higher education is facing a growing expectation to make use of and to deliver services, content, and media to mobile devices.* This challenge is even more true today than it was when it first appeared in the *Horizon Report* two years ago. As new devices continue to make content almost as easy to access and view on a mobile as on a computer, and as ever more engaging applications take advantage of new interface technologies like accelerometers and multi-touch screens, the applications for mobiles continue to grow. This is more than merely an expectation to provide content: this is an opportunity for higher education to reach its constituents in new and compelling ways, in addition to the obvious anytime, anywhere benefits of these ubiquitous devices.

These trends and challenges are a reflection of the impact of new practices and technologies on our lives. They are indicative of the changing nature of the way we communicate, access information, and connect with peers and colleagues. Taken together, they provide a frame through which to consider the potential impacts of the six technologies and practices described in this edition of the *Horizon Report*.

The Horizon Project

Since the launch of the Horizon Project in March 2002, the NMC has held an ongoing series of conversations and dialogs with hundreds of technology professionals, campus technologists, faculty leaders from colleges and universities, and representatives of leading corporations. Each year, an Advisory Board considers the results of these dialogs and also looks at a wide range of articles, published and unpublished research, papers, scholarly blogs, and websites to generate a list of technologies and practices, trends, challenges, and issues that knowledgeable people in technology industries, higher education, and museums are thinking about.

The project uses qualitative research methods to identify the technologies selected for inclusion in each annual report, beginning with a survey of the work of other organizations and a review of the literature with an eye to spotting interesting emerging technologies. When the cycle starts, little is known, or even can be known, about the appropriateness or efficacy of many of the emerging technologies for these purposes, as the Horizon Project expressly focuses on technologies not currently in widespread use in academe. In a typical year, 75 or more of these technologies may be identified for further investigation; for the 2009 report, more than 80 were considered.

By engaging a wide community of interested parties, and diligently searching the Internet and other sources, enough information is gathered early in the process to allow the members of the Advisory Board to form an understanding of how each of the discovered technologies might be in use in settings outside of academe, to develop a sense of the potential the technology may have for higher education settings, and to envision applications of the technology for teaching, learning, research, and creative expression. The findings are discussed in a variety of settings — with faculty, industry experts, campus technologists, and of course, the Horizon Advisory Board. Of particular interest to the Advisory Board every year is finding educational applications for these technologies that may not be intuitive or obvious.

To create the *Horizon Report,* the Advisory Board engages in a comprehensive review and analysis of research, articles, papers, blogs, and interviews; discusses existing applications and brainstorms new ones; and ultimately ranks the items on the list of candidate technologies for their potential relevance to the focus areas of teaching, learning, research and creative expression. Each year, once the report is published, the NMC encourages the faculty and staff at the hundreds of colleges and universities who make use of the report to take part in a starburst of follow-on activities. Among these is the annual *Call to Scholarship,* an effort to define a research agenda and call to scholarship based on the six practices and technologies featured in that edition. With the publication of the report each year the community is invited to participate in this process, contribute to the discussion, and help shape directions for future research in these topics across higher education.

Increasingly the Horizon Project is a global effort. Each year at least a third of the members of the advisory board represent countries outside of North America. Beginning in 2007, with the aid of the Universitat Oberta de Catalunya, the *Horizon Report* was translated into Spanish and Catalan. In 2008, the Horizon Project expanded with the publication of its first-ever regional report, the *2008 Horizon Report: Australia-New Zealand Edition.* Future regional editions are planned as well, and 2009 promises to see the *Horizon Report* translated into Chinese and other major languages. Sector-based editions are planned as well, with the first of these being the K-12 edition planned for release in March 2009.

Each *Horizon Report* is produced over a very short period so that the information is timely and relevant. This year, research and production spanned just over four months, from September 2008 to January 2009. The six technologies and applications that emerged at the top of the final rankings — two per adoption horizon — are detailed in the sections that follow. The research aspects of the project, many of which are ongoing and build on the work in the *Report,* are described in the section on methodology which follows the descriptions of the six emerging technologies that are profiled in this year's report.

MOBILES
Time-to-Adoption Horizon: One Year or Less

The unprecedented evolution of mobiles continues to generate great interest. The idea of a single portable device that can make phone calls, take pictures, record audio and video, store data, music, and movies, and interact with the Internet — all of it — has become so interwoven into our lifestyles that it is now surprising to learn that someone does not carry one. As new devices continue to enter the market, new features and new capabilities are appearing at an accelerated pace. One recent feature — the ability to run third-party applications — represents a fundamental change in the way we regard mobiles and opens the door to myriad uses for education, entertainment, productivity, and social interaction.

Overview

Over the past few years, mobiles have undergone a continual transformation, becoming ever more capable and flexible with each new release. The ability to record audio and video turned them into portable multimedia devices; as storage capacity increased, they became keepers of our family photos, phone books, and calendars; and now, geolocation, web browsing, and email have brought much of the functionality of a laptop to the pocket-sized devices. In a marketplace that turns out 1.2 billion new phones each year, innovation is fluid and ever-present.

About a year ago, another round of new developments took place in the mobile markets — developments that have resulted in a profound change in the way we think about and interact with mobile devices. A new generation of mobiles appeared on the market featuring multi-touch displays, the ability to access the Internet over increasingly higher-speed 3G networks or by using wifi, and the capability for sensing motion and orientation and reacting accordingly using built-in accelerometers. These new devices can use GPS to locate themselves and can run robust applications. They can communicate with and control other devices. Most significantly, their manufacturers are working with the broader community to open up the devices to all the innovation enabled by third-party developers.

These new mobile applications have nothing to do with making phone calls. Instead, they expand the capacity of mobiles to keep us in touch with information and activities that we want while we are on the move. Third-party applications are very easy to acquire and install; commonly priced at just under

a U.S. dollar, they add games, reference materials, tools for measuring and calculating, checklists, reading material, productivity applications, social networking tools, and more to a single device that slips into a pocket. In mid-2008, Apple launched the App Store for the Apple iPhone, and less than six months later, more than 10,000 such applications were offered. Other mobile platforms are encouraging similar development, such as the Android platform developed by Google and the Open Handset Alliance. The first Android phone was released to market in October 2008, and the number of applications in the still-beta Android Market is growing by the day.

Applications designed for mobiles can take advantage of built-in features like the microphone and the camera. For instance, TinEye Music (http://www.ideeinc.com/products/tineyemobile/) and Snap-Tell (http://snaptell.com/) use the camera to record a photograph of a CD, video, or book, then identify the artist or author and display that along with reviews of the piece and information on where to buy it. Shazam (http://www.shazam.com/music/web/pages/iphone.html) does the same for ambient music — the microphone records a snippet of any song that is playing in the vicinity, and the waveform is used to identify the song, artist, and album. The games available for new mobiles are full-featured and richly rendered. Some, like Nanosaur or Asphalt 4, use the accelerometer to control movement within the game by tilting the phone.

Over the past several years, we have watched mobiles become ever more capable and more

common. The rapid pace of innovation in this arena continues to increase the potential of these little devices, challenging our ideas of how they should be used and presenting additional options with each new generation of mobiles. While there are constraints in some regions on the adoption of mobiles related to local regulations, availability of bandwidth, and affordability — especially of the newest models — it is apparent that the devices and their new applications have been accepted in the mainstream. In countries like Japan, young people equipped with mobiles often see no reason to own personal computers. A recent survey by the Pew Internet & American Life Project predicts that by the year 2020, most people across the world will be using a mobile device as their primary means for connecting to the Internet (http://www.pewinternet.org/PPF/r/270/report_display.asp). It is clear that mobiles are already well on the way to becoming a universal tool for communication of all kinds.

Relevance for Teaching, Learning, Research, or Creative Expression

Mobiles are already in use as tools for education on many campuses. New interfaces, the ability to connect to wifi and GPS in addition to a variety of cellular networks, and the availability of third-party applications have created a device with nearly infinite possibilities for education, networking, and personal productivity on the go; almost every student carries a mobile device, making it a natural choice for content delivery and even field work and data capture.

Third-party educational applications are readily available for the newest mobiles, and educational content is easy to find for almost every discipline. More sophisticated tools that tap into the unique capabilities of mobile devices like the touch screen, the camera, the microphone, and the accelerometer are quickly emerging. Language learners can look up words; practice listening, speaking, and writing; and compare their pronunciation with a native speaker's. Graphing calculators display 3D graphs that can be rotated with a finger on the touch screen or viewed from different angles by tilting the phone. Detailed reference materials for medicine or astronomy include

the ability to supplement information and illustrations with online sources. The variety and quality of educational content is growing at a fantastic pace.

A sampling of applications of mobiles across disciplines includes the following:

- **Computer Science.** At Clemson University, students are developing tools with a pedagogical or social focus for mobile devices. Each student is co-mentored by two faculty — one each for content and technological development — as they propose, design, and implement projects for the device of their choice.

- **Mathematics.** By selecting custom applications, students can turn their iPhones into sophisticated calculators. SpaceTime (http://www.spacetime.us/iphone/) and QuickGraph (http://www.colombiamug.com/EN/QuickGraph.html) are just two examples of graphing calculators that display graphs in 2D or 3D; SpaceTime also includes a scripting language for custom computations.

- **Campus Life.** iStanford (http://stanford.terribly clever.com/) is a custom application commissioned by Stanford University that includes campus maps, course listings, the campus directory, current sports scores, and other campus-related information; course registration, course history, and grades are planned for future releases. iGFU (http://www.georgefox.edu/cmc/) is a similar application developed at George Fox University exclusively for the campus community.

- **Music.** Instrument simulators for piano, guitar, drums, and other instruments let students practice fingering and chords or compose simple pieces. Applications for ear training, reading music, and generating warm up exercises assist with basic practice. Artists can mix and record multiple tracks using loops, ambient sounds, or voice recordings to create unique compositions. With the right applications, a mobile can be instrument, tutor, and recording studio all in one.

Examples of Mobiles

The following links provide examples of mobile applications.

iPhone in Medicine
http://jeffreyleow.wordpress.com/2008/06/10/ iphone-in-medical-education/

> (Jeffrey Leow, *Monash Medical Student,* 10 June 2008.) Medical resources developed for the iPhone can be used by students and practitioners; a few are reviewed here.

Mobile MAAP
http://maap.columbia.edu/m/index.html

> Columbia University's Mapping the African American Past (MAAP) website now includes a mobile version designed to be viewed using the iPhone or iPod Touch. The tool includes text and audio information about historically significant locations in New York City and is designed as a tool for mobile learning.

Mobile Initiatives at Seton Hall University
http://tltc.shu.edu/mobile/

> Seton Hall University is conducting research to determine how mobiles can be used in teaching, learning, and social networking for the campus community. Part of the initiative calls for the development of a custom mobile application.

Short Messaging Service Response System (SMSRS)
http://smsrs.edtrix.com/

> Researchers at the Centre for Applied Research at SIM University, Singapore have developed a way to use any SMS-enabled mobile device as a personal response system. Students can respond to open-ended or multiple-choice questions, and their answers can be immediately tabulated, graphed and displayed to the class via a website without proprietary equipment.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about mobiles.

The Future of the Internet III
http://www.pewinternet.org/PPF/r/270/report_ display.asp

> (Janna Anderson and Lee Rainie, *Pew Internet & American Life Project,* December 14, 2008.) This report describes the results of a survey of Internet leaders, activists, and analysts assessing predictions about technology and its roles in the year 2020.

Next Generation Mobile Networks: Industry Leaders on Challenges Ahead
http://blogs.cisco.com/sp/comments/next_ generation_mobile_networks_industry_leaders_ on_challenges_ahead/

> (Larry Lang, *SP360: Service Provider,* 28 June 2008.) This blog post summarizes the remarks of several industry leaders in a session at the Second NGMN Industry Conference in June 2008.

Time to Leave the Laptop Behind
http://online.wsj.com/article/ SB122477763884262815.html

> (Nick Wingfield, *The Wall Street Journal,* 27 October 2008.) This article reports on the observed trend among business travelers to rely more on smartphones, rather than laptops, as travel computing devices.

Voice in Google Mobile App: A Tipping Point for the Web?
http://radar.oreilly.com/2008/11/voice-in-google- mobile-app-tipping-point.html

> (Tim O'Reilly, *O'Reilly Radar,* 18 November 2008.) This blog post discusses the release of speech recognition for searching with Google Mobile App for iPhone and its implications for developing computing services designed to be native to phones.

Delicious: Mobile
http://delicious.com/tag/hz09+mobile

> (Tagged by Horizon Advisory Board and friends, 2008.) Follow this link to find additional resources tagged for this topic and this edition of the *Horizon Report.* To add to this list, simply tag resources with "hz09" and "mobile" when you save them to *Delicious.*

CLOUD COMPUTING

Time-to-Adoption Horizon: One Year or Less

The emergence of very large "data farms" — specialized data centers that host thousands of servers — has created a surplus of computing resources that has come to be called the cloud. Growing out of research in grid computing, cloud computing transforms once-expensive resources like disk storage and processing cycles into a readily available, cheap commodity. Development platforms layered onto the cloud infrastructure enable thin-client, web-based applications for image editing, word processing, social networking, and media creation. Many of us use the cloud, or cloud-based applications, without even being aware of it. Advances in computer science to ensure redundancy and protection from natural disasters have led to data being shared across many different hosting facilities. Improved infrastructure has made the cloud robust and reliable; as usage grows, the cloud is fundamentally changing our notions of computing and communication.

Overview

The *cloud* is the term for networked computers that distribute processing power, applications, and large systems among many machines. Applications like Flickr, Google, YouTube, and many others use the cloud as their platform, in the way that programs on a desktop computer use that single computer as a platform. Cloud-based applications do not run on a single computer; instead they are spread over a distributed cluster, using storage space and computing resources from many available machines as needed. "The cloud" denotes any group of computers used in this way; it is not tied to a particular location or owner, though many companies have proprietary clouds. "Amazon's cloud," for instance, refers to the computers used to power Amazon.com; the capacity of those servers has been harnessed as the Elastic Compute Cloud (EC2) and can be leased from Amazon for a variety of purposes.

Cloud computing services are grouped into three types. Most people are familiar with the first type: applications that serve a single function, such as Gmail (http://gmail.com) or Quicken Online (http://quicken.intuit.com/online-banking-finances.jsp), that are generally accessed through a web browser and that use the cloud for processing power and data storage. The second group of services offer the infrastructure on which such applications are built and run, along with the computing power to deliver them. Examples include Google App Engine (http://code.google.com/appengine/), which allows developers to create and host tailored programs using Google's

infrastructure; Heroku (http://heroku.com), which does the same for applications developed in Ruby on Rails; and Joyent (http://joyent.com), which hosts and scales applications in a variety of languages. The final set of cloud services are those that offer sheer computing resources without a development platform layer, like Amazon's Elastic Compute Cloud (http://aws.amazon.com/ec2/) or the GoGrid (http://www.gogrid.com).

Cloud computing makes it possible for almost anyone to deploy tools that can scale on demand to serve as many users as desired. To the end user, the cloud is invisible; the technology that supports the applications doesn't matter — the fact that the applications are always available is key. Data storage is cheap in these environments — pennies per gigabyte — so cheap that it is often provided in surprising quantities for free.

The cloud does have certain drawbacks. Unlike traditional software packages that can be installed on a local computer, backed up, and are available as long as the operating system supports them, cloud-based applications are services offered by companies and service providers in real time. Entrusting your work and data to the cloud is also a commitment of trust that the service provider will continue to be there, even in face of changing market and other conditions. Nonetheless, the economics of cloud computing are increasingly compelling. For many institutions, cloud computing offers a cost-effective

solution to the problem of how to provide services, data storage, and computing power to a growing number of Internet users without investing capital in physical machines that need to be maintained and upgraded on-site.

Relevance for Teaching, Learning, Research, or Creative Expression

The emergence of cloud-based applications is causing a shift in the way we think about how we use software and store our files. The idea of data storage as something that can be separated from an individual computer is not unusual, but now it is becoming common to consider applications in the same light. Instead of locking files and software inside a single computer, we are gradually moving both the products of our work and the tools we use to accomplish it into the cloud. Once there, applications and data are both accessible from any computer, using tools that are free or very inexpensive. Because they live on the network, applications in the cloud make it easy to share documents, collaboratively edit, and effectively manage versions.

Educational institutions are beginning to take advantage of ready-made applications hosted on a dynamic, ever-expanding cloud that enable end users to perform tasks that have traditionally required site licensing, installation, and maintenance of individual software packages. Email, word processing, spreadsheets, presentations, collaboration, media editing, and more can all be done inside a web browser, while the software and files are housed in the cloud. In addition to productivity applications, services like Flickr (http://www.flickr.com), YouTube (http://www.youtube.com), and Blogger (http://www. blogger.com), as well as a host of other browser-based applications, comprise a set of increasingly powerful cloud-based tools for almost any task a user might need to do.

Cloud-based applications can handle photo and video editing (see http://www.splashup.com for photos and http://www.jaycut.com for videos, to name just two examples) or publish presentations and slide shows (see http://www.slideshare.net or http://www.sliderocket.com). Further, it is very easy to share content created with these tools, both in terms of collaborating on its creation and distributing the finished work. Applications like those listed here can provide students and teachers with free or low-cost alternatives to expensive, proprietary productivity tools. Browser-based, thin-client applications are accessible with a variety of computer and even mobile platforms, making these tools available anywhere the Internet can be accessed. The shared infrastructure approaches embedded in the cloud computing concept offer considerable potential for large scale experiments and research that can make use of untapped processing power.

We are just beginning to see direct applications for teaching and learning other than the simple availability of platform-independent tools and scalable data storage. This set of technologies has clear potential to distribute applications across a wider set of devices and greatly reduce the overall cost of computing. The support for group work and collaboration at a distance embedded in many cloud-based applications could be a benefit applicable to many learning situations.

Already, cloud-based applications are being used in the K-12 sector to provide virtual computers to students and staff without requiring each person to own the latest laptop or desktop machine; a handful of basic machines, provided they can access the Internet and support a web browser, are all that is needed for access to virtually unlimited data storage and programs of all kinds.

A sampling of cloud computing applications across disciplines includes the following:

- **Sciences.** Science Clouds, a project that aims to provide cloud computing resources to members of the science community for limited amounts of time in support of specific projects, launched its first cloud in early 2008. Scientists may request time on the clouds in exchange for a short write-up of their project.

- **Meteorology.** Applications that combine a desktop interface with the data storage and computing power available in the cloud make

powerful tools, once only available at large computing centers, available to anyone. One such example, Earthbrowser (http://www.earthbrowser.com), creates an interactive map populated with weather, geological, and other data; the engine that drives it lives in the cloud.

- **Media Studies.** Using cloud-based applications like YouTube, a media culture course at Pitzer College in California tracks emerging up-to-the-moment social trends through real-time news clips and user-created content posted there. Similarly, courses at Onondaga Community College in Syracuse, NY use YouTube and other cloud-based applications to host media that cannot be hosted using resources on campus.

Examples of Cloud Computing

The following links provide examples of cloud computing applications.

Cloud Computing Testbed
http://www.cs.illinois.edu/news/articles.php?id=2008Jul29-352

The Cloud Computing Testbed (CCT) is a research effort at the University of Illinois at Urbana-Champaign to explore ways to provide system-level support for data-intensive computing using cloud computing approaches.

Into the Cloud: Our 5 Favorite Online Storage Services
http://www.readwriteweb.com/archives/free_online_storage_services.php

(Frederic Lardinois, *ReadWriteWeb,* 28 September 2008.) This blog post describes five services that provide large-scale online file storage.

Open Science Grid
http://www.news.wisc.edu/12927

The University of Wisconsin-Madison and several partner schools are working on a project funded by the National Science Foundation and the Department of Energy to develop and expand a national Open Science Grid to provide computing power and data storage to solve large, data-intensive challenges in science.

Parallel Computing with *Mathematica 7*
http://www.wolfram.com/news/m7hpc.html

The November 2008 release of Mathematica 7 includes a tool to create a parallel computing grid using any set of computers.

Virtual Computing Lab at North Carolina State University
http://vcl.ncsu.edu/

North Carolina State University offers an online system for requesting and reserving a virtual computer, complete with any of a number of applications, that can be accessed from anywhere.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about cloud computing.

Cloud Computing Expo: Introducing the Cloud Pyramid
http://cloudcomputing.sys-con.com/node/609938

(Michael Sheehan, *Cloud Computing* Journal, 21 August 2008.) This article illustrates a pyramid model for thinking about the types of services cloud computing enables.

How Cloud Computing is Changing the World
http://www.businessweek.com/technology/content/aug2008/tc2008082_445669.htm

(Rachael King, *BusinessWeek,* 4 August 2008.) This article describes a perceived shift in the way we think about computing as more companies begin to use cloud-based applications for communications and productivity tasks.

The Cloudworker's Creed
http://www.ribbonfarm.com/2008/10/23/the-cloudworkers-creed/

(Venkatesh Rao, *Ribbonfarm.Com,* 23 October 2008.) This blog post introduces the concept of a cloudworker, the information professional of tomorrow.

The Tower and the Cloud: An EDUCAUSE eBook
*http://www.educause.edu/
thetowerandthecloud/133998*

> (Richard N. Katz, ed., *EDUCAUSE,* 2008.) This book, freely available as a PDF document, includes chapters by leading educators and technologists on all aspects of cloud computing and education, including accountability, implementation, social networking, and scholarship.

Use of Cloud Computing Applications and Services
*http://www.pewinternet.org/PPF/r/262/report_
display.asp*

> (John Horrigan, *Pew Internet & American Life Project,* 12 September 2008.) This data memo reports on the number of Internet users who are making use of cloud-based applications and services and reviews their expressed preferences.

Web 2.0 and Cloud Computing
*http://radar.oreilly.com/2008/10/web-20-and-
cloud-computing.html#definitions*

> (Tim O'Reilly, *O'Reilly Radar,* 26 October 2008.) This blog post describes three types of cloud computing and considers the impact of each on business.

***Delicious:* Cloud Computing**
http://delicious.com/tag/hz09+cloudcomputing

> (Tagged by Horizon Advisory Board and friends, 2008.) Follow this link to find resources tagged for this topic and this edition of the *Horizon Report,* including the ones listed here. To add to this list, simply tag resources with "hz09" and "cloudcomputing" when you save them to *Delicious.*

GEO-EVERYTHING

Time-to-Adoption Horizon: Two to Three Years

Everything on the Earth's surface has a location that can be expressed with just two coordinates. Using the new classes of geolocation tools, it is very easy to determine and capture the exact location of physical objects — as well as capturing the location where digital media such as photographs and video are taken. The other side of this coin is that it is also becoming easier to work with the geolocative data thus captured: it can be plotted on maps; combined with data about other events, objects, or people; graphed; charted; or manipulated in myriad ways. Devices we commonly carry with us increasingly have the ability to know where they (and, consequently, we) are, and to record our coordinates as we take photographs, talk to friends, or post updates to social networking websites. The "everything" in geo-everything is what makes this group of technologies interesting, and what will make them so much a part of our lives — geolocation, geotagging, and location-aware devices are already very nearly everywhere.

Overview

Geolocation technology is not new, but it is now commonly available in a growing range of devices like mobile phones, cameras, and other handhelds; at the same time, the software tools we use every day are beginning to include features that make use of geolocative data. Emerging third-party applications for mobiles that can obtain and transmit the device's physical location give us ways to integrate our experiences in the physical world with those in the online, virtual world of the Internet. Where it was once time-consuming and tedious to attach geolocative information to photographs, video, and other media, it is now easy — indeed, often automatic — with many of today's tools. It is increasingly common for photos and videos in online collections to "know" where they were taken, and social networking updates from many mobile devices are already geotagged automatically.

An increasing number of mobile and web-based services can respond to geolocative data in creative and useful ways. Radar (http://outside.in/radar) serves up local information like news, blog posts, restaurant reviews, and so on, based on a viewer's location as determined from the IP address of the computer being used. Buzzd (http://buzzd.com) is a city guide and social networking tool for mobile devices, including not only local information but also user ratings and tips. Mobile Twitter clients like Trak (http://www.trak.fr/site/en/) and Twinkle (http://tapulous.com/twinkle/) add the user's location to

tweets, indicate nearby friends, and show messages tweeted in the user's vicinity.

Collage (http://tapulous.com/collage/), a photo application for the iPhone, lets the viewer upload geotagged photos, browse photos taken nearby, and see photos as they are taken all over the world. Mobile Fotos (http://xk72.com/mobilefotos/) is another iPhone application that automatically geotags photos taken on the device before uploading them to Flickr. Dynamically updated maps on mobiles help travelers understand how to get from here to there, without having to first figure out where *here* actually is. The technology to capture and use geolocative data in user-friendly ways on mobile devices is just beginning to hit the mainstream, and we can expect to see tremendous development in this area in the coming months.

For those without devices that have built-in geolocative capability, a variety of free or inexpensive tools to capture and display geolocative data are available. The Photo Finder by ATP Electronics and the Nikon GP-1 are examples; they capture GPS data and synchronize it to a camera's data card to geotag the photos automatically. Another approach is to use a specialized device like the GPS Trackstick (http://www.gpstrackstick.com) that can be carried in a pocket or glove box. It records the path it travels, and the data can be uploaded to create custom maps of walking or driving routes, hiking trails, or

points of interest. Geotagging of media of all kinds is increasingly easy to do (or is automatic), and as a result, the amount and variety of geotagged information available online is growing by the day.

As noted in the *2008 Horizon Report,* it is also becoming easier to create mashups using multimedia and geotagged data with online tools. Many free or very low-cost tools to capture and display geolocative data are available online and they continue to improve in usability and flexibility. Google Maps (http://maps.google.com), for example, offers a one-button way to overlay public, geotagged media onto the relevant section of a map as you view it; photos or videos tagged with the location in question simply fall into place on the map. A similar feature is available to place media onto Google Earth's 3D display. With Flickr Maps (http://www.flickr.com/map), viewers can see at a glance what tags are currently being applied in a given region, or find (for instance) locations in North America where photographs of monarch butterflies were taken. Other mashup authoring tools give the user even more control, allowing the use of uploaded datasets, custom maps, and more.

Relevance for Teaching, Learning, Research, or Creative Expression

Applications for research and learning that are quick and inexpensive but still very effective are beginning to emerge as the difficulty of capturing and using geolocative data decreases. Automatic geolocation opens opportunities for field research and data acquisition in the sciences, social observation studies, medicine and health, cultural studies, and other areas. Researchers can study migrations of animals, birds, and insects or track the spread of epidemics using data from a multitude of personal devices uploaded as geotagged photographs, videos, or other media plotted on readily-available maps. By placing collected data on a map and adding easy-to-obtain data such as weather, population, urban development, or other factors, researchers and students can study the patterns that emerge.

Existing collections of geolocative data are also becoming more accessible as the tools to search, organize, filter, and display such data become more sophisticated, easier to access, and simpler to use. Open databases like those listed by Academic Info (http://www.academicinfo.net/geogdata.html) have been available for some time, and now we are seeing online tools that can display those datasets visually in a variety of ways. The array of emerging web applications that combine topographical data with geotagged media and information are at the heart of geolocation's importance to educational practice. Many such applications require no programming skills and can be used by students to produce custom visualizations layered over detailed maps or 3-D landscapes using real-world data.

Mobile learners can receive context-aware information about nearby resources, points of interest, historical sites, and peers seamlessly, connecting all this with online information for just-in-time learning. Social networking tools for handheld and mobile devices or laptop computers can already suggest people or places that are nearby, or show media related to one's location. Virtual geocaching — the practice of placing media (images, video, audio, text, or any kind of digital files) in an online "drop box" and tagging it with a specific geographic location — is emerging as a way to "annotate" real-world places for travelers or tourists; enhance scavenger hunts, alternate reality games, and other forms of urban outdoor recreation; and augment social events such as concerts and other performances. Drop.io Location (http://drop.io/dropiolocation) is one such service. Mobile users can detect the location of nearby drops and retrieve any files they have permission to access.

Relatively simple applications of geolocative data like these represent its earliest uses in websites and mobiles, but this cluster of technologies is developing very rapidly.

A sampling of location-aware applications across disciplines includes the following:

- **Literature.** Geotagging and virtual geocaching can be used to create annotated maps and real-world locations related to works of literature, enhancing the experience of reading the story. For instance, out of personal interest, one reader created a map of the course described in *The*

Travels of Marco Polo, including passages from the text, photographs of the places mentioned (historical and contemporary), annotations and links, and other information (http://idlethink. wordpress.com/2008/08/31/indulgence-sin/).

- ■ **Medicine.** The University of Florida has used a 2-dimensional web-based Transparent Reality Simulation Engine to teach students how to operate medical machinery for several years. Recently, the addition of a GPS-enabled tablet device has allowed learners who are spatially challenged to experience the transparent reality visualization overlaid directly onto the real machine, enabling them to use the machine's controls rather than a mouse as input to the simulation. Geolocation is used to track the tablet and align the physical machine with the visualization on the tablet.

- ■ **Games-based Learning.** The Local Games Lab at the University of Wisconsin-Madison (http:// lgl.gameslearningsociety.org/) is developing "local games," learning experiences set in real-life neighborhoods and ecological habitats. Combining geolocation and alternate reality games, local games immerse the learner in a physical space as they explore the unique characteristics of the location and its inhabitants.

Examples of Geo-Everything

The following links provide examples of a variety of applications using geolocation, geotagging, or location-aware devices.

CommunityWalk
http://www.communitywalk.com/
> CommunityWalk is a tool that provides a way to create and annotate custom maps with geotagged data and photographs uploaded or pulled from Flickr.

Geocoding with Google Spreadsheets (and Gadgets)
http://otherfancystuff.blogspot.com/2008/11/
geocoding-with-google-spreadsheets-and.html
> (Pamela Fox, *…And Other Fancy Stuff,* 27 November 2008.) This blog post includes step-by-step instructions for embedding a gadget,

created by the author, that plots addresses from a Google spreadsheet on a map, providing latitude and longitude data that can be used in other mashups.

Geonames
http://www.geonames.org/
> Geonames is a comprehensive geographical database containing millions of geographical names and features worldwide. The data is licensed for use under a Creative Commons attribution license.

The Mapas Project
http://whp.uoregon.edu/mapas/AGN/Guelaxe/
fullview.shtml
> The fledgling Mapas Project at the University of Oregon is dedicated to the study of Colonial Mexican pictorial manuscripts. Geolocation is being used to link real-world locations to those represented on the maps.

Mediascape
http://www.mscapers.com/
> Mediascape is a tool for creating interactive stories that unfold as the viewer moves through physical space and time. By tapping into the GPS on a viewer's mobile device and incorporating multimedia as well as interactive controls, every mediascape offers a unique experience for each viewer.

Next Exit History
http://nextexithistory.org/
> Next Exit History is a project by the University of West Florida and the University of South Florida designed to provide geotagged information (podcasts and other media) to assist tourists in finding and learning about historical sites in Florida that are near major interstate highways but often overlooked by visitors.

Paintmap
http://paintmap.com/
> Paintmap is a tool that allows artists to place their works on a map to indicate the physical location of the subject of the work. Users of Google Earth can also add artworks as an additional way to annotate places.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about geolocation, geotagging, and location-aware devices.

7 Things You Should Know about Geolocation
http://connect.educause.edu/Library/ELI/7Things YouShouldKnowAbout/47212

> (EDUCAUSE Learning Initiative, 27 August 2008.) This article provides a concise description of geolocation as it relates to tagging media, suggests educational applications, and discusses opportunities and concerns related to geolocation.

Geotagging Photos to Share Fieldtrips with the World
http://www.geographyteachingtoday.org.uk/ fieldwork/info/teaching-technology/geotagging-photos-to-share-fieldtrips-with-the-world/

> (David Holmes, *GeographyTeachingToday.org. uk,* undated.) This article describes applications for the geotagging of photos in teaching geography and suggests ways to geotag images.

How Your Location-Aware iPhone Will Change Your Life
http://lifehacker.com/395171/how-your-location+aware-iphone-will-change-your-life

> (Adam Pash, *Lifehacker,* 5 June 2008.) The iPhone's location-aware features enhance a host of applications from social networking tools to geotagging photos taken by the phone to nearby restaurant recommendations.

Location Technologies Primer
http://www.techcrunch.com/2008/06/04/location-technologies-primer/

> (Eric Carr, *TechCrunch,* 4 June 2008.) This article explains the technologies that are used for location-awareness applications.

Notes from the Classroom: Exploring Literary Spaces via Google Earth
http://google-latlong.blogspot.com/2008/06/ notes-from-classroom-exploring-literary.html

> (Jerome Burg, *Google Lat Long Blog,* 25 June 2008.) This post, written by the retired English teacher who created GoogleLitTrips.com, describes using Google Earth to enhance the teaching of literature.

Delicious: Geo-Everything
http://delicious.com/tag/hz09+geolocation

> (Tagged by Horizon Advisory Board and friends, 2008.) Follow this link to find resources tagged for this topic and this edition of the *Horizon Report,* including the ones listed here. To add to this list, simply tag resources with "hz09" and "geolocation" when you save them to *Delicious.*

THE PERSONAL WEB

Time-to-Adoption Horizon: Two to Three Years

Fifteen years after the first commercial web pages began to appear, the amount of content available on the web is staggering. Sifting through the sheer volume of material — good or bad, useful or otherwise — is a daunting task. It is even difficult to keep track of the media posted by a single person, or by oneself. On the other hand, adding to the mix is easier than ever before, thanks to easy-to-use publishing tools for every type and size of media. To cope with the problem, computer users are assembling collections of tools, widgets, and services that make it easy to develop and organize dynamic online content. Armed with tools for tagging, aggregating, updating, and keeping track of content, today's learners create and navigate a web that is increasingly tailored to their own needs and interests: this is the personal web.

Overview

Part of a trend that began with simple innovations like personalized start pages, RSS aggregation, and customizable widgets, the personal web is a term coined to represent a collection of technologies that confer the ability to reorganize, configure and manage online content rather than just viewing it. Using a growing set of free and simple tools and applications, it is easy to create customized, personal web-based environments — a personal web — that explicitly supports one's social, professional, learning and other activities via highly personalized windows to the networked world. Online material can be saved, tagged, categorized, and repurposed without difficulty and without any special knowledge of how web pages are put together. In fact, the underlying technology that supports the web has all but vanished for most users; all that is necessary is to know which tools to use, and any task — from creating and distributing content, to organizing one's personal and professional time, to developing a library of resources that constantly refresh and update themselves — becomes point-and-click trivial.

As a result, people of all ages are creating customized, personal web-based environments to support their social, professional, and learning activities using whatever tools they prefer. Highly flexible and unique to each person, these personal web environments consist of collections of tools individually selected to suit the user's style and preferences. Tools that foster personal and social forms of learning and expression, though technically unrelated, work together seamlessly without any need for complicated setup, thanks to open applications programming interfaces (APIs) and easily integrated web feeds. The vast collection of content that makes up the web can be tamed, filtered, and organized, and anyone can publish as much or as little as they wish: the web has become personal.

This transformation is gaining momentum. Blogging sites such as WordPress.com and EduBlogs, as well as tools like Twitter, Facebook, YouTube, and Flickr have become mainstream — certainly in terms of who reads work published with them, and more and more in terms of who publishes with them. Now we are beginning to see tools for online publishing pressed into service for education, whether the work comprises a few lines or is the length of an entire book. From course updates on Twitter to complete textbooks authored on collaborative networking sites, the content of education is increasingly published online by those most immediately involved with it. Nearly every social networking tool that has gained popularity in the past twelve to eighteen months has been appropriated for educational use in some form.

Collaborative work, too, is easier than ever before. Joint authoring of novels, comics, white papers, and even textbooks is supported by tools designed for that purpose. Some of these have a specifically educational focus, like Flat World Knowledge (http://www.flatworldknowledge.com), which aims to provide free, peer-reviewed textbooks online. Other online book publishing options, like WeBook (http://www.webook.com), are designed for the general public; WeBook includes everything from children's

books to cookbooks. Using tools like these, authors can create and market books on any topic, jointly or individually, and make them available online at low cost or no cost; many of the services also provide a print-on-demand option for buyers.

Relevance for Teaching, Learning, Research, or Creative Expression

The tools that enable the personal web are also ideal toolsets for research and learning. The ability to tag, categorize, and publish work online, instantly, without the need to understand or even touch the underlying technologies provides a host of opportunities for faculty and students. By organizing online information with tags and web feeds, it is a simple matter to create richly personal resource collections that are easily searchable, annotated, and that support any interest.

Tools like Delicious (http://delicious.com) and Diigo (http://www.diigo.com) use tagging as a means of saving and organizing web links. While not at all a new concept, tagging online resources and tools is already a very common strategy among researchers. Widgets, small tools that extend the functions of a web browser, are beginning to gain acceptance as they become more robust and also easier to install and use. Zotero (http://www.zotero.org) is a full-featured reference tool that adds the equivalent of bibliographic note cards to a web browser; with Zotero, a viewer can easily save a link, notes, and bibliographic reference for a resource as it is discovered on the web. Resources like these gather information in one place by assembling a list of organized, annotated links to materials published by others: a personal online card catalog of sorts.

Online publishing tools are being employed in the process of education as a means for personal and professional reflection, collaborative work, research, and the development of a public voice. Microblogging — the practice of posting brief updates to services like Twitter, Facebook, or others — is starting to gain a foothold in education, while the longer format of traditional blogging is fairly well established already. A medium optimized for social connections, microblogging can also be used to continue a conversation outside of classroom walls or provide an easy way to update students on course logistics. Numerous widgets exist for cross-posting updates (a single statement entered on one service can appear on many others automatically) and for following the updates of others. The ease of online publishing, especially blogging, gives students a place to voice their opinions, ideas, and research.

Both providers and consumers of educational content are making use of a variety of web-based services to publish and host media: YouTube and Blip.tv, Twitter, an array of blogging platforms, Flickr, Picasa, and many others. Tagging is one way to organize these scattered pieces of information, but another approach is to aggregate them — use web feeds to pull them together in a single place where updates appear automatically and others can add commentary. Tools like Swurl (http://www.swurl.com) or FriendFeed (http://www.friendfeed.com) pull all the material a person has published into an "activity stream." Students can use these tools to gather their work together in a kind of online portfolio; whenever they add a tweet, blog post, or photo to any online service, it will appear in their timeline. A "user" shared by everyone in a course could combine resources found by students and professors, all added to a single feed and updated whenever new content is posted. Tools like these help students organize their own work as well as learn to manage online references and resources. Several education-specific tools for this purpose are in development, like the California State University system's professional profile and reference tool, FRESCA (http://bssapps.sfsu.edu/fresca).

Online book publishing requires a greater investment of time and effort than micropublishing or blogging. Despite the work involved and the difficulties that arise around questions of copyright, ownership, and professional review, open content textbooks, open course notes, and collaboratively-authored textbooks are gradually appearing and gaining acceptance in some pockets of academia. Projects of this nature address the rising cost of college textbooks and the limits imposed on faculty who wish to customize the material used in their courses. Many online texts allow professors to edit, add to, or otherwise customize

material for their own purposes, so that their students receive a tailored copy that exactly suits the style and pace of the course. In some courses, students and faculty create the textbook collaboratively in an online format as the course progresses, increasing students' engagement with and understanding of the course material as they become authorities.

A sampling of applications of the personal web across disciplines includes the following:

- **Library Research.** Instead of purchasing textbooks, students in Advanced Library Research courses at Buffalo State College are required to buy a USB flash storage drive. They install the Firefox web browser and a set of portable applications on the drive, which becomes their research tool. The course website (http://sites.google.com/site/lib300site/) provides basic information about using social bookmarking tools and portable applications.

- **Media Studies.** The Open Publishing Lab at the Rochester Institute of Technology (http://opl.cias.rit.edu/projects) runs a series of projects on new media and publishing, including an online newspaper, a tool for aggregating and publishing web content in e-book form, a guide to online publishing, and a social networking game.

- **Foreign Language.** A research study at Montclair State University is investigating the potential for using PageFlakes, a customizable website tool that makes it easy to integrate multimedia and web feeds into a course website, as a means to provide a richer, more personalized learning experience for Italian language learners.

Examples of the Personal Web
The following links provide examples of educational applications of the personal web.

First-Year Composition at USF
http://collegewriting.us
> The University of South Florida employs between 70 and 90 instructors each semester to teach first-year composition. This website serves as a resource for teachers and students, ensuring that all classes are on the same schedule and working with up-to-date material. It also includes an online assessment rubric that instructors can use to evaluate and record student work.

Omeka
http://omeka.org
> Omeka is a free, open source, collections-based web publishing platform for scholars, librarians, archivists, museum professionals, educators, and cultural enthusiasts. Built and maintained by the Center for New Media and History at George Mason University, Omeka is a robust publishing tool for creating online resources.

OpenSophie
http://opensophie.org
> OpenSophie is open-source software for writing and reading rich media documents in a networked environment. Funded over its lifetime by the Mellon Foundation, the MacArthur Foundation, and the University of California, Los Angeles, OpenSophie is now a project of the open source community.

Scholarly Community Blogs
http://umwblogs.org (UMWBlogs, The University of Mary Washington)
http://ucalgaryblogs.ca/ (UcalgaryBlogs, The University of Calgary)
http://blsciblogs.baruch.cuny.edu/ (Blogs@ Baruch, Baruch College, City University of New York)
http://blogs.psu.edu/ (The Blogs at Penn State, The Pennsylvania State University)
http://blogs.ubc.ca/ (UBC Blogs, The University of British Columbia)
> A growing number of campuses are providing blog services to faculty, staff, and students; a few examples are listed here. Campus blogs generally provide a single portal that aggregates all public blogs by the campus community, as well as a system for easily setting up a blog for a course, club, or individual.

SmARThistory
http://smarthistory.org

SmARThistory is an edited online art history resource to augment or replace traditional art history texts. For a given artwork, smARThistory brings together podcasts, video clips, images, links to other resources, and commentary, providing a rich context for the work.

Stories that Fly
http://www.storiesthatfly.com/

Stories that Fly is a citizen media project that features a growing collection of digital stories about general aviation. The stories are contributed by student journalists, aviators, and interested community members and cover regional airports, events, and people in the Ohio aviation community.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about the personal web.

Datagogies, Writing Spaces, and the Age of Peer Production
http://writersatwork.us/sites/Joe_Moxley/Articles/datagogies.pdf

(Joseph Moxley, *Computers and Composition,* Vol. 25, Issue 2, 2008; pp. 182-202.) This article (PDF, 676k) describes the use of peer-to-peer technologies by groups of teachers to create and discuss pedagogy and resources, and suggests that a different kind of teaching and learning takes place in learning communities that use such approaches.

The Evolution of Personal Publishing
http://www.readwriteweb.com/archives/the_evolution_of_personal_publ.php

(Alex Iskold, *ReadWriteWeb,* December 2007.) This post traces different categories of personal publishing – blogs, social networks, and microblogs – and posits that each appeals to a different type of writer and fills a particular purpose in social publishing.

Free Digital Texts Begin to Challenge Costly College Textbooks in California
http://www.latimes.com/news/local/la-me-textbook18-2008aug18,0,4712858.story

(Gale Holland, *Los Angeles Times,* August 2008.) This article discusses how open-source and free digital textbook providers might fit into the overall textbook market.

Personal Learning Environment Diagrams
http://edtechpost.wikispaces.com/PLE+Diagrams

(Scott Leslie, *EdTechPost,* 2008.) The author has collected visual representations of various descriptions of personal learning environments, displaying them on a wiki page.

A Widget Onto the Future
http://www.insidehighered.com/news/2008/12/08/widgets

(Andy Guess, *Inside Higher Ed,* 8 December 2008.) This article describes widgets — tools for personalizing the information on a website — and provides examples of some developed expressly for education.

Delicious: The Personal Web
http://delicious.com/tag/hz09+personalweb

(Tagged by Horizon Advisory Board and friends, 2008.) Follow this link to find resources tagged for this topic and this edition of the *Horizon Report,* including the ones listed here. To add to this list, simply tag resources with "hz09" and "personalweb" when you save them to *Delicious.*

SEMANTIC-AWARE APPLICATIONS

Time-to-Adoption Horizon: Four to Five Years

The idea behind the semantic web is that although online data is available for searching, its meaning is not: computers are very good at returning keywords, but very bad at understanding the context in which keywords are used. A typical search on the term "turkey," for instance, might return traditional recipes, information about the bird, and information about the country; the search engine can only pick out keywords, and cannot distinguish among different uses of the words. Similarly, although the information required to answer a question like "How many current world leaders are under the age of 60?" is readily available to a search engine, it is scattered among many different pages and sources. The search engine cannot extract the meaning of the information to compile an answer to that question even though it can return links to the pages that contain pieces of that answer. Semantic-aware applications are tools designed to use the meaning, or semantics, of information on the Internet to make connections and provide answers that would otherwise entail a great deal of time and effort.

Overview

The vision for the semantic web, originally advanced by Sir Tim Berners-Lee, is that eventually it might be able to help people solve very difficult problems by presenting connections between apparently unrelated concepts, individuals, events, or things — connections that it would take many people many years to perceive, but that could become obvious through the kinds of associations made possible by semantic-aware applications. There are currently two theoretical approaches to developing the semantic capacity of the web. One, the bottom-up approach, is problematic in that it assumes metadata will be added to each piece of content to include information about its context; tagging at the concept level, if you will. The top-down approach appears to have a far greater likelihood of success, as it focuses on developing natural language search capability that can make those same kinds of determinations without any special metadata.

Most currently available semantic-aware applications are intended to assist with searching and finding, with making intellectual or social connections, or with advertising. Tools like TrueKnowledge (http://trueknowledge.com), Hakia (http://www.hakia.com), Powerset (http://www.powerset.com), and SemantiFind (http://www.semantifind.com) are designed to provide more accurate search results, either by scanning metadata tags added to content (the bottom-up approach, taken by SemantiFind) or by using semantic algorithms or lexica (the top-down

approach, taken by Hakia). Yahoo! has released an open search platform, SearchMonkey (http://developer.yahoo.com/searchmonkey), that allows developers to create custom applications to return a certain type of information — about movies, say, or people — using semantic search of marked-up content to categorize information.

Tools for making connections between concepts or people are also entering the market. Calais (http://www.opencalais.com) is a toolkit of applications to make it easier to integrate semantic functionality in blogs, websites, and other web content; for instance, Calais' Tagaroo is a plugin for WordPress that suggests tags and Flickr images related to a post as the author composes it. Zemanta (http://www.zemanta.com) is a similar tool, also for bloggers. SemanticProxy, another Calais tool, automatically generates semantic metadata tags for a given website that are readable by semantic-aware applications, without the content creator's needing to do it by hand. Calais includes an open API, so developers can create custom semantic-aware applications. TripIt (http://www.tripit.com), a social semantic-aware application for travelers, organizes travel plans and makes useful connections; a TripIt user simply forwards a confirmation email from any travel provider — airlines, hotels, car rentals, event tickets — and TripIt automatically creates an itinerary by interpreting and organizing the information in the email according to its semantic context.

Advertisers are also finding a use for semantic-aware applications. Tools like Dapper MashupAds (http://www.dapper.net/mashupads/) extract information from the page the user is browsing and tailor sidebar advertisements to that content. If you are browsing flights to Orlando, for instance, MashupAds might show a sidebar with Orlando hotels; if you are shopping for a home, the ad might show you sample mortgage rates for comparable properties in that particular area. BooRah (http://boorah.com) is a tool that pulls information from restaurant reviews all over the web, analyzing the tone of the reviews to assign positive or negative ratings to restaurants. The links, ads, and recommendations on a BooRah detail page are all local to the restaurant's area as well.

Semantic-aware applications like these allow meaning to be automatically inferred from content and context. The promise of these applications is to help us see connections that already exist, but that are invisible to current search algorithms because they are embedded in the context of the information on the web. Semantic-aware applications are still in early development, and many of those named here are in beta at press time; errors and incorrectly identified bits of content are not unusual. However, there is a great deal of work going on in this area, and we can expect to see significant advances in the coming years.

Relevance for Teaching, Learning, Research, or Creative Expression

Education-specific examples of semantic-aware applications are still rare. To date, development of semantic-aware applications has mostly focused on creating tools to automate the process of contextualizing information and tools to process content against a semantic lexicon; end-user applications are, by and large, still in very early development. One application that illustrates some of the potential of semantic-aware applications for education is Twine (http://twine.com), a social network organized around topics of interest. Members join a "twine" on a particular topic, like biological evolution, where they can add resources and connect with others who are interested in the topic. Twine sorts resources into categories based on the type of information they contain: places, people, organizations, and so on. Twine is not focused solely on education, but there are twines on many educational topics.

The capability of semantic-aware applications to aid in searching and finding has implications for research, especially in light of the rate at which web content is being created. As semantic search tools continue to develop, it will be more common to see highly relevant results that display desired information in the hit list summary itself, saving time that is now spent clicking through to each page in turn. Semantic search also promises to reduce the number of unrelated or irrelevant results for a given search and to facilitate natural-language queries, both potentially useful features for researchers.

Like the tools described in the *2008 Horizon Report* under Social Operating Systems, semantic-aware applications hold the potential to organize and display information embedded in our data in meaningful ways that make it easier to draw connections. Semantic-aware tools to help visualize relationships among concepts and ideas are just beginning to emerge, including mashups that not only plot data on graphs or maps, but also emphasize and illustrate conceptual links. For instance, WorldMapper (http://www.worldmapper.org/) produces maps that change visually based on the data they represent; a world map showing total population enlarges more populous countries (China, India) and shrinks those that have a smaller fraction of the world's population.

A growing number of companies and educational institutions are conducting research into semantic connections. For instance, the Multimodal Information Access and Synthesis (MIAS) Center at the University of Illinois at Urbana-Champaign is conducting research and developing prototype projects on topics such as contextualizing data automatically, natural-language search, and assembling contextual information for photographs based on text that appears near similar photographs (http://www.mias.uiuc.edu/mias/research).

A sampling of use cases for semantic-aware applications across disciplines includes the following:

- **Research.** The Fundación Marcelino Botín in Santander, Spain is seeking to create a research portal to cultural heritage information about the Cantabria region, using semantic-aware applications to draw connections and combine data from a wide variety of sources, including bibliographies, prehistoric excavations, industrial heritage, and others.

- **Collections Tagging.** The Powerhouse Museum of Science and Design in Sydney, Australia is using Open Calais to add contextual tags to objects in its online collection. The process of tagging the more than 66,000 objects in the collection would be impossible by hand, but Open Calais has been able to pick out important tags from object descriptions, facilitating navigation and search through the collection.

- **Law.** A prototype project at the Autonomous University of Barcelona assists newly appointed judicial officials in resolving complex legal questions based on collected information from prior cases. Developed for the Spanish General Council of the Judiciary, the system uses contextual information to suggest solutions to problems that new judges might typically refer to more experienced judges, potentially speeding up the legal process.

Examples of Semantic-Aware Applications

The following links provide examples of semantic-aware applications.

Cleveland Clinic
http://www.w3.org/2001/sw/sweo/public/UseCases/ClevelandClinic/

The Cleveland Clinic is using semantic web concepts to search patient data to improve future patient care.

Semantic Mediawiki
http://www.semantic-mediawiki.org/wiki/Semantic_MediaWiki

Semantic Mediawiki is an extension to Mediawiki (the software upon which Wikipedia is based) that makes it easy for editors to insert "hints" into articles to enable semantic searches.

Semantic UMW
http://semantic.umwblogs.org/about/

The University of Mary Washington, in addition to hosting a blogging platform for the UMW community, is experimenting with a semantic portal as a way to organize and find content, explore the community, and find people. For instance, the "Link Friends" exhibit makes friendship recommendations based on similar linking habits.

SemantiFind
http://www.semantifind.com

SemantiFind is a web browser plug in that works with Google's search bar. When a user types a word into the search bar, a drop down menu prompts the user to select the exact sense of the word that is desired, in order to improve the relevance of the results that Google displays. The results are based on user labels on the pages being searched.

SIOC.Me
http://www.sioc.me

SIOC.Me (pronounced "shock me") is a semantic visualization tool that lets the viewer browse an Irish bulletin board (web forum) site in a 3D space. Concepts and other data are linked semantically.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about the semantic web and semantic-aware applications.

An Introduction to the Semantic Web
http://www.youtube.com/watch?v=OGg8A2zfWKg

(Manu Sporny, *YouTube,* December 2007.) This six-minute video explains the idea of the semantic web in simple terms.

On the Cusp: A Global Review of the Semantic Web Industry
http://davidjprovost.typepad.com/my_weblog/2008/09/report---on-the.html

> (David Provost, *Semantic Business,* 30 September 2008.) This blog post announces the release of (and links to) a report by the author on the current state of the industry with regards to semantic-aware applications and the semantic web.

The Semantic Web in Education
http://connect.educause.edu/Library/EDUCAUSE +Quarterly/TheSemanticWebinEducation/47675

> (Jason Ohler, *EDUCAUSE Quarterly,* Vol. 31, No. 4, 2008.) This article introduces the concept of the semantic web in an educational context and suggests some ways semantic-aware applications might be used in teaching and learning.

Semantic Web: What is the Killer App?
http://www.readwriteweb.com/archives/ semantic_web_what_is_the_killer_app.php

> (Alex Iskold, *ReadWriteWeb,* January 2008.) This article examines what is needed for the semantic web to become mainstream: a killer app that attracts and engages.

Yahoo Embraces the Semantic Web — Expect the Internet to Organize Itself in a Hurry
http://www.techcrunch.com/2008/03/13/yahoo-embraces-the-semantic-web-expect-the-web-to-organize-itself-in-a-hurry/

> (Michael Arrington, *TechCrunch,* 13 March 2008.) This post describes Yahoo's announcement to expand their Open Search Platform to make use of semantic tags embedded in web content to improve search results.

Delicious: Semantic-Aware Applications
http://delicious.com/tag/hz09+semanticweb

> (Tagged by Horizon Advisory Board and friends, 2008.) Follow this link to find resources tagged for this topic and this edition of the *Horizon Report,* including the ones listed here. To add to this list, simply tag resources with "hz09" and "semanticweb" when you save them to *Delicious.*

SMART OBJECTS
Time-to-Adoption Horizon: Four to Five Years

Smart objects are the link between the virtual world and the real. A smart object "knows" about itself — where and how it was made, what it is for, who owns it and how they use it, what other objects in the world are like it — and about its environment. Smart objects can report on their exact location and current state (full or empty, new or depleted, recently used or not). Whatever the technology that embeds the capacity for attaching information to an object — and there are many — the result is a connection between a physical object and a rich store of contextual information. Think of doing a web search that reveals not pages of content, but the location, description, and context of actual things in the real world. The means to create, track, and use smart objects has not yet entered the mainstream, but recent advances in identification technology have led to some interesting proof-of-concept applications that suggest everyday uses are just down the road.

Overview

A smart object is simply any physical object that includes a unique identifier that can track information about the object. There are a number of technologies that support smart objects: radio-frequency identification (RFID) tags, quick response (QR) codes, and smartcards are some of the most common. Objects that carry information with them have long been used for point-of-sale purchases, passport tracking, inventory management, identification, and similar applications. RFID tags and smartcards "know" about a certain kind of information, like how much money is available in a user's account and how to transfer the correct amount to a retailer for a given purchase, or which book is being checked out at a library, who the patron is, and whether that patron has any currently overdue materials. QR codes can be read by many camera-enabled mobile devices and can call up a wealth of information about the object tagged with the code. Smart chips embedded in small household appliances "know" where they are located and can access local information: your coffeepot can tell you about the weather while you pour yourself a cup.

The thing that makes smart objects interesting is the way they connect the physical world with the world of information. Smart objects can be used to digitally manage physical things, to track them throughout their lifespan, and to annotate them with descriptions, opinions, instructions, warranties, tutorials, photographs, connections to other objects, and any other kind of contextual information imaginable. Thus far, smart objects are awkward to

tag and difficult to scan for the everyday user, but that is beginning to change as manufacturers create user-friendly systems for tagging, scanning, and programming smart objects.

Products like Tikitag (http://www.tikitag.com) and Violet's Mir:ror (http://www.violet.net) provide relatively inexpensive USB tag readers, inviting-looking stick-on tags, and an easy-to-use API that lets anyone program a tag to perform operations on a computer when scanned. Systems like these are being used to keep track of personal collections (of books or collectibles, for instance); to play certain playlists when an object is scanned; or to create one-step interfaces that launch games when a child scans a favorite toy. These simple applications of smart objects represent very early uses in everyday life, and are significant because they can be set up by laypersons without a great deal of capital outlay or technological expertise. Other current applications for smart objects include wireless location of library materials, retrieval of lost or missing items, and inventory tracking.

Smart objects can also sense and communicate with other objects and report and update their own status. For instance, the Cyber Tyre by Pirelli uses a sensor embedded in the tire of a car to monitor the tire's pressure as well as the car's movements, reporting this information to the car's electronic monitoring system to improve performance.

The vision for the future of smart object technology is a world of interconnected items in which the line

between physical object and digital information is blurred. Applications that tap into "the Internet of things," as this vision is called, would assist users in finding articles in the physical world in the same way that Internet search engines help locate content on the web. Reference materials, household goods, sports equipment: an actual instance of anything a person might need would be discoverable using search tools on computers or mobile devices. Further, while looking at an object, a prospective buyer could call up reviews, suggestions for alternate or related purchases, videos of the item being used, and more, as well as finding out whether something similar lay forgotten in the garage back home.

Relevance for Teaching, Learning, Research, or Creative Expression

Smart objects have been used in industry for years, but are just beginning to enter the market for end-users. Not unexpectedly, there are very few examples of smart objects in use in academia, although significant research is being done into how to create and track smart objects and how they might eventually be used.

Libraries are an obvious target for the application of smart objects, and indeed many are using them. Smart tags are well established as a means for collection tracking and checking materials in and out. A few libraries are experimenting with further uses for smart objects: a project called ThinkeringSpace from the Illinois Institute of Technology's Institute of Design (http://www.id.iit.edu/ThinkeringSpaces/) combines physical and virtual components to produce an environment where physical objects, like books, can be annotated with contextual information that is added manually or retrieved automatically. The information remains connected with the object and displays whenever the object is scanned.

Projects like Semapedia offer insight to some of the ways smart objects might benefit education. Semapedia is a collaborative project that aims to connect tagged physical objects with online information from Wikipedia using QR codes. Users are invited to create cellphone-readable physical hyperlinks, print them out, and attach them to objects

or locations in the real world (http://semapedia. org). Semapedia includes a map indicating the corresponding physical location of objects that have been tagged.

People can be tagged as easily as objects, and some organizations are conducting experiments and research to investigate the pros and cons of smart objects carried or worn by individuals. The 2008 Hackers on Planet Earth conference (the Last HOPE) issued RFID tags to attendees and tracked their movements with readers throughout the 3-day conference. The Attendee Meta-Data Project (http:// amd.hope.net), as it was known, was intended to bring conference-goers together based on shared interests, recommend sessions to attendees, and facilitate the hallway networking that takes place at such events.

A sampling of applications for smart objects across disciplines includes the following:

- **Archaeology.** The way that a single smart object connects to a network of information is useful for many disciplines. Consider a student or researcher examining a group of objects from an archaeological dig. A tag attached to the label of each object, when scanned with a mobile device like a camera-enabled phone, would instantly bring up photographs of other objects from the dig, video of the dig site, maps, and any other media or information associated with the area.

- **Health Care.** Researchers and students at the University of Arkansas have created a simulated hospital environment in the virtual world of Second Life to test the practical and social implications of tagging and tracking patients, hospital staff, supplies, and locations. (http://www.rfidjournal. com/article/articleview/4326/2/1/).

- **Oncology.** At Purdue University, researchers have developed a tiny smart object designed to be injected into a tumor. Once placed there, the device can report on the doses of radiation received at the site where it is implanted and indicate the exact location of the tumor during treatment. (http://www.sciencedaily.com/ releases/2008/04/080408120106.htm).

Examples of Smart Objects

The following links provide examples of applications for smart objects.

Arduino
http://www.arduino.cc/

> Arduino is an open-source electronics prototyping platform that allows users to create objects that can sense and respond to the environment. Developers build or purchase small circuit boards and customize them using the Arduino software.

Home-Based Health Platform
http://www.harris.cise.ufl.edu/projects_nih.htm

> Researchers at the University of Florida are developing an ambient system to measure a person's vital signs as he or she enters the house, transmitting the information to family or doctors, as a way of monitoring at-risk individuals or the elderly.

iPhone in Education: Using QR Codes in the Classroom
http://olliebray.typepad.com/
olliebraycom/2008/11/iphone-in-education-using-qr-code-in-the-classroom.html

> (Ollie Bray, *OllieBray.com,* 24 November 2008.) The author explains and demonstrates a way to use QR codes to convey homework assignments to students.

UW Team Researches a Future Filled with RFID Chips
http://seattletimes.nwsource.com/html/
businesstechnology/2004316708_rfid31.html

> (Kristi Heim, *The Seattle Times,* 31 March 2008.) Researchers at the University of Washington are exploring the positive and negative aspects of using RFID tags to track the movements of people in a social setting — by tracking themselves.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about smart objects.

Internetting Every Thing, Everywhere, All the Time
http://edition.cnn.com/2008/TECH/11/02/
digitalbiz.rfid/

> (Cherise Fong, *CNN.com/technology DigitalBiz,* November 2008.) This article describes the Internet of things and illustrates some current examples of smart object technology.

The Net Shapes Up to Get Physical
http://www.guardian.co.uk/technology/2008/
oct/16/internet-of-things-ipv6

> (Sean Dodson, *Guardian.co.uk,* October 2008.) This article describes the Internet of things and discusses the technologies involved, as well as considering potential applications for networked smart objects.

Thinkering Spaces in Libraries
http://theshiftedlibrarian.com/
archives/2008/06/17/thinkering-spaces-in-libraries.html

> (Jenny Levine, *The Shifted Librarian,* 17 June 2008.) This post, and the two that follow it, describe the library demonstration of ThinkeringSpace as seen by the author.

When Blobjects Rule the Earth
http://boingboing.net/images/blobjects.htm

> (Bruce Sterling, *SIGGRAPH 2004,* August 2004.) Bruce Sterling's speech at SIGGRAPH 2004 describes a vision of objects that are connected to information related to their design, creation, and use; end-user reviews, ideas, and improvements; and where they are at all times.

Delicious: Smart Objects
http://delicious.com/tag/hz09+smartobject

> (Tagged by Horizon Advisory Board and friends, 2008.) Follow this link to find resources tagged for this topic and this edition of the *Horizon Report,* including the ones listed here. To add to this list, simply tag resources with "hz09" and "smartobject" when you save them to *Delicious.*

METHODOLOGY

The *Horizon Report* is produced each fall using a carefully constructed process that is informed by both primary and secondary research. Nearly a hundred technologies, as well as dozens of meaningful trends and challenges are examined for possible inclusion in the report each year; an internationally renowned Advisory Board examines each topic in progressively more detail, reducing the set until the final listing of technologies, trends, and challenges is selected. The entire process takes place online and is fully documented at *horizon.nmc.org/wiki.*

The process of selection, a modified Delphi process now refined over several years of producing *Horizon Reports,* begins each summer as the Advisory Board is selected. About half of the thirty to forty members are newly chosen each year, and the board as a whole is intended to represent a wide range of backgrounds, nationalities, and interests. By design, at least one-third of the Advisory Board represent countries outside of North America. To date, more than 250 internationally recognized practitioners and experts have participated. Once the Advisory Board is constituted, their work begins with a systematic review of the literature — press clippings, reports, essays, and other materials — that pertain to emerging technology. Advisory Board members are provided with an extensive set of background materials when the project begins, and then are asked to comment on them, identify those which seem especially worthwhile, and also add to the set. A carefully selected set of RSS feeds from a dozen leading publications ensures that these resources stay current as the project progresses, and they are used to inform the thinking of the participants through the process.

Following the review of the literature, the Advisory Board engages in the process of addressing the five research questions that are at the core of the Horizon Project. These questions are the same each year, and are designed to elicit a comprehensive listing of interesting technologies, challenges, and trends from the Advisory Board:

1 *What would you list among the established technologies that learning-focused institutions should all be using broadly today to support or enhance teaching, learning, research, or creative expression?*

2 *What technologies that have a solid user base in consumer, entertainment, or other industries should learning-focused institutions be actively looking for ways to apply?*

3 *What are the key emerging technologies you see developing to the point that learning-focused institutions should begin to take notice during the next three to five years? What organizations or companies are the leaders in these technologies?*

4 *What do you see as the key challenges related to teaching, learning, or creative expression that learning-focused institutions will face during the next five years?*

5 *What trends do you expect to have a significant impact on the ways in which learning-focused institutions approach our core missions of teaching, research, and service?*

One of the Advisory Board's most important tasks is to answer these five questions as systematically and broadly as possible, so as to generate a large number of potential topics to consider. As the last step in this process, past *Horizon Reports* are revisited and the Advisory Board is asked to comment on the current state of technologies, challenges, and trends identified in previous years, and to look for metatrends that may be evident only across the results of multiple years.

To create the *2009 Horizon Report,* the 45 members of this year's Advisory Board engaged in a comprehensive review and analysis of research, articles, papers, blogs, and interviews; discussed existing applications; and brainstormed new ones. A key criterion was the potential relevance of the topics to teaching, learning, research, and creative expression.

Once this foundational work was completed, the Advisory Board moved to a unique consensus-building process that uses an iterative Delphi-based methodology. In the first step, the responses to the research questions were systematically ranked and placed into adoption horizons by each Advisory Board member in a multi-vote system that allowed members to weight their selections. These rankings were compiled into a collective set of responses. From the more than 80 technologies originally considered, the twelve that emerged at the top of the initial ranking process — four per adoption horizon — were further researched. Once this "short list" was identified, the potential applications of these important technologies were further explored by higher education practitioners who were either knowledgeable about them, or interested in thinking about how they might be used. A significant amount of time was spent researching applications or potential applications for each of the areas that would be of interest to practitioners.

Each of these twelve was written up in the format of the *Horizon Report.* With the benefit of the full picture of how the topic would look in the report, the "short list" was then ranked yet again, this time with a reverse ranking approach. The six technologies and applications that emerged at the top of the rankings — two per adoption horizon — are detailed in the preceding sections, and those descriptions are the final results of this process.

As in previous years, the *Horizon Report* is intended to be the first step in building a research agenda rather than the final result of one; the NMC membership uses the *Horizon Report* each spring to generate

an annual *Call to Scholarship* based on the input of hundreds of faculty and staff working in campus-based groups. The Call details recommendations for research, demonstration projects, policy formulation, tools, and technology support systems related to each topic. These recommendations are a starting place for continued dialog and reflection around the six topics in the *Horizon Report,* and are acknowledgments that while these technologies offer considerable promise and potential, much work remains to be done before many of them are really ready for mainstream use.

The *Call to Scholarship* is also a call to action, and it is our hope that it will generate a cascade of activities across the academy. The NMC is deeply interested in such activities and hopes to see new demonstration projects, papers, and presentations at conferences around the ideas in each new edition of the *Horizon Report.* Simultaneous with the release of the 2009 edition of the *Horizon Report,* the NMC will launch the process to create its related *Call to Scholarship,* planned for release in the fall of 2009.

Another ongoing component of the project involves a special set of *Delicious* links that have been established to help extend the findings of the project and allow new information to be shared within the community. These *Delicious* tags are listed under the "Further Reading" section of each of the six topic areas, and readers are invited to view not only the resources that were listed in the report, but many others that were used in our research as well. Readers are further encouraged to add their own examples and readings to these dynamic lists by tagging them for inclusion in each category.

2009 HORIZON PROJECT ADVISORY BOARD