THE HORIZON REPORT

2006 EDITION

a collaboration between
The NEW MEDIA CONSORTIUM
and the
EDUCAUSE Learning Initiative
An EDUCAUSE Program

**The 2006 Horizon Report is
a collaboration between**

The NEW MEDIA CONSORTIUM

and the

EDUCAUSE Learning Initiative
An EDUCAUSE Program

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The annual *Horizon Report* describes the continuing work of the NMC's Horizon Project, a research-oriented effort that seeks to identify and describe emerging technologies likely to have a large impact on teaching, learning, or creative expression within higher education. The third edition in this annual series, the *2006 Horizon Report* is a collaboration between the New Media Consortium and the EDUCAUSE Learning Initiative, an EDUCAUSE program.

Each year, the report describes six areas of emerging technology that will have significant impact in higher education within three adoption horizons over the next one to five years. In defining the six selected areas, the project draws on an ongoing discussion among knowledgeable individuals in business, industry, and education, as well as published resources, current research and practice, and the expertise of the NMC community itself. The Horizon Project's Advisory Board probes current trends and challenges in higher education, explores possible topics for the *Report*, and ultimately directs the selection of the final technologies.

The Horizon Project expressly focuses on the ways that interesting emerging technologies can be applied to teaching, learning, and creative expression. The format of the report is carefully designed to reflect that focus: the description of each of the selected technologies includes a discussion of its relevance to those pursuits, links to examples of how the technology is being or could be applied, and an annotated list of additional readings. The technical aspects of each topic have been detailed elsewhere and are not dwelt upon in the *Horizon Report*.

Key Trends

This year, as it has in past years, the Advisory Board again specifically looked at important trends affecting the practice of teaching, learning, and creativity, and ultimately ranked those it thought were most important for campuses to watch. The four major trends that emerged are identified below and reflect significantly changing attitudes toward technology and communication that surfaced again and again in the research.

■ *Dynamic knowledge creation and social computing tools and processes are becoming more widespread and accepted.* No longer in their infancy, tools for working collaboratively at a distance are easier to use and more commonly available than in previous years. It is no longer unusual to attend a conference online or to contribute to a project wiki. As the tools have matured, the practice of online communication and collaboration has increased. This trend is at the heart of social computing and is driving personal broadcasting as well.

■ *Mobile and personal technology is increasingly being viewed as a delivery platform for services of all kinds.* Devices such as cell phones or mp3 players are almost everywhere; delivering content to those devices simply makes sense. This trend is growing in the consumer arena and is beginning to be felt in education as well. The ubiquity of these devices has enabled personal broadcasting (podcasting and vlogging) to take off almost overnight, and that is just the first wave of broadband content that will be ported to these devices, especially phones, in the next few years.

■ *Consumers are increasingly expecting individualized services, tools, and experiences, and open access to media, knowledge, information, and learning.* The demand for personalized content and services, increasingly met by savvy retailers and service providers, and greatly enabled by the ability of the Internet to allow marketers to meet individualized needs, will

surface with increasing frequency in the world of academia. Scholarly and cultural institutions are already beginning to differentiate themselves along these dimensions and that dynamic can be expected to continue and accelerate for some time.

■ *Collaboration is increasingly seen as critical across the range of educational activities, including intra- and inter-institutional activities of any size or scope.* As the ways in which researchers, students and teachers can collaborate with each other increase, knowledge is becoming a community property, and the construction of knowledge is becoming a community activity. A renewed emphasis on collaborative learning is leading to an exploration of the science of gaming, context-aware environments and devices, and their application for teaching and learning.

Critical Challenges

For the first time this year, the 2006 Horizon Project Advisory Board explicitly identified and considered many challenges facing higher education over the five-year time period covered by this report. As with the technologies that are the primary focus of the report, and the trends described above, each was identified through a careful analysis of interviews, articles, papers, and published research, and the resultant list ranked. Those that emerged as the top-ranked were considered most critical by the Advisory Board, and are listed here, in rank order.

■ *Peer review and other academic processes, such as promotion and tenure reviews, increasingly do not reflect the ways scholarship actually is conducted.* In a climate in which the established methods of peer review are grounded in print-based publications, acknowledging and verifying scholarly contributions in unusual formats can be quite difficult. Where standards are not clearly defined, it is a challenge indeed to estimate the academic significance of digital works. This affects tenure, promotion, selection of new faculty, and other academic processes as well.

■ *Information literacy should not be considered a given, even among "net-gen" students.* The skills of critical thinking, research, and evaluation of content, not to mention creative demonstration of mastery or knowledge, are needed more than ever; yet these very skills are underdeveloped in many students. Techniques for finding and assessing relevant information from the array of resources available both on- and offline are crucial, especially in light of the rising trend toward collaborative work.

■ *Intellectual property concerns and the management of digital rights and assets continue to loom as largely unaddressed issues.* This is a difficulty that is growing in scope as more institutions invest in digital archives and collections. Questions of ownership, usage rights, storage, and tagging arise as collections expand. A related aspect, searching and finding, also presents challenges.

■ *The typical approach of experimentally deploying new technologies on campuses does not include processes to quickly scale them up to broad usage when they work, and often creates its own obstacles to full deployment.* A common model for a new use of technology in education is to see it developed and deployed in a small number of courses on a single campus. Finding ways to scale successful technologies is key to widespread adoption.

■ *The phenomenon of technological "churn" is bringing new kinds of support challenges.* Clearly support needs are increasing; each new technology comes with its own requirements for support, of course, while the support needs of established technologies also remain. The very pace of the churn, however, is also creating a backlash effect from those who are asked to change the way they work, often just as they are settling into full productivity with the last new tool.

These challenges are not new to education; nor are they restricted to cases where educational

technology is employed. Taken together with the trends also highlighted by the Advisory Board, they provide a useful lens for considering the potential impact of the six technologies which are detailed in this report.

Technologies to Watch

The technologies featured in the *2006 Horizon Report* are placed along three adoption horizons that represent what the Advisory Board considers likely timeframes for their widespread adoption on university campuses. The first adoption horizon assumes the likelihood of broad adoption within the next year; the second, adoption within two to three years, and the third, adoption within four to five years.

The two technologies that appear on this year's nearest adoption horizon, social computing and personal broadcasting, have exploded over the last year, and solid educational uses and examples can easily be found on many campuses. The technologies on the two more distant horizons are unsurprisingly less tangible along that dimension, as they are perceived to be further away in time for campuses, but each of the technologies described in this report has already received considerable private sector attention.

In the main sections of the report, the discussion of each of the featured technologies includes clear examples, but generally speaking, as the horizon moves out in time, the examples tend to be more isolated or experimental in nature. Their potential is still developing, but our research suggests that all six of these areas will have significant impact on college and university campuses within the next five years.

- **Social Computing.** The application of computer technology to facilitate interaction and collaboration, a practice known as social computing, is happening all around us. Replacing face-to-face meetings with virtual collaboration tools, working on a daily basis with colleagues a thousand miles away, or attending a conference held entirely online is no longer unusual. An interesting aspect of social computing is the development of shared taxonomies—folksonomies—that emerge organically from like-minded groups.

- **Personal Broadcasting.** With roots in text-based media (personal websites and blogs), personal broadcasting of audio and video material is a natural outgrowth of a popular trend made possible by increasingly more capable portable tools. From podcasting to video blogging (vlogging), personal broadcasting is already impacting campuses and museum audiences significantly.

- **The Phones in Their Pockets.** A little further out on the horizon, but rapidly approaching, the delivery of educational content and services to cell phones is just around the corner. Among the keys that will unlock the true potential of this technology are improved network speeds, Flash Lite, and video: as new features that take advantage of the capabilities of these appear in phones, barriers to delivery of educational content will vanish.

- **Educational Gaming.** A recent surge in interest in educational gaming has led to increased research into gaming and engagement theory, the effect of using games in practice, and the structure of cooperation in gameplay. The serious implications of gaming are still unfolding, but we are not far away from seeing what games can really teach us.

- **Augmented Reality and Enhanced Visualization.** Currently in use in disciplines such as medicine, engineering, and archaeology, these technologies for bringing large data sets to life have the potential to literally change the way we see the world by creating three-dimensional representations of abstract data.

- **Context-Aware Environments and Devices.** Advancements in context-aware computing are giving rise to devices and rooms that respond to voice, motion, or other subtle signals. In the ultimate application of these technologies, the

"computing" part simply disappears, leaving an environment transparently responsive to its human occupants.

Some of these topics will seem familiar to dedicated readers of the *Horizon Report*, and indeed, social computing, educational gaming, augmented reality, and context-aware environments have all been featured in previous editions of the *Horizon Report*. The dusty crystal ball that is technology forecasting is by no means an exact science, but when it works, one hopes that the technologies selected as important five years hence will continue to remain important over that period. Educational gaming, for example, appears in the mid-term adoption horizon again for 2006, but is now considered poised for rapid growth as a new emphasis on the science of gaming builds on serious research into its potential for learning. These developments, and a growing awareness and focus on the topic generally, will help those who regard educational gaming with skepticism to better understand its uses, applications, and implications.

Social computing, regarded as a more long-term phenomenon in last year's report, moved forward faster than anticipated, fueled by interest in folksonomic and similar tools, and is now relatively commonplace. Context-aware environments and devices have been moving into educational usage at a somewhat leisurely pace, and have been listed as something to watch on the 4- to 5-year horizon now for some time. Nonetheless, the technology continues to develop, and in very interesting ways. Context-aware devices are often so successful at dissolving the boundaries between human and computer that people do not realize they are dealing with a device in this category. Several can be found in the consumer marketplace already, providing information visually on the weather or stock portfolios. Many interesting classroom applications are emerging, including new ways of conceiving the classroom itself that will make it much more responsive and adaptable than the spaces we use today.

Augmented reality has also been on the four-to-five year horizon for some time now, and like context-awareness, has continued to evolve in compelling ways. The underlying technology shares much in common with emerging 3-D visualization tools, and the two are discussed together this year.

Each of these returning technologies have been part of Horizon Project discussions for some time; the fact that they again have risen to the top of the rankings for 2006 is a strong indication of the impact they promise for campuses.

About 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, and websites to generate a list of technologies, 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, 50 or more of these technologies may be identified for further investigation; for the 2006 report, more than 80 were considered.

By engaging a wide community of interested parties, and diligent Internet searching, 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 may be used in settings outside of academe, to appreciate the potential of each for higher education settings, and to envision applications of each technology for teaching, learning, 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 *2006 Horizon Report*, the 21 members of this year's Advisory Board engaged in a comprehensive review and analysis of research, articles, papers, and interviews; discussed existing applications, and brainstormed new ones; and ultimately ranked the items on the list of candidate technologies for their potential relevance to teaching, learning, and creative expression. Most of this work took place online over the fall of 2005, using a variety of social computing tools, most notably a special wiki site dedicated to the project.

From the more than 80 technologies originally considered, the twelve that emerged at the top of the initial ranking process 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.

Penultimately, 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. The six technologies and applications that emerged are detailed in the sections that follow, and those descriptions are the final results of this process.

SOCIAL COMPUTING

Time-to-Adoption Horizon: One Year or Less

The topic of social computing is not new to this report; it has been on the horizon for some time and moving closer over the past few years. Already in common use outside of the educational arena, social computing practices are cropping up on campuses with increasing frequency. The promise of social computing has been—and continues to be—more effective knowledge generation, knowledge sharing, collaboration, learning, and collective decision-making. This promise is now beginning to be realized in the areas of distributed learning, research, and campus work settings.

Overview

Social computing is essentially the application of computer technology to facilitate collaboration and working in groups. The emphasis is on the social part of social computing: what makes this phenomenon interesting, and what is likely to make it long-lasting, is the way it facilitates an almost spontaneous development of communities of people who share similar interests. In just twelve months, this technology has moved from the distant horizon to the near-term one. This change has been driven in part by the widespread acceptance and use of the tools that make social computing possible; but it has also resulted from an atmosphere of openness to the kinds of activities that can take place.

Professionals are increasingly willing to take part in meetings and conferences online and to work in distributed groups that may meet in person only a few times a year. The venues for "virtual" meetings have matured, making the experience of working together online easier and more pleasant. It is not uncommon to make substantive connections with people online, making it possible to develop extensive personal and professional networks. Among young people, it is already very common to connect online with those in one's social circle.

Small, easy to use, and often free, social networking tools are influencing this trend, and an interesting new dimension is appearing as these tools find applications in social computing. Social computing interactions are beginning to transfer from the world at large into the world of education. Students, already familiar with tools for working together and sharing knowledge and information (think of Flickr, an online community for sharing photographs; instant messenger, for getting quick answers to questions and arranging get-togethers; or Skype, for inexpensive voice-over-IP conversations in realtime), are bringing these tools to campus and continuing to integrate them into their pattern of daily life and work.

An emerging aspect of social computing developing alongside online communities is the way that formal taxonomies for information are gradually giving way to "folksonomies." Instead of a scholar designing a taxonomy for, say, describing web resources on a given topic, a folksonomy—a collection of tags defined by people in the community of interest—emerges spontaneously from members of the community. Simply by applying tags that make sense, using tools that allow commonly applied tags to float to the surface, the community develops its own sorting and ranking criteria for materials of interest.

Relevance for Teaching, Learning, and Creative Expression

Social computing practices have obvious application for distance learning and training. Taking courses at a distance can now have a substantially similar feel to the interactions possible in face-to-face courses, thanks to synchronous meeting rooms that take advantage of voice-over-IP or video capabilities. Conferences take place without the expense of travel—and with the added benefit of an online

archive of conference materials once the event is over. Applications like these are already taking place in educational settings.

Of interest for the near future is the potential of folksonomic tools to transform the way we label and find articles, resources, and other materials. Just as tools like Flickr, Facebook, del.icio.us and others have replaced taxonomies and ontologies in social networking contexts, it is anticipated that folksonomic tools will allow researchers to dynamically create coding and classification schema that reflect the collective wisdom of their community. College websites incorporating such tools would use tags created by users to enable sophisticated non-linear browsing, searching, and finding based on user perceptions and needs. Tagging by members of a specific learning community such as students in a particular course could lead to a course-specific language, or a kind of shorthand for complex topics, that would enrich discussion and increase a feeling of community instead of isolated learning.

As the amount of material available on the Internet expands, it is increasingly valuable to be able to quickly determine the relative value of any particular piece of information or media. One way to do this is to review the opinions of trusted friends and colleagues; folksonomic tools make this possible. By tagging the good and ignoring the bad, the community makes it easier to find useful material. This process has obvious application to teaching, learning, and research, as well as to creative expression (consider remix culture: the easier it is to find something, the easier it is to reuse it).

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

- **Collaborative Writing and Research.** Using blogs, wikis, or group writing tools, students and researchers can review, edit, and comment on each other's work, create an archive of resources and reference materials, or write a collaborative document. Faculty in the Department of English at York University require students in a literary criticism course to keep a weekly blog journal—and to comment on the journals of their classmates.

- **Visual and Performing Arts.** Art history faculty at the State University of New York use Flickr's notes and comments feature to have students analyze and comment on artworks. Students can select a portion of an image to attach a short comment to, and can also add longer comments beneath the image.

- **Business.** Students could work with counterparts in other countries to learn local business practices, conversational etiquette, and customs. Using groupware tools, they could develop collaborative "business manuals" describing what they have learned.

Examples of Social Computing

The following links provide examples of social computing applications.

Art Museum Community Cataloging Project
www.steve.museum/
> The Art Museum Community Cataloging Project seeks to resolve the disparity between museum professionals' tagging terms and those of museum visitors—which rarely match—by encouraging public tagging of museum collections online.

43 Things
www.43things.com
> What are the top forty-three things you would like to accomplish? List and tag a goal, find out how many people share it, and get advice from people who have already done it, whatever it is.

"Images of Africa" Syllabus
weblogs.swarthmore.edu/burke/?p=87
> A Swarthmore faculty posts the syllabus for his course on African art and culture, and receives comments and suggestions from his peers.

Wikipedia

www.wikipedia.org

> One of the best-known wikis, Wikipedia is an online editable encyclopedia.

World Jam

www.research.ibm.com/SocialComputing/WorldJam.htm

> For 72 hours, IBM employees all over the world participated in a community activity that let them find and connect with each other, synchronously and asynchronously, using a variety of social computing methods.

For Further Reading

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

Communal Categorization: The Folksonomy

www.davidsturtz.com/drexel/622/sturtz-folksonomy.pdf

> (David Sturtz, December 16, 2004) This white paper provides a general overview of folksonomy, including examples.

Designing for the Virtual Interactive Classroom

www.campus-technology.com/article.asp?id=11046

> (Judith V. Boettcher, *Campus Technology*, May 1, 2005) This article discusses possible ways to use technology for synchronous collaboration in small and large groups.

Folksonomies: Power to the People

www.iskoi.org/doc/folksonomies.htm

> (Emanuele Quintarelli, June 24, 2005) This paper discusses the history and evolution of folksonomies and describes how they may address issues of classification that taxonomies do not.

Folksonomy for Applied Analysis and Market Action

thecommunityengine.com/home/archives/2005/02/folksonomy_for.html

> (*The Community Engine Blog*, February 23, 2005) This article contains an overview of folksonomy and discusses cultural issues regarding tagging and how tagging can be used to target a specific group.

Romantic Poetry Meets 21st Century Technology

chronicle.com/free/v51/i45/45a03501.htm

> (Brock Read, *The Chronicle of Higher Education*, July 15, 2005) This article describes how wikis are being used in literature courses—with satisfying results.

RSS Feeds College Students' Diet for Research

www.usatoday.com/tech/news/2005-08-01-rss-research_x.htm

> (Anh Ly, *USA Today*, August 1, 2005) Discusses how RSS is becoming more popular among college students to obtain research information from the web.

Wiki Pedagogy

www.profetic.org:16080/dossiers/dossier_imprimer.php3?id_rubrique=110

> (Renee Fountain, 2005) This extensive article describes wikis and explores their potential pedagogical aspects.

PERSONAL BROADCASTING

Time-to-Adoption Horizon: One Year or Less

At the leading edge of a wave that will last for the next several years and beyond, personal broadcasting takes advantage of small, easy-to-use devices that people already carry to capture and share personal experiences, information, and events. This trend, which has roots in text-based media (personal websites and blogs), is expanding to include audio and video, as the tools for capturing and sharing those media become smaller and better. From podcasting to video blogging (vlogging), personal broadcasting is an increasingly popular trend that is already impacting campuses and museum audiences.

Overview

Already in common use among consumers, informally produced personal audio and video content is rapidly moving into academia as a form of personal expression and as a means of information delivery.

Recording devices for both audio and video are small, portable and relatively inexpensive, the quality of captured media is high, and the process of publishing video and audio is becoming easier and easier. Already it is possible to drop a video clip directly onto a web page, trimming and uploading it in one step (see VideoEgg, www.videoegg.com, for one example; there are others). The clip can be embedded in any web page with a few lines of provided code. Audio is equally easy to share: a podcast can be quickly published to the iTunes music store, for example, where it is easily retrieved.

The podcasting phenomenon is a good example, and in retrospect, it seems obvious why it has become so widespread. Young people were the target of very sophisticated marketing campaigns that assured the popularity of the iPod; almost overnight, it seemed that nearly everyone had one. The appeal of the device itself was increased by its size (tiny) and weight (light). Utterly portable, popular, and cute, the iPod is also incredibly easy to use: adding content is a snap. Podcasting provides an easy means for educators to take advantage of this ready-made, widely available tool and deliver educational content for it as well.

Webcasting, a video counterpart to podcasting, is also growing in popularity. At some universities, certain courses are routinely webcast (video is recorded and streamed live to the web and/or made available as a recording after class), providing students with an archive of each class session for review. Stanford, MIT, and others have made selected seminars freely available online. Vlogging, a form of blogging where the main content is in the form of video clips and text entries serve as annotations, is gaining popularity among bloggers. As it becomes easier to capture, publish, and search video, personal video broadcasts will become more common. As devices for recording audio and video begin to converge with the most ubiquitous personal tool, the cell phone, personal broadcasting will take off even faster.

Social networking tools which cater to a specific community and allow users to generate and share content offer another avenue for personal broadcasting. Consider Facebook, which is aimed specifically at high school and college students. As a place where students can connect with age mates in their own geographical area, Facebook became incredibly popular almost overnight. This trend is expanding as social networking tools incorporate video and audio. This integration will unfold very quickly as cell phones that can capture high-quality audio and video gain market share.

Relevance for Teaching, Learning, and Creative Expression

Personal broadcasting has applications not only for transmitting content for students' use, but also in having students create content. In terms of prepared content, the increasing presence of ever more

capable devices among students, such as today's iPods, has already spurred the creation of podcast content expressly for that platform.

Many students who own laptops do not carry them to class because they are bulky, heavy, and "uncool." Small devices like the iPod, however, without these limitations, go wherever the student goes. Since students buy them anyway, universities do not incur the expense of providing the equipment. Even the content delivery mechanism has been provided for: any mp3 file can be downloaded and copied onto the device. The promise of portable devices is that they are small and students already own and carry them; the challenge is to deliver educational content and services to those devices.

The other side of the coin is content created by students. Small recording devices can obviously be used to capture lectures for later reference; but the potential goes far beyond that. Imagine students recording interviews with classmates, faculty, or domain experts, or capturing video footage during fieldwork, and then using the raw recordings to create a multimedia presentation. A collection of clips captured over time and presented in blog format could document the development of a project.

Personal broadcasting has applications across the disciplines, as the following examples suggest:

- **Foreign Language.** Readings from poetry and literature, and recordings of conversations, can be podcast so students get a feeling for the sound of the language, or to practice dictation. Students could prepare and host a weekly podcast on current events—delivered in the language they are studying.

- **Visual and Performing Arts.** Drama faculty at the North Carolina School for the Arts are using iPods to record accent and dialogue for students to study. At Skidmore College, when students in a sculpture class break into project groups, one student in each group is assigned the task of documenting the group's work with photographs, audio and video—and putting it on the web.

- **Multidisciplinary Coursework.** At Johns Hopkins University, students use an interactive map software application developed at JHU's Center for Educational Resources to collaborate in "digital field experiments." In one multidisciplinary course, students work in teams to study urban issues such as public health, crime, or public art. Using iPods and digital cameras, the students record interviews and take photographs and videos in the field to document their topic. The data is organized using the interactive map tool, which allows the students to tell a story and analyze the data spatially. To complete the project, the students create an NPR-like news article using recorded narrative and clips of their interviews.

Examples of Personal Broadcasting

Personal broadcasting is becoming more common in educational settings, as the following examples show:

Artcasts at SFMOMA
www.sfmoma.org/podcasts

This monthly podcast from the San Francisco Museum of Modern Art features the voices and sounds of artists, writers, curators, musicians, and visitors as they respond to exhibitions and artworks on view at SFMOMA. Available free through iTunes, the podcasts can be listened to at home or brought into the museum to enjoy while looking at the works being discussed.

Ask the Techies at Ohio University
cscwww.cats.ohiou.edu/aac/lab/techies/

Ohio University offers a weekly video podcast (vodcast) series covering a range of technology topics, from how-tos to reviews of current technology. The vodcasts are informative, but also light-hearted and fun, designed to appeal to non-techies. Available on the campus website and also through iTunes, the vodcasts are free to anyone. Upcoming topics include digital copyright issues, Photoshop tips, and an inside-the-case computer tour.

Interdisciplinary Center for eLearning, University of North Carolina at Greensboro
ice-notes.blogspot.com/

The Interdisciplinary Center for eLearning (ICE) maintains a blog that discusses technological issues of import to the campus. Another program in the works by ICE, the mLearning (or Mobile Learning) Institute, will train interested faculty who want to incorporate personal broadcasting (video or audio) in their courses. (See the December 9, 2005 blog entry for further details on the mLearning Institute.)

Out of the Past: Investigating Film Noir at Saint Mary's College of California
outofthepast.libsyn.com

Out of the Past is a film analysis podcast hosted by faculty members Richard Edwards (Communications) and Shannon Clute (Modern Languages). Considered "a serialized academic text," it forms the basis of a co-taught course at Saint Mary's College of California in which specific episodes are assigned as published articles would be. The podcast is available at iTunes and most major podcasting directories.

For Further Reading

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

Edupodder.com
www.edupodder.com

Edupodder.com is a website founded and maintained by Steve Sloan, an academic technologist at San Jose State University. The site includes resources, examples and a blog about the medium of podcasting.

The iPod iDea
www.dukemagazine.duke.edu/dukemag/issues/091005/ipod2.html

(James Todd, *Duke Magazine*, September/October 2005) Duke University gave iPods to incoming students—and faculty incorporated them into their courses. This article gives an account of how the iPod experiment has been perceived by faculty and students.

Podcasting & Vodcasting: A White Paper
edmarketing.apple.com/adcinstitute/wp-content/Missouri_Podcasting_White_Paper.pdf

(Peter Meng, University of Missouri, March 2005) This white paper provides a detailed discussion of podcasting and vodcasting, including how to do it, possible uses of the technologies, and pedagogical implications.

SixApart Simplifies Video Blogging
www.eweek.com/article2/0,1895,1877776,00.asp

(Shelly Solheim, *eWeek*, October 26, 2005) This short article describes how one blog service provider makes it easy to add video.

Trend: Podcasting in Academic and Corporate Learning
www.learningcircuits.org/2005/jun2005/0506_trends

(Eva Kaplan-Leiserson, *Learning Circuits,* June 2005) This article provides an overview of podcasting and includes potential applications for education.

Vlog Map
www.vlogmap.org/

How many video blogs are there in the world? This map will give you an idea. Click a pin on the map to view a blog and find out who keeps it and where they live.

Wikipedia: Podcasting
en.wikipedia.org/wiki/Podcasting

The Wikipedia offers an extensive article on the history and current state of podcasting, including links to examples, tutorials, and discussion about the topic.

THE PHONES IN THEIR POCKETS

Time-to-Adoption Horizon: Two to Three Years

Cell phones, which are commonly carried by virtually every college student, have begun to feature many capabilities that initially were associated with other devices, such as e-mail, instant messaging, web browsing, web services, and now even video. Phones are small, convenient, and increasingly powerful. As faster networks spring up to support data transfer at speeds that rival the wireless cards in most laptops, phones become the ideal device for accessing content of all kinds. This transition is still in its infancy but is destined for rapid growth: its value to education will become apparent when we are able to use it to deliver educational content—right to the phones in their pockets.

Overview

Today's cell phones (or mobile phones, as they are called in most of the world) are leaps and bounds beyond those that were available just a few years ago. The capabilities of even run-of-the-mill phones now include scheduling, text messaging, assorted tools and games, and web browsing. With each newly released phone, another technology is assimilated: cameras and cell phones converged almost overnight, and now there are phones that can shoot video, play music, and pay for your lunch. These features are commonly found in European and Asian markets, and will become broadly available in North America over the coming months as well.

The technology that makes this possible is known as third-generation mobile telephone technology, or simply, 3G. This infrastructure allows significantly faster upload and download times than were previously possible (64 kbps for upload and up to 200 kbps for download on 3G networks compared to just 9.6 kbps for upload and 29.8 kbps for download on older 2G networks). The first nationwide implementations—in Japan, Korea, and Singapore—will be fully completed in 2006.

In the United States and Canada, 3G (and its successor, 3.5G, which is even faster) is already finding its way into major metropolitan areas, and the entertainment industry is taking advantage of it. The implications for content delivery are profound: television broadcasting, music, and sophisticated web content will soon be available on one device

that fits in your pocket. Currently, the majority of applications are commercial; but networks that carry television, movies, music videos, and sports can also carry educational content. Just as we did with the Internet, educators will find ways to create and deliver materials for teaching and learning through channels that began as commercial venues.

When broadband hit the Internet, an explosion of content and services—both commercial and educational—was the result. Third-generation mobile telephone technology is broadband for phones. Just as broadband brought video, file sharing, music, shopping, and rich avenues for interaction to the Internet, all of these applications are now headed to the phone in your pocket.

Relevance for Teaching, Learning, and Creative Expression

This technology is moving so quickly that it is difficult to find specific educational examples, but it is precisely this rapid growth that puts mobile phones into this adoption horizon. It is assumed that many applications for 3G mobile phones will be similar to what is currently available on the Internet, but with a smaller form factor—and a wider reception area: mobile phones do not require hotspots like wireless computers do. The fact that so many students already own mobile phones, and do not object to carrying them, only increases their potential utility as a way to access educational material.

That is not to say that there are no existing examples of the educational use of mobile phones; and we can certainly extrapolate some possible scenarios from observing current commercial uses. Some professors have begun to use SMS (short messaging service, also called text messaging or texting) as a means for polling students during class, or for providing short pop quizzes. Language learners take advantage of short lessons over the phone by calling in and listening to a recorded lesson, or conversing with a speaker of the language they are studying. In the United Kingdom, universities are experimenting with allowing students to take examinations using their mobile phones; their unique voice print identifies them as the test-taker, and answers are spoken into the phone or keyed in.

Using the phone as a web browser opens up the Internet to access anytime, anywhere, without the hassle of carting around a laptop and finding a wireless node. As mobile phone technology improves, the resolution of the screen is becoming less of a barrier to reading content; Flash and similar technologies are increasing the display capabilities to the point where sophisticated formatting is possible, even on those tiny faces. In Japan, where *manga* (comic-book-like graphic literature) is used not only for entertainment but for training manuals, how-to guides, cookbooks, and other reference materials, the transition of such material to the mobile phone has already begun. The frame-by-frame style of *manga* lends itself particularly well to small-format displays.

Another application emerging in Japan is the two-minute video. These short clips, which include music videos, mini-documentaries, and snippets of news or information, can be downloaded and viewed on a mobile phone whenever the owner has a few free moments. It is easy to visualize a series of two-minute videos related to a course, released weekly like podcasts, that expose students to additional aspects of the topic or reinforce key points, complete with diagrams and animations—mobile learning objects, delivered right to a learner's cell phone.

Mobile phone technology also commonly includes a variety of software and productivity tools, and these are already being used to store and access useful reference materials. Physicians can look up drug interaction information, recommended dosing schedules, and other medical data by subscribing to *Hippocrates,* a service that provides updated electronic copies of commonly-used reference materials. Similar services could easily supply fields like law, engineering, government, and education. With these materials in your phone, and your phone within arm's reach, detailed and up-to-date reference information is available whenever and wherever you need it.

For many students, mobile phones belong to the set of necessary equipment without which they do not leave the house. If we can first recognize how students use mobile phones and then design activities that will help them access educational materials, form learning communities, and participate in rich conversations that take advantage of those avenues, we will be able to ride the wave of mobile technology right alongside them.

Examples of Educational Use of Cell Phones

A wide variety of experimentation is taking place with cell phones in education, as the following examples show:

Classroom Experiments Using Mobile Phone Messaging as a Response Medium
papers.ssrn.com/sol3/papers.cfm?abstract_id=605863

> Stephen Cheung of the University of Sydney used SMS messaging to conduct classroom experiments in economics, including the bargaining game and the contributions game. This replaced the previous, inefficient paper and pencil method; it is worth noting that creating a full computer simulation of these games was not a practical option, but moving them to text messaging on cell phones was.

Learn Chinese Via Mobile Phones
cnx.rice.edu/content/col10286/1.1/

> This course, described on Rice University's Connexions website, teaches Chinese using the Imperial Method—and takes place entirely over the phone.

Pocket Education
westmidlands.ideasfactory.com/new_media/ features/feature51.htm

> At Coventry University in England, students in the New Media Studies Program are using smart phones to download videos and to receive their grades.

For Further Reading
The following articles and resources are recommended for those who wish to learn more about the educational potential of mobile phones.

Cell Phones: Nuisance or Necessity?
www.glencoe.com/sec/teachingtoday/ educationupclose.phtml/52

> (Elizabeth Melville, *Teaching Today*, January 2005) Presents pros and cons of allowing cell phones in classrooms, and suggests some possible educational uses for phones.

Cingular Wireless Launches Cingular Video™ with Exclusive Content
www.prnewswire.com/mnr/cingular/23356/

> (Press release, December 15, 2005) Cingular Wireless and HBO announce the release of on-demand streaming video, including episodes of popular television shows, clips of selected scenes, and bonus content, to 3G phones. The service will be available early in 2006.

Enabling Mobile Learning
www.educause.edu/er/erm05/erm0532.asp

> (Ellen D. Wagner, EDUCAUSE Review, May/ June 2005) A discussion of what mobile learning might mean for education.

The Future of Mobile Technology: Learning "on the Run"?
www.nestafuturelab.org/viewpoint/vision/vision_ 01_04.htm

> (*Vision*, June 2005) Discusses mobile technology and some possible educational applications.

The Future of Cell Phones
news.designtechnica.com/featured_ article34.html

> (Chris Nickson, *DesignTechnica,* October 24, 2005) This article describes features available with 3G phones, discusses 3G network implementation, and offers a peek at what lies beyond.

Software Allows College Test Prep Via Mobile Devices
www.technewsworld.com/story/42644.html

> (Jack M. Germain, *TechNewsWorld*, April 30, 2005) Software for certain mobile devices, including some cell phones, provides practice for college preparation exams like the SAT.

What Can You Learn from a Cell Phone? Almost Anything!
www.marcprensky.com/writing/Prensky-What_ Can_You_Learn_From_a_Cell_Phone-FINAL.pdf

> (Marc Prensky, 2004) This paper suggests a variety of uses for cell phones in classrooms.

EDUCATIONAL GAMING

Time-to-Adoption Horizon: Two to Three Years

Educational gaming has seemed tantalizingly close yet somehow not quite within our reach for a number of years, but the promise of educational gaming continues to fascinate us. The potential for learning in this space is broad, and there is much work to be done. We are just beginning to see the results of research into gaming and engagement theory, the effect of using games in practice, and the structure of cooperation in gameplay. By studying the principles of game design, educators are learning more about how to package and deliver content to facilitate comprehension and retention. Educational gaming is a growing field with serious implications for adult learning that we are only beginning to understand.

Overview

The past year has seen a subtle shift in the way educational gaming is perceived in higher education. A number of interesting examples have shown anecdotally that games can be very effective tools for learning. As a result, there is an increasing interest among scholars in researching the subject, not only to quantify the actual effect of using games to teach, but also to define the essence of gaming itself in order to better apply its principles to education. Educational gaming is no longer a fringe activity pursued only by extreme technophiles—it is emerging as a discipline unto itself, multifaceted and rich.

Degree programs are springing up in game design and game theory, two subjects that have not traditionally been among the program offerings in higher education. Courses range from mathematics for game programmers to ethics in cyberspace to storyboarding and character sculpting. These programs embrace the technical considerations of creating games, certainly; but the theoretical aspects of gameplay, the ideas that have implications for all kinds of educational activities, are beginning to receive an equal share of attention.

By studying successful consumer games of all kinds (massively multiplayer online games, console games, board games, and physical games, for instance), researchers are teasing out the basic principles of gaming that lead to engagement and success. Students in game design courses apply these principles as they develop educational games, but the same guidelines may also transfer to development of non-game educational materials. Imagine a set of curricular materials that are as approachable—and as hard to put down—as your favorite game, but that contain solid educational content. Further research in this area is warranted, of course, but the possibilities are intriguing.

The complexity of the discipline is reflected in the array of activities that fall under the umbrella of educational gaming. Consider just a few of the many types of games that are being explored in terms of their educational potential:

- **Simulations.** A simulation essentially mimics a real-world process. Based on complex mathematical formulae that operate on large data sets, simulations allow repeated practice of difficult procedures or experience with delicate and complex equipment. Common uses include flight training, medical applications, and conflict resolution. Creating a simulation can be as educational as using one: skills in mathematics, statistics, and domain knowledge of the field being modeled are required in order to model a real-life process accurately.

- **Virtual environments.** The popularity of consumer games like *Second Life* and *World of Warcraft* has its source partly in the visually rich, engaging environment in which these games are played. The engines that are used to create those environments are like a set of drawing tools; they

are inherently theme-independent and can be used to create any kind of world that is desired. A number of projects are underway to develop open-source gaming engines for educational or other use that can recreate ancient spaces, develop models of cities or campuses, or bring remote ecosystems right to your computer for study.

- **Social and cooperative play.** Online or not, one appealing aspect common to many games is the interaction with other players. Whether competitive or cooperative, social interactions during gameplay offer a rich source for study by game theorists. While face-to-face cooperative play has been the subject of scholarly studies for several years, a new facet is being explored as researchers venture into the world of massively multiplayer online role-playing games (MMORPGs) to study the interactions that take place there.

- **Alternative reality games.** Mixing gameplay and real life, alternative reality games challenge players to critically examine items and events that appear to be real, at least on the surface, in order to first discover and then solve a mystery. This type of game operates in both space and time, often taking months to complete and involving clues online, in public spaces, even in players' personal mail. Orchestrating such an experience is demanding as well: the puppet masters, as the game designers are called, must conceive of the mystery, design and plant clues, and monitor players' progress throughout the game.

These are only a sampling of the kinds of games that are being studied for potential learning applications. The power of gaming to engage learners of all ages marks this emerging discipline as one of special import for education.

Relevance for Teaching, Learning, and Creative Expression

Games can be applied across the curriculum, and research is continually uncovering new uses. Using games in practice helps present concepts in new and interesting ways, makes topics more approachable to the novice learner, and provides new opportunities for collaboration and competition among learners.

One aspect of gaming that makes it so flexible a tool for teaching and learning is the way it can be approached from the angle of game creation as well as play. A significant level of research is required to develop a compelling game. Depending on the kind of game, detailed statistics, descriptions, measurements, and historical data must be gathered and assimilated to inform development of the game environment or rules. At the College of New Jersey, the new Game Design Program addresses this by offering a year-long multidisciplinary learning experience in which students collaborate across disciplines to develop a multiplayer online game. Students learn to understand and appreciate concepts outside their own areas of expertise while developing advanced skills in their chosen fields.

A sampling of disciplines using educational gaming include the following:

- **Anthropology.** A course at Trinity University required students to use a combination of quantitative and qualitative research methods to explore sociological issues associated with massively multiplayer virtual worlds (*World of Warcraft*, in this case). Each student in the class pursued a different research question, preparing a scholarly paper based on data collected during the study.

- **History.** An online game representing the cultures of antiquity is being developed as a collaboration between scholars at Oxford

University and the University of British Columbia. Students use open-source tools to reconstruct content from archaeological data; the content undergoes verification by academic peer review, and approved content is added to the game. The final result will be a massively multiplayer "game of antiquity" designed to bridge the gap between growing popular interest and ongoing research in the field.

- ■ **Mathematics.** Simulation and game engine design draws on mathematics as much as on computer science. Mathematical formulae can be used to represent in-game events that occur when environmental rules are influenced by player-generated variables. A student-led team at the University of Illinois at Urbana-Champaign is designing a mathematically-based open-source gaming engine that will be used to create three-dimensional virtual worlds.

- ■ **Nursing.** Several simulations have been developed for nursing students, focusing on topics like pain management, the effects of drugs on the human system, and drug interactions. These activities allow the student to explore different options without involving a living patient, broadening their understanding of core concepts in the field of nursing.

Examples of Educational Gaming

The following links provide examples of educational gaming applications.

Basic Genetics at MIT: Live Long and Prosper
education.mit.edu/pda/igenetics.htm

This game, designed to be played on a PDA, helps players understand basic genetics. Players work with five different traits as they try to figure out which chromosomes affect which traits, and how to breed the traits that will result in longest life.

Girls as Game Designers
spacepioneers.msu.edu/

The Comm Tech Lab at Michigan State University has a project funded by the National Science Foundation called *Girls as Game Designers,* which does research on how girls and boys approach games, and how games affect them. One of the projects that has grown out of the *Girls as Game Designers* research is *Alien Games,* which is designed to interest high school and middle school girls in biology and space science.

Houston Community College, Southwest: Digital Gaming Simulation Department
swc2.hccs.edu/digiGAME/html/courses.php

The Digital Gaming and Simulation Department at Houston Community College, Southwest offers career training to prepare students for employment in the game industry; typical careers include game artists and game programmers.

Intermediate Multimedia Authoring at Bradley University
multimedia.bradley.edu/gaming/313syllabus.pdf

This course offered at Bradley University uses game design as a conceptual topic to teach user-centered design, complex programming constructs, and team-based production processes. Over the course of the semester, student teams design and create a major game.

University of California, Berkeley: Field Work in Anthropology
anthropology.berkeley.edu/courses.html

The University of California, Berkeley offered an anthropology field work course in fall 2005, *Theory and Practice in the 6th Grade Archaeological Afterschool Program*. In this course, undergraduate students work with 6th graders, designing and facilitating experiences involving digital storytelling, computer games, web browsing, and hands-on exploration of real artifacts to share the archaeological experience.

For Further Reading

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

Designing Courses: Digital Games for Learning
www.ibritt.com/resources/dc_games.htm

This website includes a detailed annotated bibliography with links to game-related articles.

Games on Mobile Phones Could Improve Science Education Across Europe
www.brad.ac.uk/admin/pr/pressreleases/2005/grid.php

(Press release, May 9, 2005) At The University of Bradford in England, the GRID project is researching the delivery of educational content to handheld devices and mobile phones. The project's hope is to inform the techniques and best practices of teaching science and technology in schools.

Play and Learn
theage.com.au/articles/2005/08/23/1124562860174.html

(David Stonehouse, *The Age*, August 27, 2005) Outlines the educational possibilities for gaming, raises pertinent questions, and gives an overview of the academic movement toward digital gaming.

Proof of Learning: Assessment in Serious Games
www.gamasutra.com/features/20051019/chen_01.shtml

(Sande Chen and David Michael, *Gamasutra*, October 19, 2005) Discusses the challenges and issues of assessing game-based learning.

Viewpoint: Online Courses as Video Games
www.campus-technology.com/article.asp?id=11309

(Dr. Rodney P. Riegle, *Campus Technology*, July 15, 2005) Discusses role of video games in different forms of learning and issues that arise when non-gamers teach using games.

AUGMENTED REALITY AND ENHANCED VISUALIZATION

Time-to-Adoption Horizon: Four to Five Years

While still a few years away from general acceptance and use in education, augmented reality and enhanced visualization are already in use in disciplines such as medicine, engineering, the sciences, and archaeology. By offering a visual representation of large data sets, these technologies open the door to new ways of understanding the world. Augmented reality overlays information onto the real world, supplementing what can be seen with what is hidden. Enhanced visualization creates a three-dimensional experience based on a set of data, bringing the information to life in a way that makes it almost physically present. Both have the power to transform understanding, and both will have greater implications for education in the coming years.

Overview

Well underway in disciplines such as medicine, engineering, the sciences, and archaeology, augmented reality and enhanced visualization techniques offer dramatic new ways to use visual comprehension skills to explore complex phenomena, situations and relationships. Large data sets can be experienced as three-dimensional spaces or objects; exact models of anatomical features can be created and held in the hand; systems too small or too large to actually be seen can be scaled up or down, filling a room or fitting on the top of a desk. Faithful copies of fragile objects can be "printed" on rapid prototyping printers, to be safely examined and manipulated. The hidden is made plain: internal wiring projected onto walls, or a broken bone superimposed on the outside of a leg.

Augmented reality (sometimes called annotated reality) overlays data onto the real world. A very simple example is common in language classrooms, where objects are labeled with their names in the language of study. Some applications of augmented reality require special glasses that display information as the wearer looks around, like those used for night vision. The kind of information shown, and the way it is displayed, can vary from text lists or statistics to diagrams and drawings, depending on the context.

Enhanced visualization takes a different approach; instead of overlaying data onto the real world, a new world is created from data. You can walk into this space and look around. For example, based

on seismic data of an oil field, a visualization of the entire field can be created and scaled down to fill a room. Looking at this field, engineers can determine the best way to get to the oil before they install any equipment in the field itself. Rapid prototyping printers are another enhanced visualization device: by sending a large dataset to the printer—the makeup of a complex molecule, say, or the specifications for a new aircraft—a physical scale model is created that can be handled and examined.

Both use the same underlying technology to get at data in a new way. In both cases, something is created that isn't really there, to give us a deeper understanding of the world we live in.

Relevance for Teaching, Learning, and Creative Expression

Thus far, augmented reality and enhanced visualization have seen widest use in military and industrial applications. New uses are beginning to emerge as the underlying technologies are further developed. The possibilities are tantalizing; the potential applications span academic disciplines, from history to mathematics, from the arts to the sciences.

In disciplines such as archaeology, history, and anthropology, it is already possible to virtually recreate ancient spaces and artifacts for study. Small-scale models of ancient buildings, complete with original paintwork, have been created digitally,

allowing students to move through the spaces on a computer. Soon, it may not be uncommon to project these models in 3D at a size that allows students to walk through the buildings themselves. The same is true for cultural artifacts; models of ancient utensils can be created onscreen, or projected in 3-D, or printed on rapid prototyping systems so they can actually be handled. The modeling can be quite complex; under development are human-sized avatars in historically accurate costumes that can be programmed for all sorts of activities, from performing folk dances to speaking to students in the language and style of their time.

Paleontology, botany, biology, and other life sciences invite exploration with augmented reality. By analyzing the data from ground-penetrating radar, for example, and projecting a model over the dig site, paleontologists can best decide how best to retrieve fossils from underground. Consider how field studies could change when students are able to call up information about plants and animals they are observing and see it alongside the specimen—taking measurements, perhaps, or comparing a juvenile with a stored image of an adult.

Examples of Augmented Reality and Enhanced Visualization

Applications like those above are on the way; on some campuses, they are already here, as the following links illustrate.

Augmented Reality Simulations at MIT
education.mit.edu/ar/

At MIT, students are using handheld devices to participate in activities that combine real-world experiences with simulated events and data. In one activity, students interview virtual people, travel the campus taking measurements, and analyze data to determine the source of a toxic spill (simulated, of course). In another, set in Boston's Museum of Science, students use wifi-enabled handheld devices to gather clues to solve a murder mystery. The projects

are a collaboration between the MIT Teacher Education Program and the Education Arcade.

EducationAR, a NESTA Futurelab Project
www.nestafuturelab.org/showcase/education_ar/education_ar.htm

EducationAR is an ongoing BBC research project evaluating the potential use of augmented reality (AR) technologies in the classroom. The project includes a simple and intuitive interface that allows one or more users to physically manipulate and visualize complex subjects in real-time.

The Envision Center, Purdue University
www.envision.purdue.edu/

Purdue University's "Envision Center" focuses on research and design in computer-based visualization, with the aim of enhancing teaching and learning across disciplines. The center combines computer science, engineering, perception, technology, and art to process and display information. Current projects range from GIS applications to creating human avatars to assist in sign language education.

Transparent Reality Simulation Engine
vam.anest.ufl.edu/wip.html

The University of Florida has developed a transparent reality simulation engine which can be applied to a variety of disciplines, including nursing, chemistry, and physics. The engine renders abstract processes and concepts with symbols that can be seen and manipulated to help users understand how they work.

VEMDis™ (Virtually Enhanced Museum Display)
www.rcuk.ac.uk/innovation/bpc/vemdis.asp

At University College London's Petrie Museum, an augmented reality display prototype is being used to add optional 3D images to real-life sculptures, paintings, textiles, archaeological artifacts and other exhibits. It has allowed missing parts of sculpture or paintwork to be restored virtually, showing the piece in original condition, to enhance the museum experience for visitors.

Virtual Lab at McHenry County College

www.insidemcc.mchenry.edu/PD/Tutorials/virtuallab2.pdf

> In the 3D Virtual Lab, any model from 3D Studio Max can be converted into a special format that is displayed via two computers and two projectors. The projectors have polarized filters which are perpendicular to each other, and students wearing polarized glasses view the projected image in three dimensions. The lab was used for the first time in fall of 2005 to show models of the human skeleton, muscle system, and major organs. Wider use in biology, anatomy and physiology, astronomy, and meteorology is planned for 2006.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about augmented reality and enhanced visualization.

Augmented Reality Brings Maps to Life

www.newscientist.com/article.ns?id=dn7695

> (Will Knight, *New Scientist*, 19 July 2005) Paper maps can be brought to life using hardware that adds up-to-the-minute information, photography and even video footage.

Mixed Reality in Education, Entertainment, and Training

www.computer.org/portal/cms_docs_cga/cga/content/Promo/promo3.pdf

> (Charles E. Hughes, Christopher B. Stapleton, Darin E. Hughes, and Eileen M. Smith, *IEEE Computer Graphics and Applications*, November/December 2005) This article describes how a multidisciplinary research team used mixed reality technology and methods in a variety of applications, including museums and public spaces.

Recontextualizing the Collection: Virtual Reconstruction, Replacement, and Repatriation

www.archimuse.com/mw2005/papers/tolva/tolva.html

> (John Tolva, *Museums and the Web: Papers*, April 2005) This paper explores issues related to using virtual reconstructions or copies of museum pieces, from simple virtual representation (such as the Hermitage Museum project) to actual replacement of artifacts at their point of creation or discovery (the Eternal Egypt project).

Seven Things You Should Know About Augmented Reality

www.educause.edu/ir/library/pdf/ELI7007.pdf

> (EDUCAUSE Learning Initiative, September 2005) This short document provides a quick overview of augmented reality and a scenario describing possible uses.

Trend: Augmented Reality Check

www.learningcircuits.org/2004/dec2004/0412_trends.htm

> (Eva Kaplan-Leiserson, *Learning Circuits*, December 2004) This article summarizes different types of augmented reality and examines their applications in education.

CONTEXT-AWARE ENVIRONMENTS AND DEVICES

Time-to-Adoption Horizon: Four to Five Years

Context-aware environments and devices, broadly being explored in experimental settings, will erase the boundaries between people and the things they use. Already, computers exist that can make decisions based on contextual clues such as the user's location and orientation, the date and time of day, ambient conditions of lighting and temperature, and so on. Experimental classrooms can already sense the location and actions of the teacher and students, and change the environment accordingly. Over time, as sensors and portable devices converge, these technologies will make learning environments seem almost intuitively responsive.

Overview

It is now practical to produce computers that can make decisions based on contextual clues, such as what the user is attending to, the user's location and orientation, what the user is focused on, the date and time of day, lighting conditions, other objects or people in the environment, accessible infrastructure in the immediate vicinity, and so forth. The implications are only beginning to be explored, but may be profound. Context-aware computers can interact with the user or can program themselves to have particular responses appropriate to a situation; for example, to lower the volume of music being played when a telephone rings nearby, or to silence all calls during a meeting or class.

Context-aware environments have been around for a long time. Early applications emerged in the 1980s, with rooms where the lights turned on as someone entered. Voice and face recognition and gaze and gesture tracking are currently used in security systems and user interface labs. As technologies like these continue to be developed, and as the equipment that enables them recedes into the floor, the walls, and the ceiling, interesting possibilities for a truly responsive environment emerge. Imagine a smart classroom that recognizes the professor when she walks into the room; a lectern that lights up when she stands in front of it; a projector that brightens when she gestures toward the screen.

Science fiction? Hardly. Experimental classrooms that behave this way are currently being prototyped in universities in Canada and China. Hidden in the walls, the computing aspect recedes, leaving only the context-aware: a room that responds to the needs of its occupants as they move about in it naturally.

Another application of context-aware computing takes the technology to the other extreme. Instead of permeating the walls, technology actually creates walls where there are none, allowing the user to design custom spaces that can change as needed. A single room can be divided into multiple spaces for different uses separated by invisible soundproof barriers. Light and objects (and people) can pass through, but sound does not, creating spaces for individual study, collaborative work, and lecture in a single room (see the Gooru example, below, for more information).

Relevance for Teaching, Learning, and Creative Expression

Although widespread educational application of context-aware computing is still several years away, early experiments continue to spark ideas about how this group of technologies may be applied. On a small scale, some universities have employed GPS-capable handheld devices for campus tours, giving the viewer information about whatever building or monument happens to be nearest. This kind of application for context-aware computing will increase as the technologies that make it possible become integrated with commonly carried portable devices, such as cell phones.

For many faculty, the fact that technology tends to be intrusive is a stumbling block to using it in class. The technology too often gets in the way of dialog and discussion, rather than enhancing it. The promise of context-aware environments and devices is to erase the boundaries, making technology easily accessible, intuitive, and seamless, without getting in the way. Consider the following scenario:

> *Professor Mary Harper arrives at her classroom a few minutes before her class is scheduled to begin. As she enters, the room identifies her by scanning her ID badge—she doesn't even need to take it off her key ring—and the presentation station automatically logs in to her user account. By the time she reaches the podium, the web browser is open, her bookmarks are ready, and her presentation files, stored on the computer in her office, are accessible. She gestures at the wall behind her and the screen lowers automatically; the projector turns on, and she is ready to go.*

> *As the students come in, the room identifies them also. During class, Professor Harper asks a question and has the students answer by keying it on their cell phones. The answers are tabulated on the front computer; the professor can see how each student answered, and she can display the aggregate answers for the whole class.*

> *Today's lecture includes a guest speaker. He is not local, and Dr. Harper has arranged for him to be present via videoconference. At the appointed time, he connects at his end and waits. In Dr. Harper's classroom, a green light glows on the podium, and all she has to do is press a button to open the connection. The room has told her that all is ready. If something had gone wrong, the light would have glowed red, and she would have used her backup lesson without the guest speaker.*

Applications of context-aware devices are turning up in museums like the De Young in San Francisco, where interactive programs are projected onto glass panels. Visitors access information and activities by moving their hands in front of the glass; lasers mounted in the ceiling invisibly track the movements, responding appropriately to turn pages, move images, and so on. As these technologies move closer to adoption in education, we can look forward to devices and environments that facilitate discussion and dialog, rather than getting in the way.

Examples of Context-Aware Environments and Devices

The following links provide examples of context-aware environments and devices.

CAERUS

portal.cetadl.bham.ac.uk/Lists/Publications/Attachments/1/CAERUS_CAL.pdf

> CAERUS provides visitors to outdoor centers and museums with location-based multimedia content on handhelds. Using GPS technology to pinpoint where a user is, CAERUS delivers audio content about objects nearby. Audio content is used so that the environment, not the device, remains the focus of the visitor's attention.

Gooru

www.wired.com/news/school/0,1383,51518,00.html

> Herbst Lazar Bell is developing a "customizable education system" called Gooru that redefines the spatial characteristics of a classroom and replaces the books, desks and writing tools. Each student gets a special device known as a GooBall, consisting of a PDA, a backpack-cum-power supply, and a removable, touch-sensitive LCD screen that functions as laptop. The teacher is placed in the center of the room, which is divided into three work areas separated by transparent noise-cancellation barriers. In one area, the teacher lectures, unheard by students in the areas set aside for group and individual work just a few feet away. Students move between the spaces as necessary.

MIT's Context-Aware Cell Phone Project

www.eurekalert.org/pub_releases/2004-11/ns-tpt112404.php

The context-aware cell phone project at MIT is attempting to build a wearable cell phone which will receive signals about the user's location and behave appropriately (turn themselves off, for example). This research builds on a prior MIT project to develop a phone that acquired data for its owner about people called, places visited, and common activities performed; the phone could then give the user feedback based on the information it collected.

Rutgers University's C.O.O.L. Classroom

www.coolclassroom.org/home.html

The C.O.O.L. Classroom (Coastal Ocean Observation Laboratory) at Rutgers University brings an oceanography lab right into the middle- and high-school classroom. The C.O.O.L. Classroom allows students to access real-time data collected off the coast of New Jersey and includes lesson plans and a rich array of resources to help teachers use the data in their classrooms.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about context-aware environments and devices.

Context-Aware Computing: A World That Knows What to Do for You

www.usabilityviews.com/uv010028.html

(Paul Brand, Stanford HCI Seminar, May 2005) In this webcast of a seminar from Stanford University, Paul Brand discusses several context-aware computing projects from around the world.

Intrinsically Motivated Intelligent Rooms

www.arch.usyd.edu.au/~mary/Pubs/2005pdf/Ubiq_Comptg_Macindoe.pdf

(Owen Macindoe and Mary Lou Maher, December 2005) This paper, presented at the Second International Symposium on Ubiquitous Intelligence and Smart Worlds in Nagasaki, Japan, describes classrooms that respond and adapt to human occupants and the technologies that can be used to create them.

Potentials and Challenges of Context Awareness for Learning Systems

www.andreas-p-schmidt.de/publications/abis05_aschmidt.pdf

(Andreas Schmidt) This paper discusses the challenges of a context aware e-learning system, which would ideally know what material to deliver to the student, and when to do it.

Remote Labs on the Internet Around the World

telerobot.mech.uwa.edu.au/links.html

This list, maintained by the Telelabs Project at the University of Western Australia, links to schools around the world that have remote laboratories for a variety of disciplines accessible over the Internet.

Technology-enabled Classrooms: Simplicity and Uniformity of Tools Make Them Truly 'Smart.'

www.uctltc.org/news/2005/02/feature.php

(Dan Gordon, *TLtC Contributor*, February 2005) This article discusses the use of smart classrooms at UC Berkeley and related pedagogical and technical issues.

HORIZON PROJECT ADVISORY BOARD

Phillip Long, Chair
Senior Strategist for the Academic Computing
Enterprise & Director of Learning Outreach
MIT iCampus, Information Services & Technology
Massachusetts Institute of Technology

Bryan Alexander
Director for Emerging Technologies
National Institute for Technology and Liberal
Education (NITLE)

Richard Baraniuk
Victor E. Cameron Professor
Rice University

Sue Bauer
Director of Computer Training
California Lutheran University

Malcolm Brown
Director, Academic Computing
Dartmouth College

Vincent Doogan
Director, Academic Computing Services
New York University

Lev Gonick
Vice President, Information Technology Services
Case Western Reserve University

Joeann Humbert
Director of Online Learning
Rochester Institute of Technology

Jean Paul Jacob
IBM Research, Emeritus
IBM Almaden Research Center

Larry Johnson
Chief Executive Officer
The New Media Consortium

Alan Levine
Instructional Technologist
Maricopa Community Colleges

Cyprien Lomas
Director, Learning Centre
Faculty of Agricultural Sciences
University of British Columbia

Nick Noakes
Associate Director, Center for Enhanced Learning
and Teaching
Hong Kong University of Science and Technology

Diana Oblinger
Vice President
EDUCAUSE

Ruben Puentedura
President and Founder
Hippasus

Ruth Sabean
Assistant Vice Provost, Educational Technology
College of Letters and Science
University of California, Los Angeles

Peter Samis
Associate Curator of Education
San Francisco Museum of Modern Art

Rachel Smith
Director, Special Projects and Publications
The New Media Consortium

Len Steinbach
Chief Information Officer
Cleveland Museum of Art

Krista Terry
Director, Technology in Learning Center
Radford University

Kristina Woolsey
Learning Experience Designer
Woolsey & Associates