

By Joel Foreman

NEXT-Generation Educational Technology versus the Lecture

Despite the waves of IT-driven transformation sweeping through the higher education system, many obsolete academic structures remain obdurately intact. Among these, a leading candidate for the title “most worthy of change” is the large lecture found in such undergraduate staples as the introductory courses in psychology, sociology, physics, chemistry, and biology. Even though it contradicts most of the tenets of high-yield instructional technique, the large lecture persists—mainly because it is cheap and pragmatically useful: the economies of scale generate a surplus that supports low teacher-student ratios in major classes.

Of course, cheap products always conceal their total cost. In the case of the large lecture and its student consumers, the cost (could it be quantified) is the lost opportunity for more meaningful and more enduring learning. The fact is that far too many of the students in large lecture courses are uninterested pragmatists who cram for tests, commit the material to short-term memory, and quickly forget it thereafter.

A “radical new approach” is in order.¹ The business thinkers Ryan Mathews

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and Watts Wacker suggest that to find one, potential innovators should search through ideas developing in the margins of respectability.² I will here present and promote one such “fringe idea,” one that is certain to test the conventional academic’s notions of propriety yet one that has the potential (many believe) to revolutionize the educational system. The idea, briefly stated, is that large lecture courses may someday be replaced by the kind of immersive digital environments that have been popularized by the videogame industry. Viewed in this light, the advanced videogame appears to be a next-generation educational technology waiting to take its place in academe.

Given the discussions I have had with academics and laypeople, I know that readers are likely to react to this proposition in various ways:

- Those who have been tracking the ongoing convergence of education and digital game technology will not be surprised.
- Those who conceive of videogames as a mindless indulgence that encourages antisocial impulses will regard as preposterous and potentially dangerous the notion of a college course that resembles a videogame.

- Many of those who have videogame-playing children will recognize the power of the medium but will be anxious about the unintended consequences of its application in higher education.
- Those who are open-minded but whose exposure to PC and console games is limited or nil will have a difficult-to-impossible time imagining a videogame college course.

In what follows, I attempt to address as many of these concerns as possible by (1) explaining why the format of the large lecture course is ripe for replacement, (2) reviewing the activity in the field of game-based learning and the claims of the authorities, and (3) using the example of an introductory course in psychology to explore how learning objectives can be achieved in an immersive environment and which impediments will need to be removed in order for game-based learning to become viable.

Deficiencies of the Large Lecture Course

To address the deficiencies of the large lecture, I invoke five learning-theory desiderata:

1. *The ideal learning situation is customized to the very specific needs of the individual.* Every student approaches a learning situation with a unique knowledge level and a particular set of dispositions. Optimal learning takes place when instruction targets an individual's proximal zone and learning styles.

2. *The ideal learning situation provides students with immediate feedback.* Because learning extends what is known and can be understood, a student working with new material will inevitably encounter some confusion and uncertainty. Optimal learning takes place if a student is able to seek immediate clarification or amplification when he or she encounters problems.

3. *The ideal learning situation is constructive.* It allows students to explore learning environments (preferably multisensorial) that encourage the active discovery of new knowledge and the development of new kinds of comprehension.

4. *The ideal learning situation motivates students to persist far in excess of any externally imposed requirements.* If students are engaged in what they perceive as a personally meaningful and rewarding activity, they will devote more time to the effort than is prescribed in a course: witness the willingness of the game generations to play videogames for thousands of hours.

5. *The ideal learning situation builds enduring conceptual structures.* It ensures that concepts and procedures are committed to long-term memory and are available thereafter for the analysis and interpretation of related but novel real-world experiences.

In contrast to these ideals, the large lecture is a one-way communication medium that relies principally on a single sensory channel: hearing. Most lecturers do augment their voices with chalkboards, transparency projections, and PowerPoint slides, but these static and occasional "enhancements" are weak in relation to the visual standards set by professional image-makers in the television, film, videogaming, and advertising industries. In the lecture, the voice always dominates, and the lecture is delivered in a speed and manner (depending on the individual lecturer) that assumes the perceptual and intellectual uniformity of hundreds of individual students. Even if the lecturer is

charismatic, holding the attention of several hundred students for an entire lecture of fifty minutes or longer is impossible. The result is that the large lecture produces many opportunities for students' attention to wander and for the lecturer's intended messages to miss their mark.

For the students in attendance (a number that can be ensured only by taking roll and giving tests), there are few if any opportunities to interrupt the lecturer's determination to "get it all in" and thus few opportunities to confirm that learning (as opposed to mislearning) is actually taking place. The rote learning that does succeed involves facts and figures. Some of the better students will, on their own, reflect on this material, commit it to long-term memory, and transform it into active hypotheses and real-world applications. Most students will cram for the short-term benefits of testing and then forget what was temporarily learned.

In sum, what we know about good learning is almost wholly contrary to the structure and conditions of large lecture courses. The result, all too often, is that courses deemed important enough to be undergraduate requirements are taught in a way that severely limits learning outcomes. Would we not prefer an approach (assuming we could afford it) that exploits the pedagogical promise of emerging interactive technologies, meets students' expectations for deep digital engagement, motivates persistence, customizes the experience to each student's unique needs, and promotes both long-term memory and the transfer of learning to the practical realm of everyday life? This is the promise of digital game-based learning.

Activity in the Field of Game-Based Learning

Chris Dede, Timothy E. Wirth Professor in Learning Technologies at Harvard University, predicts that "shared graphical environments like those in the multi-user Internet games Everquest or Asheron's Call" will be the learning environments of the future.³ Henry Jenkins, Director of MIT's Games to Teach Project, leads an effort to "demonstrate gaming's still largely unrealized pedagogical potentials" and to explore "how games might enrich the instruction . . . at the advanced

placement high school and early college levels."⁴ And Randy Hinrichs, Group Program Manager for Learning Science and Technology at Microsoft Research, claims that game technology (among other innovations) "will move us away from classrooms, lectures, test taking, and note-taking into fun, immersive interactive learning environments."⁵

These pronouncements are based on some incontestable facts. First, the world is now populated by hundreds of millions of game-playing devices. Second, the videogame market, approximately \$10 billion in 2002, continues to grow rapidly and to motivate the push for increasingly sophisticated and powerful interactive technologies. As in other areas of IT development, these technologies are maturing and converging in novel and unexpected ways. Text-based MUDs (Multi-User Dungeons) and MOOs (MUDs Object-Oriented) have evolved into massive multiplayer online communities such as Ultima and The Sims Online, in which hundreds of thousands of players can simultaneously interact in graphically rendered immersive worlds. And previously standalone game devices, such as Sony PlayStation2 and Microsoft Xbox, are now Web-enabled for geodistributed multiplayer engagements. Imagine that all of these networked "play stations" are "learning stations," and you can begin to sense an instructional revolution waiting to happen.

Still, some might argue that higher education students already have networked learning stations in the form of the Web-enabled PC. What value is added by a game-based "learning station"? The major difference is that game technologies routinely provide visualizations whose pictorial dynamism and sophistication previously required a supercomputer to produce.⁶ These visualizations, best referred to as *immersive worlds*, can bring a student into and through any environment that can be imagined. Instead of learning about a subject by listening to a lecture or by processing page-based alphanumeric (i.e., reading), students can enter and explore a screen-based simulated world that is the next-best thing to reality.

Want students to learn about Gothic architecture? Structure a discovery mission

that leads them to explore the intricacies of a fully rendered simulation of Laon Cathedral. Want nursing students to test their knowledge of emergency procedures? Have them operate a game-based simulated ambulance attendant who has to manage the simulated medical problems encountered during a night run in a simulated city. Want sociology students to grasp some of the basics of group dynamics? Team them up for a structured survival mission in a simulated online jungle.

Again, some might argue that text-based education post-Gutenberg has done a pretty good job without such simulations. Why replace it? And why consider replacing it with a pictorial medium?

One pragmatic reason is offered by Marc Prensky, who argues that the game-playing generations (current and future

initiator of the Logo movement and its emphasis on teacher- and student-built computer games, proposed a “knowledge machine” intended to immerse children in computer-simulated educational microworlds. Papert’s early prediction that such learning environments would become the norm⁸ is on the way to being realized in the edutainment programs produced by serious-minded game producers, such as Lucas Learning, which seek “to bridge the gap between pedagogy and play.”⁹

Another example is a review (game reviews are now a regular feature of the *Washington Post* and other major newspapers) of Knowledge Adventure’s game JumpStart Advanced 2nd Grade. The reviewer noted that her kids “opted for the game rather than the park one recent

fully put to use.”¹² David Rajeski, Director of the Foresight and Governance Project, hopes to “‘ubiquitize’ educational gaming,” especially for managers and policymakers. With the support of the Sloan Foundation, in February 2003 he hosted a “Serious Games” workshop, which brought together educators and game developers for two days of brainstorming various public-policy game scenarios. Rajeski envisions a future in which “games and simulations . . . teach people to set up refugee camps in troubled areas, orchestrate disaster relief, negotiate environmental treaties more effectively, make better health policy choices, handle complex air traffic logistics, or grapple with options for taming urban sprawl.”¹³

Given the emerging promise of interactive technologies, it is not surprising



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students) are fundamentally different from those who have not spent thousands of hours playing digital games.⁷ Although empirical studies have yet to conclusively support the notion that the game-playing generations actually think differently, there is no question that the numerous hours spent in playing games are a critical formative experience. If nothing else, games expose players to deeply engaging, visually dynamic, rapidly paced, and highly gratifying pictorial experiences that make almost any sort of conventional schoolwork (especially when mediated by a lecture or a text) seem boring by comparison.

The Trend toward Game-Based Learning

The power of games to engage and maintain attention has motivated a constant stream of educators to propose (and often create) games that have pedagogically desirable learning goals. For example, in 1993 Seymour Papert, well-known as the

Sunday.” She added: “Little did they know they were studying geography, beefing up their reading comprehension, adding with fractions, and learning about money.”¹⁰ Though K–12 systems have done little to exploit the instructional uses of such digital play, the “edutainment” market (supported by parents who want their kids to learn something useful when they are having fun) is a growing presence that could threaten to bypass the formal educational system in advancing the skills of those who have access to home computers.¹¹

Within the areas of higher education and adult learning, game-based learning is no newcomer. Business strategy games have been a standard feature of numerous management programs for many years. In the public policy field, a report from the Foresight and Governance Project of the Woodrow Wilson International Center for Scholars noted, “Game-based modeling . . . has already been success-

that a major foundation has already funded a videogame for higher education. Designed to teach the skills and knowledge required to manage a college or university, Virtual U was conceived in 1997 and is supported with \$1 million from the Alfred P. Sloan Foundation. Version 2, released in 2002, is used in courses in more than thirty colleges and universities, including Harvard, George Washington University, Stanford, Michigan State, New York University, Ohio State, and the University of Virginia.¹⁴

Based on the Integrated Postsecondary Education Data System and modeled by former Stanford CFO Bill Massey, Virtual U provides student-players with a systems approach to the interdependencies that college and university administrators must manage. For example, after attempting to improve faculty diversity, a player quickly discovers that the new hiring policies affect promotion and tenure and require more

turnover. This in turn produces morale problems for those unable to get tenure. If the player then tries to expand the workforce, he or she will encounter budget and economic constraints. In such a simulated environment, the student-player can make mistakes without any serious consequences and can develop an understanding of the intricate and interconnected variables of college/university management.

3-D Immersion

Despite its hefty price and its place as the most sophisticated digital game (to date) for higher education, Virtual U does not use leading-edge game technology. The leading edge—as represented, for example, by the infamous Grand Theft Auto 3—produces immersive three-dimensional

with its objects and inhabitants according to structures designed to achieve specific learning objectives.

Given the prevailing business models governing higher education, the cost of such an immersive learning environment is hard, perhaps impossible, to justify or to amortize. But the U.S. military, a leader in its commitment of funds to instructional videogaming, faces no such impediments. One project, run jointly by the Department of Defense and the University of Southern California, “is developing combat video games to enhance the strategic, combat, and decision-making skills of next-generation military field commanders.”¹⁵ Another—the Army Game Project, funded with \$6.3 million—resulted in *America’s Army*, a two-part game that introduces users to army

sual monotony that are the norm in large lectures, interactive immersion requires constant interaction in a simulated world that progressively changes in response to a player’s probing exploration. Rather than learning by listening and/or by reading fact-filled and not-too-exciting textbooks, the student engaged in an immersive world has to perform a set of complex actions to achieve desired learning goals. The advantage is quite simple: learning through performance requires active discovery, analysis, interpretation, problem-solving, memory, and physical activity and results in the sort of extensive cognitive processing that deeply roots learning in a well-developed neural network.

Game worlds are usually organized as a series of levels, each associated with a



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(3-D) environments that must be experienced to be appreciated. 3-D game worlds are rapidly approaching photorealism and are able to represent large-scale environments populated by autonomous characters that interact with a player’s in-world representative (known as an *avatar*). The player controls his or her avatar’s interactions within this world and can perform complex activities like driving vehicles and can engage in social interactions with other avatars.

Imagine that with a sufficient budget (say, several million dollars), a team of game developers and scholars could render a historically accurate 3-D Elizabethan London that embodies the best research on the social, economic, and architectural practices of that time. This 3-D London could be populated by historical luminaries (e.g., Shakespeare), whose actions would be governed by artificial intelligence programs. The student’s avatars could navigate this world and interact

careers and provides teams of online users with realistic combat simulations.¹⁶

Dr. Michael Capps, Executive Producer of the Army Game Project, explains that it is ultimately a “shooter” game but that players must learn much before they can start shooting. They must go through basic training, choose a career path, and conduct a tour of duty—all while learning about the specifics of army life. Even when the combat missions begin, success (especially in the multiplayer mode) depends on the player’s ability to communicate and to participate in teamwork.¹⁷ *America’s Army*, a leading-edge attempt to integrate fun and instruction, anticipates the pedagogical use of immersive environments in academe.

An Example: Psychology 101 in an Immersive Environment

What would such an immersive environment look like?

In contrast to the passivity and the vi-

different performance challenge that must be overcome in order to unlock access to a next level and a new challenge. The levels are often organized in a graduated difficulty progression so that the skills learned on one level form the foundation for the skills learned on the next. As such, the game world resembles a well-designed academic course, one that (1) builds and integrates knowledge in a structured continuum that leads from the beginning of the semester to its end; and (2) requires that a student actively and continuously engage with subject matter and learning goals.

Keeping these criteria in mind, let us consider what a couple of the “levels” might look like in an immersive 3-D learning environment called “Psychology 101.” Since it is especially difficult to conceptualize how such a game might begin, we will consider two levels (call them levels X and Y) that could be connected and positioned somewhere in the

middle of the game course. The student arrives at level X after successfully mastering various challenges associated with the course learning objectives. On level X, the learning objectives entail an understanding of the voluntary and involuntary aspects of bodily movements and the complex linkages among the eye, the brain, neural pathways, and muscle. Since the game needs to be graphically stimulating (not gratuitously, but as a means to promote the deep processing that results in meaningful and enduring learning), level X uses the *Fantastic Voyage* motif in which a miniaturized vessel (inhabited and guided by a student's avatar) must navigate its way through a human body; trace and activate the neural pathways linking eye, brain, and muscle; and thereby “escape” to the next learning level.

This process is a structured inquiry (a complex intellectual process) governed by the student, who must form hypotheses, make decisions, troubleshoot problems, consult maps and guides, and correct false leads in order to find a way through the simulated human body. After demonstrating an understanding of these linkages in level X, the student unlocks access to level Y. In effect, assessment is built into the game: the student-player is unable to move to a higher level until competence at the current level is established and confirmed.

The entire process must be “fun,” a quality that (as game developers have learned) is not incompatible with hard work and achievement. Fun is ensured by the game play itself (the actions and interactions that the student-player performs), the concealment of “testing” in the game play, and the visual and interactive qualities of the immersive environment.

Whereas immersive environments can be highly realistic, they can also be fantastic and whimsical, depending on what works best. Thus the student's avatar, guiding a miniaturized submarine in level X, can exit the body by stimulating an appropriate sensory-motor reflex that ejects the avatar into a room-sized birdcage populated by two multihued pigeons and B. F. Skinner (what gamers call an “NPC,” or non-player character, governed by artificial intelligence). In this level, the student will learn about the

principles of conditioning and, more specifically, must find out how to use reinforcement procedures to control the movements of a pigeon. The student is introduced to this task by the Skinner NPC and must then reproduce the well-known experimental work by which a pigeon's pecking behavior is focused through a series of food rewards. When the pigeon is eventually induced to peck a target a certain number of times in succession, a transportation chamber materializes to take the student's avatar to the next learning level.

Developing an Overwhelmingly Successful Immersive Course

Let's suppose that a deep-pockets angel wants to invest in the development of an immersive course and has committed enough funds—say, \$10 million—to be sure that it is done first-rate. We will assume that the donor has targeted a large lecture course like Psychology 101 for a couple of reasons:

- Because the large-lecture deficiencies cited above suggest that advanced technology would produce significant improvements in the course
- Because the ubiquity of Psychology 101 indicates that widespread adoptions could amortize the investment

How would the investor proceed in this venture? The pattern has already been set by the cross-functional design teams organized to produce complex distance courses. In this instance, game developers would have to be included in a project team of subject matter experts (SMEs) and instructional designers. The SMEs would need to be respected within their disciplines, so that their work on the immersive course would be well received by their peers. Participants would likely be academic psychologists who teach Psychology 101, authors of existing introductory textbooks, and/or those who have written about how to teach the course.

Since professor SMEs are content experts, but not necessarily expert teachers, the instructional designers on the team would ensure that the course structure and course activities predictably and consistently produce the desired learning yields. The instructional designers would

help their psychology SME team members to make critical decisions with exactitude and precision: How many learning objectives can be accomplished in a fifteen-week period? Which are the most important learning objectives? How will they be organized and integrated? How (other than by conventional tests and essays) will they be certified in terms of action transferred into the domain of real life?

Although I am reluctant to call instructional design a science, it does offer a disciplined and systematic approach that emphasizes measurement and accountability—critical elements in any technology-enhanced course that claims high-yield learning. Measurement and accountability are critical because the system currently in place has no agreed-upon standards and no means (other than conventional testing) to assess the performance of a Psychology 101 course. That situation needs to be corrected in order to make a case for the adoption of an expensive immersive course. The course designers must

be able to prove that the immersive course promotes significantly better learning than do large (or small) lecture classes.

In this case, the “better” learning goal is based on the notion that rote learning of facts and figures is far less valuable than learning how to do things in the human world that students (as workers, parents, team members, and citizens) must live in. The great potential value of an immersive Psychology 101 is the guidance it would provide to effective action in that world. Large lecture courses that deposit knowledge in passive students and then test it via such methods as multiple-choice questions are a long-shot attempt at producing informed activity in the world outside of the lecture hall. In contrast, a well-designed immersive environment populated by simulated humans and simulated human interactions would provide opportunities to engage interest, to generate meaningful learning, and to apply it in ways that would transfer to real-life situations.

The game developers would be in-

involved in discussions about course design from the start but would become most active only when the content of the course is agreed upon. The actual design of the course would map the learning objectives onto the game play. This very complex process would have to be iterative and subject to frequent testing to ensure that the resulting game play achieves the learning goals in a specified period of time for a variety of students—women as well as men, slow learners as well as fast, and so on.

The final test of the efficacy of the game course would have to be conducted by a group of independent psychologists who are in the business of assessing learning. Their work would need to confirm that the course game does a much better job than a large lecture (or even a small Psychology 101 class) and would thereby address the next obstacle to be faced by the project—adoption.

Professors and Farmers

Adoption would be problematic. A Web-based interactive course that monitors

students' performance and produces viable assessments runs contrary to the locally produced approach to the development of Psychology 101 courses. This approach requires a professor at a specific location who does his or her own course-design work, usually with the help of a mass-produced textbook. This familiar situation (one that is rarely challenged) is reminiscent of small-farm America before the surge of twentieth-century agriscience consolidated the atomized farmscape into large, efficient, and highly productive units. In the same manner, a superior Web-based and interactive Psychology 101 would probably eliminate the need for place-based psychology instructors and would aggregate the value of their collective labor to support a far better learning experience for students.

Although student interest in a videogame Psychology 101 would have to be great, the consequences for place-based psychology departments would be transformative in ways that academics would not like to consider. Yet if interactive technologies were to do for learning yields what agriscience did for crop yields, who could object?

Adoption, Revenue Streams, and Engines of Change

Let's assume a future in which local Psychology 101 courses face a very competitive challenge from the immersive version described above. Let's assume that the immersive course is tested and certified by a respected group of psychologists. Let's assume that the learning it promotes is faster, better, and deeper than that of a conventional course. Let's assume that early adoptions, demonstrations at conferences, and a well-funded marketing campaign result in rave reviews and students' mounting requests for the option. And let's assume that within a few years, 50,000 to 100,000 students are enrolled annually in the course at a cost (to subscribing colleges and universities) of \$100 per student.

The revenue stream would quickly amortize the costs of course production. More important, the revenue would fund annual upgrades based (as is the case with all good software) on what the course/game producers learn from their users.

The resulting economic-pedagogical engine would do more than just replace an instructional technology (the lecture) whose form is obsolete and whose mediocre returns are not acceptable in a high-tech and rapidly evolving post-modernity. It would power an improvement cycle unlike anything available in the educational world today, one that would

- continuously evolve the interactive technology mediating the course, and
- eliminate the unfortunate gap that

currently separates the technologies of instruction and entertainment.

Understanding the advanced videogame as a next-generation educational technology that will replace the large lecture course is indeed a "radical new approach." Its implementation would require, first, the sort of significant investment that is rarely associated with undergraduate required courses. In addition, a political revolution would be needed to wean academia away from the low, if certain, learning yields of a

dominant educational product: the large lecture. But these are not reasons to be discouraged. Information technology revolutions inevitably lead to cultural revolutions. For those of us in higher education, the Gutenberg printing press is the most potent reminder of the speed and force with which an advanced information technology can assault tradition and change accepted norms. The videogame has already won the leisure time of many students. The scenario I have described above suggests that the videogame, when furnished with pedagogical power, will also eventually win in the instructional marketplace.

Instructional videogames offer the prospect of a learning experience that fulfills the classical and pragmatic admonition (subscribed to by thinkers from Plato to Piaget) to delight and instruct. An educational technology that does both is badly needed to help twenty-first-century students cope with information overload and engage successfully with the complexities of our time. *e*

Notes

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1. I borrow the phrase from Ada Demb, "The Intellectual Supermarket," *EDUCAUSE Review* 37, no. 4 (July/August 2002): 13–14. I agree with Demb's assumption that many *EDUCAUSE Review* readers would welcome "radical new approaches" to "transform the higher education landscape" and "explode the boundaries of the industry."
2. Ryan Mathews and Watts Wacker, *The Deviant's Advantage: How Fringe Ideas Create Mass Markets* (New York: Crown Business Publishing, 2002).
3. "Interactive Media in Education: An Interview with Chris Dede," *Syllabus* 15, no. 11 (June 2002): 12–14.
4. Henry Jenkins, "Game Theory," *Technology Review*, March 29, 2002, <http://www.technologyreview.com/articles/wo_jenkins032902.asp> (accessed February 23, 2003).
5. Hinrichs quoted in Lisa Neal, "Predictions for 2003: E-learning's Leading Lights Look Ahead," *eLearn Magazine*, January 24, 2003, <http://www.clearmag.org/subpage/sub_page.cfm?article_pk=6541&page_number_nb=1&title=COLUMN> (accessed January 24, 2003).
6. Theresa-Marie Rhyne, "Computer Games and Scientific Visualization," *Communications of the ACM* 45, no. 7 (July 2002): 41–44.
7. Marc Prensky, *Digital Game-Based Learning* (New York: McGraw-Hill, 2001).
8. Seymour Papert, "Obsolete Skill Set: The 3 Rs," *Wired Magazine* 1.02 (May/June 1993) <http://www.wired.com/wired/archive/1.02/1.2_papert.html> (accessed December 28, 2002).
9. Paula Parisi, "The Teacher Who Designs Videogames," *Wired Magazine* 5.01 (January 1997) <http://www.wired.com/wired/archive/5.01/esschilling.html?person=george_lucas&topic_set=wiredpeople> (accessed January 7, 2003).
10. Hope Katz Gibbs, "Reviews," *Washington Post*, July 14, 2002, H9.
11. Douglas Levin and Souses Arafeh, *The Digital Disconnect: The Widening Gap between Internet-Savvy Students and Their Schools* (Washington, D.C.: Pew Internet and American Life Project, August 14, 2002) <<http://www.pewinternet.org/reports/toc.asp?Report=67%20>> (accessed February 15, 2003).
12. Ben Sawyer, "Serious Games: Improving Public Policy through Game-Based Learning and Simulation," Foresight and Governance Project, Woodrow Wilson International Center for Scholars Publication 2002-1, <<http://wwics.si.edu/foresight/game/>> (accessed February 23, 2003).
13. David Rejeski, "Gaming Our Way to a Better Future," *The Adrenaline Vault*, September 23, 2002, <<http://www.avault.com/developer/getarticle.asp?name=drejeski1&page=2>> (accessed April 17, 2003).
14. See the Virtual U Web site: "Virtual U in Use," <<http://www.virtual-u.org/vuinuse.html>> (accessed February 23, 2003).
15. Rhyne, "Computer Games and Scientific Visualization," 41.
16. Jeff Adler, "A Chance to Be All That You Can Be—In a Virtual Army," *Washington Post*, May 23, 2002, A31.
17. See the NVIDIA Web site: "Games: America's Army: Operations and Soldiers," <http://www.nvidia.com/view.asp?IO=games_army> (accessed February 23, 2003).