has begun to explore the potential of games for decision support. The DOD exploration gave rise to an Army-funded center at the University of Southern California, the Institute for Creative Technology; related work had already begun at the Naval Postgraduate School in Monterey, California.

Computer games offer a unique playground for serious research, not only because of the underlying allure of fun and competition, but also because important new questions arise. For example, what is a body, a surface (when infinitely malleable), or a space? How does one deal with a changing sense of time given that one can go back to a saved game? How then does one change the way one plays? How does one convey the essence of person despite screen form—gestures, and so on—varying? Most interestingly, designers of massively multiplayer online games are grappling, with a large degree of success, with the social, political, and aesthetic issues inherent in virtual worlds. What is the social contract between participants, and between the participant and the designer? What are the consequences of conflicts in the virtual world, and to what degree should those consequences be determined by the online population, versus the administration? How should people deal with the distribution of authorship in an environment where narratives are participatory and emergent? How does one foster organic, self-organizing social structures in a virtual world? How does a designer make places people want not only to visit, but also to inhabit for hundreds or thousands of hours over the course of several years? These questions raise various issues for a number of computer science fields, including information retrieval, database management, and computer graphics, to name a few—though such questions are not purely CS ones, but rather questions that are truly transdisciplinary. There is evidence that CS is beginning to address some of these questions (e.g., see the special issue "Game Engines in Scientific Research" in the *Communications of the ACM*, January 2002).[33]

## NARRATIVE INTELLIGENCE

In the early 1990s, a group of graduate students at the MIT Media Lab formed a new reading group, which they called narrative intelligence (NI).[34] The group explored issues at the intersection of narrative and both human intelligence and AI, seeking to develop a dialogue between new computational concepts and technologies and the insights of literary theories such as poststructuralism and semiotics. The group came together with an understanding of, and the desire to

[33]One reviewer observed that the CS research agenda was being only modestly influenced as of November 2002.

[34]Marc Davis and Michael Travers, 1999, "A Brief Overview of the Narrative Intelligence Reading Group," pp. 11-16 in *Proceedings of the 1999 AAAI Symposium on Narrative Intelligence*, Michael Mateas and Phoebe Sengers, eds., AAAI Press, Menlo Park, Calif.

reconcile, the contradictions and incompatibilities between these two world views: AI technology focused by and large on formal, logical representation and objectivity, whereas the analytical tools provided by new literary theories focused on subjectivity, multiplicity, and the limitations of formalism. The pragmatics of negotiating the differences between these world views led to a creative foment. The group flourished, exploring issues in the philosophy of mind, media theory, HCI, psychology, social computing, constructionism, and AI, developing theories and applications in all these areas, influencing the direction of the doctoral program at the Media Lab, and connecting to a wider network of researchers who joined in the group's discussions over e-mail. Narrative intelligence as a field was born.

NI research obviously incorporates influences from a variety of fields. Artificial intelligence, with tools to model human emotion, personality, and narrative abilities, provides a framework from which much of the research grows. Psychology, especially narrative psychology, generates explanations of the human ability to understand the world through narrative, creating a basis for systems that model or support this ability. Art research raises new questions about the nature of narrative representation, keeping the concept of narrative fresh. Cultural studies analyze hidden cultural narratives, including the stories AI researchers tell through their research. Literary studies examine the nature of narrative in traditional and interactive forms. Drama provides understanding of the real-time performance of narrative. This emphasis on mixing technology development with artistic and humanistic perspectives is unusual in AI. It has supported the generation of new research fields within AI, such as lifelike interactive computer characters, as well as an increase in cross-disciplinary engagement between AI and other fields.[35]

At the same time, narrative trends took on importance in related fields. The concept of supporting human narrative understanding through the interface of human and computer began to gain ground in the field of HCI. Work in media studies on hypertext and interactive fiction was inspiring a generation of systems that support narrative in new ways. Within AI, this interest began to spur research in AI for interactive fiction and entertainment,[36] including interactive computer

[35]Narrative as a topic of research is not new to AI. In the 1970s and early 1980s, there was substantial interest in modeling story understanding and story generation, particularly by Roger Schank's research group at Yale University. Programs developed by the group—which were able to generate stories and answer questions about them, albeit in limited ways and domains—illustrated theories of human understanding and the structure of knowledge in the mind. Massive, unwieldy, and hard to extend, these systems ran into trouble during the "AI winter" of the 1980s. Researchers, seeking to combat the image of AI as never living up to its inflated claims, favored clearly defined problems with easily measurable outcomes—a situation that is not conducive to this kind of creative work—and, therefore, narrative fell out of favor for a decade as a research topic in AI.

[36]Joseph Bates, 1992, "Virtual Reality, Art, and Entertainment," *Presence: The Journal of Teleoperators and Virtual Environments* 1(1): 133-138.

**BOX 4.2**

**Virtual Characters—Improvisational Actors**

The research, development, and commercialization of a new class of intelligent-agent applications that reflect a philosophy of learning through play is the focus of Extempo Systems. Software-driven virtual characters, which Extempo Systems' founder Barbara Hayes-Roth[1] calls improvisational actors, can take the form of a human, an animal, or just about anything the imagination can dream up, to interact directly with people visiting a Web site. What makes them different from other types of intelligent agents is their ability to improvise stories. According to Hayes-Roth, this design allows the actors to achieve their goals while providing engaging conversation for many different Web site visitors. One of Extempo's creations, a dog named Jack, seeks to achieve six goals when people interact with him: get them involved, guide them to target information, gather customer data, personalize the experience, delight them, and build site loyalty. Jack accomplishes his goals by improvising appropriately in response to a situation. For example, as a visitor enters a site, Jack says what he can do for the person. If the visitor stops "talking," Jack is programmed with a few things to say based on the content of the conversation thus far. Like a human, Jack is designed to have a certain protocol involving turn taking and interruption. This allows him to have characteristics of intelligent conversation, such as making functional transformations and analogizing between topics.

[1]See <http://www.extempo.com> for additional information about Extempo Systems and the work of Barbara Hayes-Roth, who was a briefer at the committee's January 2001 meeting held at Stanford University.

characters and interactive plots. Many of these research areas explicitly draw on the arts and drama as a source of inspiration. With the growth of the computer game industry has come an interest in new game forms that support narrative in more complex and interesting ways than a stereotypical shoot-and-kill form.

Research in NI is flourishing, with applications in a variety of areas. Narrative interfaces explore possibilities for making interfaces more usable by incorporating elements of story, for example by embodying interaction in a storytelling character. Artificial agents can themselves be designed to use narrative, as humans do, to make sense of the world and each other (see Box 4.2). Researchers are developing systems to support human storytelling, as in the case of plush toys that children can program to tell their stories to families and friends.[37] Databases of stories allow people to search for and share stories pertinent to their experiences.[38] Stories can be automatically generated, perhaps in response to input from human users. Interactive digital video allows video sequences to be generated interactively, telling

[37]Marina Umaschi, 1997, "Soft Toys with Computer Hearts: Building Personal Storytelling Environments," pp. 20-21 in *CHI '97 Proceedings*, ACM Press, New York.

[38]See Justin Cassell and Jennifer Smith, 1999, "The Victorian Laptop," pp. 72-78 in *Narrative Intelligence: Papers from the 1999 Fall Symposium*, Technical Report FS-99-01, Michael Mateas and Phoebe Sengers, eds., AAAI Press, Menlo Park, Calif.

interactive stories.[39] The field of interactive fiction and drama has exploded,[40] including the subfield of interactive computer characters, or characters with emotion and personality who respond to human users in the context of a story.[41] A complementary area of narrative intelligence studies the stories that AI researchers themselves tell about what they are doing.[42] Sometimes, analysis of these stories can lead to new forms of AI technology by building on alternative stories.[43]

In this explosion of research, the interdisciplinary engagement begun by the NI group at the Media Lab remains present—in work taking place in traditional computer science departments, in cross-disciplinary arenas like the Media Lab, in humanities and arts departments that incorporate new media such as Georgia Institute of Technology's School of Literature, Communication, and Culture,[44] and in the computer game industry.

## NON-UTILITARIAN EVALUATION

As discussed above, artists traditionally use evaluation techniques that differ radically from those of computer scientists, with little interest in formal user studies and more interest in social impact, cultural meaning, and the potential political implications of a technology. They seek to provoke as well as to understand the user. There is an opportunity to develop hybrid evaluation methodologies to combine the broader concerns of artists with the narrower and more structured methodologies of HCI. For example, Angela Garabet, Steve Mann, and James Fung use strategies that are open-ended and interpretive[45] to evaluate users' reactions to wearable computing designs. Interestingly, they demonstrate that users are more open to and accepting of new technology that is presented as the product of a commercial venture rather than as art. Jonas Lundberg and colleagues uninten-

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[39]See Glorianna Davenport and Michael Murtaugh, 1997, "Autonomist Storyteller Systems and the Shifting Sands of Story," *IBM Systems Journal* 46(3): 446-456.

[40]For example, see Peter Weyhrauch, 1997, *Guiding Interactive Drama*, Ph.D. Thesis, School of Computer Science, Carnegie Mellon University, Technical Report CMU-CS-97-109, Pittsburgh, Pa.

[41]See Bruce Mitchell Blumberg, 1996, *Old Tricks, New Dogs: Ethology and Interactive Creatures*, Ph.D. Thesis, MIT Media Laboratory, Cambridge, Mass.

[42]See N. Katherine Hayles, 1999, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*, University of Chicago Press, Chicago.

[43]See Philip E. Agre, 1997, *Computation and Human Experience*, Cambridge University Press, Cambridge, U.K.; also Phoebe Sengers, 1998, *Anti-boxology: Agent Design in Cultural Context*, Ph.D. Thesis, School of Computer Science, Carnegie Mellon University, Technical Report CMU-CS-98-151, Pittsburgh, Pa.

[44]Described in Chapter 6.

[45]For example, because evaluators are trying to understand how people react to a system, users might not be told about the purpose or operation of a system. See Angela Garabet, Steve Mann, and James Fung, 2002, "Exploring Design Through Wearable Computing Art(ifacts)," *Computer-Human Interaction 2002, Interactive Poster: Fun*, pp. 634-635.