University of Colorado at Boulder

Center for LifeLong Learning and Design (L3D)

Department of Computer Science

ECOT 717 Engineering Center
Campus Box 430
Boulder, Colorado 80309-0430
(303) 492-1592, FAX: (303) 492-2844

Proactive Multimedia Systems to Support Learning While Working

James F. Sullivan, Jr.[1] and Gerhard Fischer[2]

[1] James F. Sullivan, Jr.
Lieutenant Colonel, US Army
Department of Systems Engineering
United States Military Academy
West Point, New York 10996-1779
fj2236@se.usma.edu

[2] Gerhard Fischer
Center for LifeLong Learning and Design (L3D)
Department of Computer Science and Institute of Cognitive Science
University of Colorado
Boulder, CO 80309-0430
gerhard@cs.colorado.edu

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Introduction

High functionality computer applications are rapidly growing in size and complexity. Loaded with cascading functions and menus, modern direct manipulation applications have steadily evolved into environments rich with tools, but requiring extensive knowledge about when and how to employ program features and functionality.

As the Internet evolves into a mainstream software distribution channel, this trend will undoubtedly continue. While only few years ago the life span of a software product was about 18 months, new releases are now appearing every three to four months without the traditional shrink-wrap and printed documentation (Markoff 1996). Given this rate of change and the relentless pace of the workplace, learning is driven by a need for new knowledge relative to an immediate task at hand.

Just as software tools are changing, technology-oriented domains are also undergoing rapid change and evolution. In technology domains such as network design, information published in textbooks and presented in classrooms is quickly rendered obsolete. Given the rapid obsolescence of technology domains, continuous lifelong learning has become a necessity.

These two driving forces have thus emerged from the Internet Information Age: an explosion of new knowledge to learn, and an accelerated evolution of workplace tools. At the intersection of these two trends is the knowledge worker who must continually acquire new domain expertise, and employ this knowledge

to solve problems with rapidly changing tools. It is also within this intersection that several opportunities and challenges emerge for multimedia information systems.

Opportunities for multimedia information systems

The relentless stream of technology-driven knowledge demands that workers use their time to learn more efficiently (Sachs 1995). Supporting this need, integrated working and learning environments have been proposed to support "just in time learning" or "learning on demand" (Fischer 1991).

As knowledge delivery systems, multimedia information systems (Chorafas and Steinmann 1995) represent a promising technology to support a learning on demand conceptual framework. Like rapidly changing software applications, multimedia information could be updated and downloaded transparently through Internet distribution channels, providing the latest knowledge about domain technology and tools.

But if interactive multimedia information tools are to realize their greatest potential, designers must change the way information that multimedia information is organized and presented. All too often, multimedia systems employ instructionist approaches similar to those used in the classroom and simply describe or demonstrate application features or functionality without regard to the actual tasks facing the user.

Like traditional classroom learning approaches, this approach is problematic because (1) workers engaged in a task also need to know new domain knowledge, and (2) because of the pace of working, there is insufficient time available to learn what is not known. This self-limiting need to work and learn is known as the "production paradox" (Carroll and Rossen 1987), and it is only compounded by technological change and an increased frequency of application releases.

Proactive systems

Proactive systems have been proposed as an approach for designing systems that support the demands of lifelong learning in the workplace (Sullivan 1995). For the purpose of this discussion, a proactive computational system (1) supports the "delegation" of tasks, and (2) provides explanations about both the domain and application contextualized by the work at hand. In contrast to the "reactive" nature of modern direct manipulation systems, proactive applications offer promise for both helping people get work done while also supporting natural learning opportunities that occur while working.

A proactive architecture. To gain insights about this approach, a proactive domain-oriented design environment (Fischer 1994a) for creating bus topology networks called ProNet (Sullivan 1995) was implemented. ProNet provides constructive tools, implemented as autonomous "agents", allowing high level spatial design representations for a network. Once a high level design is completed, delegation is supported by specifying and weighting hierarchical design priorities such as network speed, cost, and maintainability. Using these priorities, intelligent agents collaborate to add design details that best satisfy the weighted design priorities. As these design details appear, the user can request explanations about what the details are, and why they are needed in the design. As new information is learned, the user can modify the design or override the computed details.

Argumentative hypermedia (Fischer, Lemke, et al. 1991) is an essential component in the ProNet design environment because it provides a cooperative problem solving environment (Fischer 1994b) with contextualized explanations of possible alternatives, rather than explanations illustrating one single solution. Through these argumentative contexts, interleaved opportunities for designing and learning are supported, and users can immediately see how the new knowledge is useful through the task at hand.

To create a computational system that could be directly compared with a traditional stand alone knowledge source such as LAN primer textbook, the ProNet argumentation was organized using hypertext linkages, graphics, speech, and sound. Further refinements could also be made to integrate high resolution photos, video, animation, and other richer multimedia forms into the argumentative hypermedia.

Insights from ProNet. User evaluation studies were conducted with undergraduate users performing network design tasks to compare ProNet with a traditional "book-based" stand alone learning environment. These studies highlighted several significant problems with traditional learning environments where working and learning are not well integrated, and provided encouraging insights about how a proactive environment could be used to work and learn. These studies indicated the following:

- Users take advantage of intelligent delegation mechanisms to complete assigned tasks.
- Users will access argumentative hypermedia to learn about new details that appear in their network designs while working.
- Novice users are able to reuse new information in subsequent tasks.

In short, the ProNet prototype illustrated that integrated interactive multimedia help for learning while working yields significant benefits when compared with traditional "stand alone" approaches (Sullivan 1995).

While encouraging learning results were demonstrated with ProNet, this proactive prototype also highlighted shortcomings of traditional programming and multimedia development environments. For example, three separate programming environments were required implement the ProNet prototype, including Macintosh Common Lisp, HyperTalk, and Agentsheets (Repenning 1994). This lack of a single architecture creates significant problems in designing, developing, and maintaining proactive systems.

Challenges for multimedia information systems

This paradigm presents new challenges for multimedia systems. To support the development of intelligent "proactive" applications, multimedia information systems should:

- be domain-oriented and tightly coupled with the digital work or design environment,
- provide seamless, contextualized access to current knowledge about both the application and application domain, and
- provide integrated opportunities for "reflection and action" (Schön 1983, Norman 1993).

To accomplish these goals, designers of multimedia substrates have to consider the following challenges:

- Eliminate barriers between multimedia substrates and traditional programming environments so multimedia information systems can be seamlessly integrated with applications.
- Integrate intelligent, cooperative problem solving technologies (Fischer 1994b) with multimedia development environments so application developers can create intelligent proactive systems that help users get work done, while also providing contextualized "on demand" learning opportunities.
- Provide transparent access and navigational support across networks so rapidly evolving application and domain knowledge can be obtained without interruption to work "flow" (Csikszentmihalyi 1990).

If these challenges can be met, multimedia can be more effectively employed to create intelligent, proactive applications that significantly reduce the learning and working dilemmas faced by modern day knowledge workers (Drucker 1994).

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