Chapter VI

Courseware and Its Possible Evolution through the Use of Agent Technology

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ABSTRACT
This chapter explores the potential for the application of agent technology to evolve an information system. In particular, the use of agents to evolve an educational subject management application is viewed in relation to an on-going project. Such software forms part of a courseware information system currently in use, and being further developed at Victoria University. Agent software is an emerging technology that has its roots in artificial intelligence research. With the recent proliferation of “agent” applications in areas such as e-commerce and Internet marketing, many agent applications fall squarely in the domain of Information Systems. Although there is little consensus at present regarding the nature and capabilities of software agents, agent technology may have the potential to advance Web-based subject management courseware to a further evolutionary stage.

INTRODUCTION
The term “courseware” is a relatively recent term that is used to describe the comprehensive software available to manage many aspects of the educational delivery process. The software that preceded what we regard as modern courseware had many names: Computer-Aided Instruction (CAI); Computer-Managed Instruction (CMI); Computer-Aided Learning (CAL); Computer-Managed Learning (CML); on-line teaching and learning and more recently Web-Based Learning (WBL) (Darbyshire and Wenn, 1996). However, the World Wide Web technology we now use as the platform for courseware, and the sophistication of the software have reached a stage of maturity that courseware products are attracting academics in greater numbers than ever before. Of course there are other factors driving this migration, including the rationalization of education as an economic activity.

The increased sophistication of courseware has evolved over many years by the addition of improved functionality. This evolutionary process has been largely driven in the
past few years by advances in the technological environment, which is consistent with Lehman’s observations of the evolutionary process (Lehman, 1982). The development of the Web has led to Web-based courseware which offers flexibility previously unavailable in many areas of delivery and management (Darbyshire and Wenn, 1998). However, as a commercially available Information System, courseware products as a whole may have enabled the substitution of computer power for manual human effort in many aspects, but have not yet progressed as far down the evolutionary path as they might given today’s technology. There are some excellent commercial products available, such as, TopClass, Learning Space, Virtual-U, WebCT, Web Course in a Box, CourseInfo and First Class. Landon (Landon, 1988) provides an on-line comparative analysis of fourteen courseware products, including those just mentioned; however, they have thus far not enabled us to alleviate the need for conscious human control at all times.

If we view the development of courseware products as an evolutionary process, then it is interesting to pause and ask the questions, “How have courseware systems evolved” and “How might courseware systems evolve in future”. Of course future directions will depend on available technology at the time, but we can pose some directions for this evolution based on emerging technologies. Agent technology may provide the means by which courseware can “evolve” and anticipate and assume many of the functions that humans must now initiate.

While agent technology holds considerable promise, it is still in an embryonic stage. Despite this, a broad range of organizations and disciplines are researching and pursuing software advances through agent technology. The Web provides a good architectural framework for the development of agents because it facilitates many of the characteristics of agent software such as mobility and communication. Given the existing base of courseware information systems and the functionality they provide, agents can be used to evolve these systems by supporting development based on a predictive model rather than simply relying on traditional incremental improvements.

It should be noted that some excellent work is already being undertaken in the area of Intelligent Tutoring Systems (ITS) (Ottmann and Tomek, 1998). However, we are particularly interested in viewing courseware from the perspective of the academic as the stakeholder (Darbyshire, 1999; Darbyshire and Wenn, 1999). With this perspective, the subject administration and management functionality of such systems take on more importance and indeed become the focus of the research described in this chapter.

In the following sections the notion of information system evolution is explored and some definitions for evolutionary stage (based in part on the work of Lehman and Belady (Lehman and Belady, 1985)) are introduced. Some background material on agents is provided and in particular the notion of autonomous agents which expands on the base idea of agency. The use of autonomous agents to enable evolution of course management software is then explored, and finally, a detailed description of the application of autonomous agents to an on-going courseware project is given.

**INFORMATION SYSTEMS EVOLUTION**

The early work on software evolution began in the late 1960’s and early 1970’s with much of the work credited to Lehman, Belady, Boehm and a few others whose names appear in the early literature. One of the earlier papers to seriously discuss software evolution as applying to individual artificial systems was written by Gerald Weinberg (Weinberg, 1970). Weinberg drew an analogy between program evolution and that of the natural evolution of living organisms proposed by Charles Darwin. However, the first recognition of the
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