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BEYOND CAD: THE ENRICHMENT OF COMMUNICATION *TEACHING MASONRY USING INTERACTIVE MULTIMEDIA INSTRUCTION*

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ABSTRACT

Technical education, with respect to its content and methods of delivery, must constantly be reevaluated in an effort to meet the changing demands being made on it by the architectural and engineering professions, by technology, by the state of our environment and by the students. The 1990's has come to see an increasingly computer and media literate society. Where computers have found a place in increasing the efficiency and variety of design explorations through the use of CAD and 3-D modeling systems, multimedia instruction and authoring systems can be used to expand upon computer information systems through the creation of new *courseware.* This vehicle can begin to make more effective use of our finite amount of *education* time by creating more time for *learning.* The computer has too long been relegated to exclusive use in, word processing, CAD and three-dimensional modeling applications. It must come to be seen as an excellent vehicle for *learning* and *communication*, accessible to all areas of technical education. Interactive Multimedia Instruction is an excellent means to enhance the teaching of masonry design in architectural and engineering applications.

INTRODUCTION

> *"The implementation of multimedia capabilities in computers is just the latest episode in a long series: cave painting, hand-crafted manuscripts, the printing press, radio and television.... These advances reflect the innate desire of man to create outlets for creative expression, to use technology and imagination to gain empowerment and freedom for ideas."* (Vaughan, 1994)

Architecture and Masonry Technology as highly visual and tactile disciplines are ideally suited to applications of Interactive Multimedia Instruction. These can be seen to take place within the regular university or college curricula, in correspondence courses, in continuing education, in training applications and in professional applications. It is not intended that Interactive Multimedia

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Instruction replace first hand teaching and information delivery, but be used to pedagogically enhance teaching and the dissemination of information, thereby creating more time for design related and hands-on activities through more effectual communication of factual and background material. Interactive software, multi-media, spreadsheets, virtual reality, simulation/optimization programs and expert systems are able to create a new means of masonry education and training.

Incoming students are increasingly computer literate and accustomed to Computer Aided Instruction (CAI). This, in addition to the rapid growth and effectiveness of the Internet for accessing and disseminating information, has created a changed atmosphere for instruction and telecommunication. (Mitchell, 1995) In many cases, University and College Architectural programs, professional practices, training centers and industry are lagging in the creation of a contemporary computing culture, in favour of traditional, often out of date methods. In anticipation, it is time to start developing a greater variety of architectural and industry related courseware for use readiness in the near future.

THE IDENTIFICATION OF NEEDS

Educational and training facilities prepare students for interaction with the profession and industry. Where educational content and use of new technologies may reasonably be expected to be "cutting edge", industry and the profession must remain abreast and current. It must be ensured that curricular content and industrial technical information continues to address ever increasing technical requirements and material scope in spite of a seeming finite amount of available time to explore, develop and apply this information. Many institutions and industries continue to stagnate, or flounder, through exclusive use of traditional methods which in many instances are incapable of meeting current and future needs. Most schools of architecture, industries and professional offices are so engaged in keeping up with the latest CAD and 3-D modeling systems that they ignore the potential for learning and information dissemination inherent in contemporary educational programming software as represented by Interactive Multimedia Instruction.

Many authoring systems are currently available for use with which courseware can be created, which require little or no programming knowledge, making computer technology increasingly accessible to all groups of educators, industry and practitioners. (Seiter, 1994) Increasingly, the introduction to computer applications occurs at the secondary school level, with some school systems making widespread use of computers in libraries and classrooms in elementary school. Many students are already entering post secondary education having learned word processing and CAD in high school and are often finding our approaches to teaching these subjects either out of date or unnecessary. Interactive Multimedia Instruction is currently being employed on an increasing frequency in courseware from Kindergarten to Grade 12, (Vaughan, 1994) and is a common format for reading and math readiness program software targeted at the Preschool age. Its effectiveness as a learning tool is being tested, monitored and confirmed. Youth take the inclusion of computers in their educational process for granted. Incoming students in the next several years will not only be experienced in this style of learning, but will expect such technology to be an integral part of architectural education and the industry. In anticipation, it is time to start developing a greater variety of Interactive Multimedia software for use readiness in the near future. (Gross, 1994)

> *"Multimedia enhances traditional text-only computer interfaces and yields measurable benefit by gaining and holding attention as well as interest. Multimedia improves information retention. When properly woven, multimedia can also be tremendously entertaining."* (Vaughan, 1994)

Interactive multimedia instruction (IMI) can be a solution to addressing the need to make more effective use of our time in order to *creatively:*

- deliver information
- increase the effectiveness of delivery
- capture the attention of the students/specifiers/practitioners
- make *learning* more informative and meaningful
- in schools, make time for the addition of hands on activities, site visits, experiments, and design exercises
- make detailed visual and technical information about masonry more accessible to a wider audience
- enable efficient and timely updates of technical and specification data at a reduced cost through the virtual elimination of paper products

Architecture and the construction industry, as a highly visual disciplines are ideally suited to Interactive Multimedia Instruction. It is not intended that IMI replace first hand teaching, but be used to enhance teaching, and create more time for activities by more effectively communicating (Teicholz et al, 1993) factual and background material. Interactive software, multi-media, spreadsheets and other program types are able to create a new means of education. Dry textual reference readings and background information can be replaced with more useful, dynamic information in multimedia format with access to a multitude of colour slide as well as diagrammatic images, and pertinent video clips. The computer coupled with a CD-ROM drive (Gruber, 1993) makes searching through database information quicker (i.e.. for video it is not necessary to fast forward through the entire film to find a certain part).

UNDERSTANDING INTERACTIVE MULTIMEDIA INSTRUCTION

Interactive multimedia instruction (IMI) can be defined as a uniquely designed instructional program which includes a variety of integrated media sources in the instruction with a computer at the center of the system. The program is intentionally arranged in segments, usually in response to course or content structure, and viewer responses to these structured opportunities (e.g., menus, problems, simulated crises, questions, virtual environments) influence the sequence, size, content, and shape of the program to varying degrees as is chosen by the direction of the instruction. (Schwier et al. 1993)

Interactive Multimedia Instruction can be created for unique situations employing levels of interactivity and environments which specifically respond to the demands and expectations for the desired end use of the user. Levels of interactivity are classed from Low Level (I) to High Level (IV) which depends ultimately on the amount of control the learner has in accessing and rearranging the sequencing of the flow of information.(Schwier, 1993) Interactivity is additionally categorized as *Reactive, Proactive* and *Mutual.* In a reactive interaction, the learner responds to given, controlled stimuli or questions and results in a low level of learner control and interactivity. A proactive interaction works towards learner construction and generative activity. The learner is able to make constructions and additions beyond the limits originally imposed by the designer and in this way extends the learning environment. Mutual interactivity involves the learner as the program adapts to the learner's responses and vice versa. This includes virtual reality. All three types of interactivity can to varying degrees allow the learner to confirm information, navigate through the information, pace the learning (or have it automatically pace according to the response time), allow for inquiries, and permit elaboration of information.

Interactive Multimedia Instruction makes use of three distinct types of multimedia instruction environments. These may be defined as *Prescriptive, Democratic* and *Cybernetic.* (Schwier, 1993)

The Prescriptive environment sets out precisely what the learner is to learn in order to comply with set learning objectives. Learners are granted or denied access to areas of instruction based on their progress. Three formats are used for this type of delivery; *Drill and Practice, Tutorials* and *Games/Simulations.* Drill and Practice takes the form of an answer feedback session. The questions can be formulated using words, diagrams, maps, etc. Often this type of vehicle is used to review previous learned material as a gateway control for access to subsequent more advanced information. Tutorials are used to teach new information and are the most routine applications of CAI (Computer Assisted Learning). Opportunity is included for the learner to demonstrate their newly acquired skills. Tutorials constrict the learner's control over the instruction and are lower level in their interactivity, although they can make full use of all the media bells and whistles: print, still video, full-motion video, CD-quality audio, computer generated graphics, animation and textual overlays. Games usually have a target goal to constitute a success and are often competitive. Simulations employ an abstraction of reality and require the learner to create a "model" within a set of parameters or rules. Simulations can be used to test an understanding of given information or to create and evaluate new alternatives which optimize the given parameters. (Bachman, et al., 1994)

Democratic Environments allow more control by the learner, thus shifting the responsibility for the course taken through the program to the learner. The learning is less structured and less objective oriented. These types of environments are constituted by *Supplementary Instruction, Learning Resources* and *Hypermedia.* Supplementary Instruction is considered as a secondary educational device, undertaken on the prerogative of the learner to address insecurities or to access review material or additional information on a topic. The student chooses a path through this content, and the completion of the content is not required to access the remainder of the program or subsequent lessons. Learning Resources are constituted by a well organized database of multimedia information. Learning is more accidental and requires that the student create independently motivated topic searches. Multimedia Encyclopedias are typical of this type of interactive database. Hypermedia environments can be "additional" to previous types, both Prescriptive and Democratic, and are constituted by add-on information loops that the learner can jump into or out of at will or by discovery. Hypermedia uses a multi-path approach to the organization of information which the learner can access at will and in any sequence. (Davis et al., 1994)

Cybernetic Environments speak to the use of Artificial Intelligence (Luger et al, 1989) in IMI systems. Through the inclusion in the program of IF THEN rules, the program will respond to the learner based on their input. This may involve the language of instruction, speed of delivery, level of difficulty of the program or ability to access certain areas or hypermedia loops. These types of environments are categorized as either *Expert* or *Heuristic Systems* (Luger et al, 1989). In Expert Systems the computer is programmed with a knowledge base in a specific technical field, along with limiting variables and parameters (Seebohm, 1993). The learner is able to pose a "question" or request a "simulation" based on the information contained in the program. Heuristic Systems impose qualitative judgments on the progress that a learner is making through the program as a way to personally adjust speed of delivery or accessibility of information. In more sophisticated applications, these types of systems can modify the information available to the learner based on their responses.(Schwier et al, 1993) This capability is especially useful in the creation of courseware which is suitable for a broad entry level base of learners of varying specific abilities.

TYPES OF SOFTWARE

There are numerous types of software programs currently on the market which to varying degrees allow for the creation of Interactive Multimedia Instruction.

Courseware

Courseware can be developed using *Authoring Programs.* It is important to recognize that not all authoring systems were designed to work with Interactive Multimedia Instruction. The best of the systems offer an icon based flowchart of activities (Seiter, 1994), to work with and expand upon, that does not require the learning of a programming language, and that allows for the scanning in of diagrammatic images, slides, video, music/sound, hypertext, looping, and animation. Many of these also offer performance tracking, networkability and license agreements. It is important that a system have a stand alone run time option of the program. This enables the instructor to see the program while it is still in production without trouble, edit and make changes.(Authorware Professional, Apple Media Tool) The systems have different approaches to license agreements which may make some more appropriate for the development of certain types of courseware. Most systems will permit the distribution of materials to students enrolled in the course, but will require that a license be purchased for material designated for general sale, distribution and marketing. The issue of copyrights of visual materials scanned into the programs is a critical issue whose legal ramifications are as yet undecided. Most courseware is currently limiting its use of visuals to slides or videos taken by instructors or students. If images are taken from books or periodicals copyright permission would be necessary.(Teicholz et al, 1993)

Simulation /Optimization and Expert Programs
Simulation/Optimization and Expert Systems offer the ability to statistically and three dimensionally realize the ramifications of architectural, material, mechanical, environmental and siting decisions on energy consumption,(AEDOT, 1993) effectiveness, performance, efficiency and built form. Such systems can be constructed as an extension of the information contained in a CAD two or three-dimensional representational system of a proposed building, or can be assembled using a database of existing building performance information. There exist a range of simulation and optimization tools which can be employed by architects and the technically interested which can interface with conventional design activities.(Architectural Record, April 1992) These will enable architects to evaluate more options at each phase of design and be less dependent on consultants for constant technical oversights of the creative process.(Bachman et al, 1992) The potential inherent in the application of simulation and optimization systems is to enable highly educated choice based on comprehensive study.

Virtual Reality
Virtual reality extends the notion of "multimedia" into a new realm that exists only in computer technology. Whereas other Interactive Multimedia Instruction applications derive their sensibilities from an extension of traditional teaching "techniques" and "materials" into a more effective delivery medium, the computer, virtual reality creates a unique environment within the computer for testing and experiencing architectural space. "New "virtual reality" technologies immerse the designer in highly convincing interactive visual simulations." (Gross, 1994) The inclusion of virtual reality as a medium in the design field has the potential for an incredible impact on the client's understanding of Design, given that it provides a "habitable" simulation of projects and a realistic representation of both spatial qualities and texture. Options can be introduced into the program which will reflect material choice, brick or block size, texture and colour, and light quality, allowing the Designer or Client to make informed choices. Virtual Reality software is in its infancy stage and we can expect significant development in the next several years to increase its accessibility. The major drawback to Virtual Reality within current technology is the prohibitive costs associated with establishing a laboratory.

APPLICATIONS OF INTERACTIVE MULTIMEDIA INSTRUCTION

Because interactive multimedia instruction can be designed to provide a variety of learning trails through the instruction, it is one of the better methods available for addressing learners of varied backgrounds. (Davis et al, 1994) IMI can be developed which is capable of providing distinct learning trails for students, apprentices, architects and specifiers, all within the same program. By pretesting material with typical "users" who represent the range of abilities you are likely to encounter, you may identify difficult or confusing portions of instruction which may require additional explanation. With appropriately designed IMI, it is possible to accommodate the needs of a complex audience within specific courseware through the use of remedial segments, flexible sequencing of presentation, Hypermedia options for bypassing or looping around extraneous instruction, and variable feedback. (This does not preclude the incorporation of printed media). Computers, videodisc, and CD-ROM lend themselves naturally to the problem of designing multiple trails through instruction. (Schwier et al, 1993)

The inherent variability in the level of difficulty addressed by the programming methods makes this medium suitable to the varying concerns of students, technical trainees, practitioners and specifiers. Users with highly technical requirements can skip ahead as they see fit, whereas with less expertise, or who feel less confident in the subject matter can engage in supplementary or remedial work to their level of satisfaction.

> *"The number of potential learners is also a significant selection variable. Although there are not absolute numbers necessary to justify production of various configurations of IMI, generally speaking, the greater the number of potential learners, the more closely the cost-per-learner of IMI approaches traditional approaches such as print or classroom instruction. Large-scale interventions are usually more cost-effective than smaller projects, so in our "bottom-line" society the size of the audience becomes a factor."* (Schwier et al, 1993)

It is recognized that there is increasing pressure in the practice of Architecture to address additional material, both technical and theoretical, in an age which changes rapidly and records that change with due haste. (Davis et al, 1994) The amount of time available to address issues within the context of the modern educational structure is limited. Keeping the professional practice abreast of changing products and technical requirements poses difficulty as well.

Putting masonry information into an Interactive Multimedia Instruction format will be able to replace some aspects of reference and technical literature with more pedagogically relevant interactives (to include line images of wall sections and specific details, slides of construction sequences and installations, video clips of installations in progress to illustrate techniques, text and product specifications, and, quizzes). Where existing reference texts, product catalogues and specifications are quickly outdated as construction methods, code requirements and stylistic concerns constantly change, Authoring programs have the ability to be quickly updated, thus keeping material current, without the difficulties associated with the complete editing and reprinting of a text. This notion carries over into issues of Sustainability and the waste associated with paper use in the printing industry. Courseware and CD-ROM databases are capable of significantly reducing paper waste in education. Consider only that a single CD-ROM disk is capable of containing the text and images of an entire encyclopedia. The programs are able to include vast quantities of color images, both still, animated and digital video transfers. These can be specifically tailored to the needs of the masonry instruction, issues of regionality and compliance with Provincial and National Codes. This offers an improvement over existing publications, who by virtue of cost, are limited to still reproductions, and seldom can offer specific regional points of view or case study examples. Digital video, is very useful in many technology courses to explain "processes", particularly in reference to construction, which cannot be properly covered with still images, editing to include only critical points of interest in video format thereby enabling the inclusion of a variety of worthwhile cases.

For teaching, authoring programs have the ability to track individual student use of the material and the depth they have reached into the program. This device is not only useful for recording student progress, but can be used analytically by the instructors to identify areas of uncertainty, redundancy and guide to the creation of clarifications. Authoring programs can include internal tests (including tracking the number of tries for the right answer) which can be used as a gateway to more advanced regions of the software.

IMI can be used as an introductory basis to explain the function and manipulation of spreadsheets, simulation programs, and expert programs through the creation of tutorials which use hypercard sequences, animations, textual loops and database access. IMI can be used to easily catalogue previous projects and case studies from various sources which instructors/industry can make available to students/practitioners within a more pedagogically appropriate format, including the addition of personal annotations and references. Simulation/Optimization programs and Expert Systems can be used as design and analysis tools, in both technical and design courses, to aid in a greater understanding of the ramification of decisions on the building performance characteristics.

Faculty at the School of Architecture at the University of Waterloo are developing a prototype Expert System for the assembly of three-dimensional computer models of architectural construction details suitable for cold climates. (Seebohm, 1994) The project supposes that architects, students and contractors will be able to understand the details more precisely if the details are shown in three dimensions, and, shown in assembly sequence demonstrating how each component is installed one after the other. The database of information included statistical information on materials, and Codes, for the eventual expansion of the ability of the program to calculate thermal and moisture performance. Applications would include Building Construction and Building Science courses, masonry training, professional detail design and selection of materials.

The College of Architecture and Planning at the University of Colorado at Boulder outlines three categories of instruction using computers which make up their curriculum: Tool-using courses which teach specific applications, tool-building courses which focus on developing new design software, and design theory and methods courses which provide a rationale for specific computational approaches. They identify four roles for computer use, namely; in Image Making and Visualization -- through CAD, modeling programs, virtual reality; Analysis and Decision Making -- through quantitative modeling and simulation programs; Information Systems -- through on-line databases of design, plans, handbooks of standards, collections of images; and, Design Theory and Systematic Methods -- through modeling and management of the design process, expert system applications. (Gross, 1994)

Distance Education

> *"The location of the audience can also be important. If learners are centrally located, then many types of training approaches are possible, including such things as classroom instruction and site visits. But if the audience is dispersed, located over a wide geographic area, then an individualized approach which has the potential for power, immediacy, durability, and flexibility of interactive multimedia becomes more attractive. Multimedia can*

provide a cost-effective means of distributing instruction, especially considering the savings realized from travel and lodging expenditures often associated with events centrally offered." (Gross, 1994)

The educational style and accepted teaching methods which constitute the majority of correspondence teaching programs in architecture, can easily be cited as in serious need of vitalizing and upgrading. Correspondence students typically learn in isolation via a series of audio tapes and assigned readings. The benefits of Interactive Multimedia Instruction as applied to the development of correspondence courses are many. The development of IMI in regular architecture courses could easily be extended to offer an increased selection of topics to correspondence students. There has not been a proliferation of architectural correspondence courses at most Universities as the traditional very visual format of lecturing with personal slides and film was not adaptable to cassette format. The costs associated with the multiple duplication of slide sets, and their distribution to distant students was prohibitive. IMI is a cost effective means of duplicating and distributing such materials in a more pedagogically meaningful manner. (Vaughan, 1994)

Continuing Education: Industrial and Professional Retraining

The impending adoption by the American Institute of Architects (AIA) of a continuing education requirement in 1995 (Bachman et al, 1995) will soon begin to place pressure on the profession and educational facilities. Similar arguments for the use of IMI in distance education hold effectively for the adoption of IMI for some aspects of continuing education and continual upgrading on masonry construction practices and product information. Many graduate students, practicing architects and masonry people are situated remotely from large centers where courses and seminars are normally offered, and find regular in-person attendance prohibitive. Additional professional pressures often preclude seminar attendance when it is in conflict with client and project demands. Since most offices are making wide spread use of computers for CAD and word processing, and are beginning to include CD-ROM hardware as a response to the database and detailing offerings of industry, it makes sense to offer courses in the IMI format. The ability of authoring programs to track use and performance in the experience of the course material aids in the monitoring process if desired.(Authorware Professional) Seminars, courses and retraining could still require more traditional submissions and testing to complement the IMI instruction. A combination of IMI and less frequent group seminars could be developed to encourage a degree of personal contact for persons requiring continuing education in more remote locations. Our institution has had very little luck in running Continuing Education Courses on CAD, due to the availability of time, faculty, and cost to the professional (who is probably under or unemployed right now). Courseware could be developed to address this issue, through Hypermedia looping applications to instruct and access various programming problems.

CONCLUSION

The creation of Interactive Multimedia Instructional programs, although accessible by most with moderate computer knowledge, is a time consuming endeavor if it is to be well done. If we do not commence working on creating vital programs to enhance teaching in the field of masonry NOW, we will be unprepared in several years for those who will not only be *accustomed* to this type of delivery, but who will *expect* it to be an integral part of Architectural Construction Technology. Additionally, given the increase in the development of Multimedia, Simulation/Optimization and Expert application programs for both technological and design use in Architectural practice (Teicholz et al, 1993) we as post secondary educators may be accused of inadequately preparing students for their professional careers.

How do we not "turn off" faculty, students and industrial partners that do not wish to see computers used extensively and fear for a diminishing of personal contact in teaching, lecturing and marketing? There is a need to emphasize the *appropriate or selective use of computer technology* in the development of courses and literature which will increase effectiveness by adding to the delivery of the information. Courseware is not intended to replace lecturing and personal contact. Courseware, when used properly, should allow for *increased quality personal interaction* between faculty and students, and, between industry representatives and practice. It should create time for more meaningful discussion and experiments, commandeering only the information that comprises the rote aspects of teaching and information systems to Interactive Multimedia Instruction. *The net effect should be an overall improvement in the delivery of information and the level of intellectual discussion achieved.* Interactive Multimedia Instruction should be able to deliver superior support material, and allow the use of time for more vital purposes.

REFERENCES

ACSA West Regional Conference. Representation. October 1993.

AEDOT. Integrating Energy Efficiency into Commercial Building Design and Operation. Pacific Northwest Laboratory. The Advanced Energy Design and Operation Technologies Project, 1994.

A Model of Efficiency. Architectural Record. April 1992.

Authorware Professional 2.0.1. Macromedia, Inc. San Fransisco, 1993.

Bachman/Thaddeus/Sylvester. Simulation and Optimization as New Activities in Architectural Practice. College of Architecture. University of Houston. June 1992.

Davis, A.J. and Mike O'Brien. A Project for the Digital Development of Technology Courses at the Graduate and Undergraduate Level in Architecture. Virginia Tech. Presented at the ACSA Construction and Materials Institute, July 1994.

Gross, Mark. Roles for Computing in Schools of Architecture and Planning. JAE. September 1994.

Gruber, David. Practice: Computers: CD-ROM Technology. Progressive Architecture. 3:93.

Luger, George and William Stubblefield. Artificial Intelligence and the Design of Expert Systems. Benjamin/Cummings Publishing Company, Inc., 1989.

Schwier, Richard and Earl Misanchuk. Interactive Multimedia Instruction. Educational Technology Publications, 1993.

Seebohm, Thomas. CAD in Education: University of Waterloo. ACADIA Quarterly, Winter 1994.

Seebohm, Thomas. Rule-Based Assembly of Architectural Details for Cold Climates in Three Dimensions. Fall 1993.

Seiter, Charles. Reviews: Authorware Professional 2.0.1. Macworld. February 1994.

Smith, David Lee. Connector. Fall 1993.

Teicholz, Eric and Larry Yu. The Promise of Multimedia. Progressive Architecture. 10:93.

Vaughan, Tay. Multimedia: Making It Work. Osborne McGraw-Hill, 1994.