CD-I Compendium:
Production and Evaluation
of a Multimedia Reference Tool
for the Construction Industry.

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ABSTRACT

CD-I COMPENDIUM: PRODUCTION AND EVALUATION OF A MULTIMEDIA REFERENCE TOOL FOR THE CONSTRUCTION INDUSTRY.

ANDRÉ PLANTE

The following thesis-equivalent involved the development and evaluation of an interactive repository to be used by the construction industry. It has been pointed out by architects and engineers that there is a lack of expertise about brick veneer wall construction. Not only are there not enough human resources available but the existing workers are not adequately trained, due to a lack of readily available information about this specific type of construction. From these concerns emerged the need for a single repository or compendium that could be used both as a training tool and as a reference database. Since the contents were available and/or best presented in various forms, the CD-I technology was selected. CD-I integrates a variety of media such as video, computer animation, text, photographs and digital audio. This report relates the development phases and the evaluation of a prototype designed on a microcomputer emulating the CD-I environment. The compendium was evaluated with the help of a multi-disciplinary team composed of a professional courseware developer, a general contractor, a construction worker and an architecture student. Results of the interviews and hands-on sessions are discussed. Attitudes toward the CD-I compendium were also probed at a Construction Industry Trade Show held in Toronto, Canada. Results of the questionnaire which was employed are discussed.

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I dedicate this work to my parents.

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Chapter 1 Introduction

Context of the problem

There is an overall distrust in the construction industry concerning the brick veneer wall and it has been growing over the past few years. It has been pointed out by architects and engineers that there is a lack of expertise about brick veneer construction. Not only are there not enough human resources available but also some of the existing workers are not adequately trained, due to a lack of available information about this specific type of construction.

Siricon

Siricon, a research center devoted to the technological advance of the construction industry, decided to develop a tool which would attempt to alleviate the problem. The researchers at Siricon had somehow heard about a new audiovisual technology, called Interactive Compact Disc, and decided to produce their reference tool with it. Their first reaction was to find producers that were familiar with the technology and to ask for estimates of price and production time. Since most production companies offered turn-key packages in which Siricon would have had little control over the final product, the research center opted for a different production model. In January 1992, Siricon contacted the Educational Technology Department and arranged a meeting with Dr. Steven Shaw, a specialist in computer-based training. Dr. Shaw, then decided to form a small team of graduate students who would do the required analyses, development and production of the instructional materials.

Siricon (Research and Computer Applications for the Construction Industry), was established in 1985, by the Québec government with the support of Concordia University.

Siricon has a mandate to transfer the latest technologies to the construction industry and to assist it in acquiring the required knowledge to operate efficiently and effectively. Siricon offers its services to architectural and engineering firms, to construction contractors, and to manufacturers of construction materials.

Needs

The initial meetings were used to identify the needs of the client. They already had set their minds on a new and exciting technology. This obviously is not an ideal strategy. When a technology is chosen before considering all the alternative solutions, inevitably one will encounter some interesting developmental problems at a later time. In any event, since this decision had been taken unilaterally and it was not catastrophic in any way, we went along with it.

Representatives of the client, Siricon, explained their need for a unique source of information about a very specific aspect of the construction industry. They wanted to provide a tool that would set the standards straight and would hopefully become the 'Brick Veneer Wall Bible'. The idea sounded great; it made sense to put all the available knowledge about brick construction and their related building codes standards in one convenient package. The unique repository or compendium would be used primarily as a reference tool and indirectly as a training tool.

To be effective the tool should:

- allow for individualized learning since prior knowledge of the topic varies among individuals
- have the possibility to store a very large amount of information in one repository.
- be simple to use, since the majority of the target population is not computer literate.
- integrate a variety of media such as video, computer animation, text, photograph and audio, since the content would be available and best presented in various forms.
- be portable, since it could be used directly at the construction site and at home.
- be inexpensive.

Target audiences

Architects and General Contractors were to be the target of this solution scenario. The target audience was identified by the researchers at Siricon. They felt that targeting these two groups of individuals would produce the best results. The researchers believed that a lack of communication due to non-overlapping points of view was partly the cause of the problem. It seemed not so much a problem with the vocabulary but rather with understanding of the specific concepts related to the trade.

- **Architects**

Architects design and have a global view of a building project. In this regard their perspective is different from that of an engineer, who has to focus on specific areas of the same project. An electrical engineer, for example, is only concerned about his specialized field and how it relates to a specific building project.

- **General contractors**

General contractors also have a global view of the construction project, but it is fundamentally about the production component of the project. They are in fact realizing the architect's design. Their role is to manage the project completion while respecting the building code, budget, time and other unforeseen constraints.

Media Selection

Interactive media

- **Historical and conceptual viewpoints**

Vannevar Bush in his seminal article entitled "As we may think" described a concept of an all integrating work environment, the memex. He explained that the human mind operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts (Bush, 1945). With this concept in mind, he developed an imaginary tool precisely designed to help trigger and manage such associations. It never was realized since the required level of technology was not available at the time. But his work was not forgotten and later became the basis of a computer revolution.

Inspired by the concept of Vannevar Bush, Douglas C. Engelbart tried to structure the capabilities of the tool envisaged by his predecessor into some sort of framework. Engelbart envisioned an augmentation tool that would give a small work group of people, working together, a better chance at solving problems that were becoming ever more complex (Fraase, 1990).

Engelbart eventually founded the Augmentation Research Laboratory at the Stanford Research Institute. He was task-oriented and invented a number of computer tools that are today taken for granted. In the late 1960's, he invented the mouse, the computer window, electronic mail and computer conferencing (Fraase, 1990). However, a full-fledged version of his augmentation system was never really implemented.

During the same period, the mid-1960's, the term 'hypertext' was coined by Theodor Holm Nelson. He defined hypertext as any piece of nonsequential writing whose layout requires us to read nonsequentially. Encyclopedia, newspapers and magazines are examples of what Nelson meant (Slatin, 1991).

Nelson has worked for nearly 30 years on a grandiose project called Xanadu. The Xanadu project is to constitute a global repository of information that would be accessible from anywhere in the world. Nelson believes that information is a universal treasure and that users should be able to access and organize it as they please.

The concept of hypertext was somehow revitalized and augmented to encompass text, graphics, animations and sounds with the advent of Apple's Hypercard software in the late 1980's.

- **Contemporary and technological viewpoints**

With this brief historical and conceptual background established, let us proceed to examine contemporary issues concerning interactive media.

- Active involvement

Essentially interactive media demands a higher level of active involvement than does traditional media from its audience. It may integrate

text, video, music, computer animations and, more importantly, represents an environment fostering exchanges between the user and the delivery system.

- Technology

Digital technologies permit the integration of all traditional communication media into one environment. The computer has thus become a multiple media processor. This digital revolution has enabled developers to replicate our multisensory environment within a relatively simple technological framework. It should be noted that some analog technologies such as the videodisc are often integrated within interactive media but, in these cases, it is the delivery hardware that is controlled digitally.

Vannevar Bush never realized his dream because of inadequate or not-yet available technologies. Douglas Engelbart provided genuine technological solutions but in an era when computers were not universally available. Theodor H. Nelson has imagined a universal network of hypermedia users but network applications are still limited until issues of bandwidth, resolution, compression and free access to information are addressed and resolved.

Technology indeed plays a large role in interactive media. Nowadays, we can witness a global struggle for interactive media standards. The players in this highly strategic confrontation seem to belong to three groups, namely, the electronic hardware manufacturers, the software developers, and the entertainment industry. Interests range from content royalties, optical disc technology to software interface and networks.

Although there are still a lot of technological barriers to bring down, there are available solutions for smaller scale projects. The average mid-range microcomputer is now powerful enough to deliver full-fledged interactive media. Software is available to design interactive environments. Peripherals are more easily acquired.

- Interactive media and the consumer market

The new trend is to bring interactive media to the consumer market at large. The strategy is to camouflage the microcomputer and to treat it as a black box. Although powerful, the processors found in toys like Nintendo or Sega game players and in the new Interactive Compact Disc are not presented as computer hardware but merely as the innards of a consumer product, just like the processors found in your microwave oven, wristwatch or VCR.

Since interactive media has largely been within the computing community in the past, the changing focus is certainly an interesting one. The general consumer population has not yet experienced, or not as often, basic human/computer interaction.

Interactive media is thus a mixture of a philosophy and concepts such as nonlinear thinking, cross-referencing, universal access to information and technological solutions such as the mouse, videodisc, hypercard, networks and Interactive Compact Disc, among others.

Compact Disc Technology

As stated above, Compact Disc-Interactive (CD-I) is aimed at the consumer market. It is similar to the now well-known Compact Disc-Audio format that has replaced vinyl records. Not only can CD-I store music, but also images, text, animation, video and software. It also uses the same silvery discs

but requires a more elaborate coding format. Beside mastering differences, the discs can and will probably be produced in the same plants as their audio counterpart.

CD-Audio was the first Compact Disc to be introduced. Its technical specifications are found in the Red Book (Young, 1991). In short, the Red Book defines the standards to encode music on the disc. CD-Audio is an international standard with universal adherence that guarantees worldwide compatibility.

Another disc format followed. The Compact Disc 'Read Only Memory' format (CD-ROM) was aimed at the computer industry. It is now commonly use to store large amounts of reference information and more recently to publish interactive media for the computing community. Its specifications are found in the Yellow Book (Young, 1991). In summary, CD-ROM is a peripheral. It can only be accessed with a computer. It has limited compatibility, especially with non-text data and across operating systems.

CD-I is an agreement on a third compact disc standard that was announced by Philips and Sony on February 24, 1986. CD-I is a specific application of CD-ROM with rigidly defined implementations similar to the 'Red Book' defining CD-Audio. The 'Green Book' specifies not only the way data is stored on the CD-I, but a configuration capable of reading the discs and decoding the information. CD-I is a self-contained system, not a computer peripheral (Moes, 1986). It is also an established international standard received worldwide.

Pre-selection of media

The CD-I technology had already been selected as the platform of choice for this architectural project. Sadly, this is often the case with clients. They

will often take unilateral and frequently ill-informed decisions about the technology to use and hope it will fit their needs and content. With CD-I, in this case, I concede that it would be difficult to be wrong since all major media are available and can be integrated in one package.

The major problem is that a year after this decision was taken, CD-I has still not yet become well established as a consumer product. A senior BBC education producer, Robin Mudge, comments that since it is reasonably priced and "plugs into the all-pervasive T.V..." (Johnstone, 1992). CD-I has a good chance of becoming a standard.

Some major consumer equipment companies are behind CD-I and Philips is leading the assault. Nonetheless, as we know, the financial and technological backing of the giants in the industry are not always a guarantee of success. As Robin Mudge puts it: "We've seen what happened with interactive Laservision..." (Johnstone, 1992). Another interesting example is the fate of the Sony Beta consumer video standard.

- **Prospect of CD-I**

My only fear is that the CD-I format could become stillborn since it is not yet readily available in the stores and fairly little marketing has been done at the consumer level except for trade magazines. Hong Kong is the only place I have actually seen the players being offered and displayed in store windows together with VCRs and Walkmans.

- Marketing issues

The reason for this slow entrance on the consumer market is summarized by Andrew Young in his article on the evolution of CD-ROM

standards. He argues that Philips' entire CD-I market lead has essentially disappeared.

> The rapid development of competing technologies has slowed CD-I trip to market. When Digital Video Interactive (DVI) was introduced, it created such a stir that CD-I developers went back to the drawing board to add comparable technology. This actually turned out to be premature, since DVI product cost will prevent its becoming a consumer technology in the near future. Now, as CD-I developers once again approach the consumer market, they are confronted with Commodore's CD-TV, a comparable product build around the company's Amiga (1991).

If we compare this strategy to the aggressive marketing that Kodak has displayed for its more recent Photo-CD technology, we may be left with some apprehensions for the future acceptance of CD-I as a consumer standard.

One potential and detrimental scenario for the premature death of CD-I would be the following: Electronic games manufacturers such as Nintendo or Sega decide to extend their development facilities and marketing to encompass the training industry. Their players are inexpensive and there are already millions of them installed in the living rooms of average consumers. As a matter of fact, Nintendo in collaboration with Sony is presently working on a CD-ROM system that is tentatively scheduled to be launched in the United States and Japan in August 1993. According to the agreement, Nintendo and Sony each plan to license third-party companies to develop, manufacture and sell both 'game' and 'non-game' software... (Anonymous 1992).

The CD-I platform and technical specifications

There was no doubt in my mind that CD-I would be an effective medium and that it would fill the needs expressed by the client. It offers all the needed elements and more. Here is a summary of the technical

specifications found in various Philips publications (Philips International, 1988; Philips Interactive Media Systems, 1989; Philips Interactive Media Systems, 1991; Philips Interactive Media Systems, 1992; Philips Interactive Media Systems, 199?):

- Video: Unlike other media, CD-I is not dependant of any national television standard. It can be watched on any television set anywhere in the world. CD-I offers two full planes and two auxiliary planes of video for a full range of special effects: cuts, wipes, fades, curtains, dissolves and granulation.
- Pictures: There are four encoding methods: High-quality natural images (RGB), natural images (DYUV), graphic images (CLUT), Cartoon images (RLE). There is also another type of compression for use in extended players: Higher resolution (QHY).
- Motion: Normal resolution video is now supported - at either 25 or 30 frames/sec. Cartoon-quality animation is feasible.
- Sound: CD-I provides four levels of audio quality that can be exemplified by comparing them to CD Digital Audio, New vinyl disc, FM broadcast and AM broadcast.
- Text: Text is held on the disc either as characters or as graphics (an RLE image is usually better). ASCII format is used to display system messages on screen and uses the font resident in the player. Other typefaces can be downloaded at runtime, but memory in the player must be taken into consideration. Certain anti-aliased fonts are also available and takes up slightly more memory space than an ordinary font.
- Capacity: CD-I stores up to 650 MBytes of data. The actual capacity for specific applications will take into account all the media types used in the software - text, drawings, graphics, video and audio.
- Interface: User control is provided by an X-Y pointing device, on-screen hot-spots and menu-driven operation. A two-button mouse, thumbstick remote control unit, joystick, track ball can be utilized.
- Operating System: The CD-RTOS (Real-time operating system) is a specially adapted version of Microware's OS-9.

- Hardware: The standard unit consists of a CD-I player and a Multi-Media Controller.

Chapter 2: Prototype

Introduction

When the coding and production of the content is finalized, pressing a CD-I is relatively inexpensive. Surprisingly, the cost of a production platform for CD-I is quite high. The special hardware and software needed in combination with a powerful computer has kept the price up. This is thus the reason why the client, Siricon, opted for a computer-based prototype before taking a final decision on the actual production of a CD-I.

Disadvantages of computer emulation.

There are obviously some draw backs to emulating the CD-I environment on computer. Continuous soundtracks and video images amount to a lot of disk space and can significantly slow down the system. This prototype has pushed the machine to its limits with more than three hours of material, and I would not recommend that the application size be increased. As with all technology, the computer has its own set of limitations, be it the amount of Random Access Memory available, the disc space or the speed of the processor.

There are also some invisible application size thresholds that, when crossed, seem to slow down development on an exponential scale. This could be best illustrated by a desktop publishing example: If a designer had a document containing 30 pages of text and half a dozen photos, she would be able to navigate from page to page, cut and paste sections of the work with no apparent slowing down of the computer. She would also be able to create a mental global model of the document. Let's imagine the same designer, but

this time the document contains 300 pages of text and 60 photos. The task of manipulating such a document causes an obvious stress on the machine and indirectly on the designer.

Originally, the prototype for the Siricon CD-I was to contain about 100 screens; however, the existing prototype comprises nearly 300 screens (see Appendix F for a precise breakdown by media). The added screens had a negative impact on the development speed, resulting in slower navigation, file compression, saving and back-up operations. It also limited my ability to keep a constant up-to-date mental model of the whole project. This model of course helps the designer keep his application consistent and coherent. These extra screens also obviously added in pure and simple production time and ultimately meant less time to explore new interactive strategies.

On the other hand designing the prototype on computer and not investing in the CD-I developer's kit leaves us with the possibility to implement on another technology if something better comes along in the near future.

The team

- Stanley Hason: Project Manager for the Client.
- Steven Shaw: Supervisor.
- Maria Corsi: Engineering, Subject Matter Expert.
- Dominique Derome: Architectural Subject Matter Expert.
- André Plante: Supervision of all phases, interface designer, graphic designer, program code designer.
- Geneviève Légaré: Instructional designer
- Hung Truong: Technical illustrator
- Frank Roop: Cameraman on site
- Teiichi Ota: Quicktime video capture

Selection of prototyping platform

CD-I qualities and limitations were to be emulated on a micro-computer.

My familiarity with the Apple Macintosh family of computers and their renowned graphical environment made me favor the following platform:

- A Macintosh IIci equipped with a large hard drive and 8 meg of RAM on-board.
- Version 7 of the Macintosh operating system
- Quicktime, a system extension that manages temporal events such as digital video and audio. Although the quality of the video image is somewhat poor, it makes for an excellent and cost-effective prototyping tool for the integration of video sequences with the designed interface.
- Aldus Supercard, an authoring software.
- Macromedia Director, an animation software.
- Deneba Ultrapaint, a drawing software.
- An Abaton Black and White scanner
- A Sharp Color scanner
- Adobe Photoshop, a photo retouching software.
- Supermac VideoSpigot, a Quicktime digital video capture board.
- Adobe Premiere, a Quicktime video editor.
- Macromedia Soundedit, a sound editor.

Scope of the prototype

The prototype, as mentioned earlier, contains nearly 300 screens. The screens are a combination of text, photos and illustrations. The courseware also contains dynamic data such as sound tracks, animations and video sequences.

It is always difficult to estimate the amount of time a learner will take to go through an interactive program, since she will navigate at her own pace and may repeat some sequences more than once. This said, I estimate the courseware to represent from three to five hours of interaction. This estimate is based on my own experience of going to every single screen and spending 30 to 45 seconds proof-reading and testing the interactive functions. Since some screens demand more interaction while others display animation or video excerpts, I believe that an individual could easily spend half a day exploring the prototype. It is worth noting that since parts of the courseware would be used as reference materials, some contents may only be consulted intermittently by the learner.

Timeline

The analysis phases were completed over a period of five months (January to May 1992). The flowchart and storyboard were completed within two months (June to July 1992). The actual production of the prototype was accomplished in two months (Mid-July to mid-September 1992). It should be noted that by working an average of 70 hours a week, the prototype was produced at an accelerated pace.

Development Methodology

- **Conventional ISD based Approach**

There are currently two basic approaches to development of computer-based training. The first, traditional approach, is based squarely on instructional systems design models. These models (e.g., Dick & Carey, 1985) prescribe a series of steps related to analysis, design, development, production,

and evaluation. Typically these steps would include front-end analyses (training needs analysis, needs assessment), instructional analyses (learner analysis, content analysis or task analysis, writing of objectives, strategies selection), development tasks (media selection, storyboarding or scripting, authoring of content), production activities and formative and summative evaluation procedures.

In practice these steps are carried out largely sequentially, and frequently by different groups within the overall development team. The approach is similar to the traditional waterfall model of software engineering which presents a lockstep, linear process with heavy emphasis on a strict definition of design features and standards during the early analysis phases.

The difficulties with such an approach are several. In the first place, the premise is that there will be no surprises during the production phase. This is a dangerous assumption when working with new technologies and when there exists little collective experience with the design of whatever kind of artifact is being developed. This was indeed our situation with respect to the project reported in this thesis. In general, the linear character of the traditional approach can lead to the "over the wall" syndrome, where one group completes a task and tosses it over the wall to the next group to perform the next activity or transformation. Frequently, failure to communicate requirements or standards across divisions results in work getting tossed back over the wall for expensive revisions.

This traditional model also depends on evaluation to ensure effectiveness despite the emphasis on analysis activities. When Andrew and Goodson (1980) reviewed 40 instructional design models they found 38 which recommended that instructional materials be tried out and revised before implementation. Since production usually occurs last in this approach, it is

difficult to effectively evaluate hypermedia applications formatively. It is hard to assess many features in the development phases (storyboarding). This is due to the fact that the medium of development (paper-based) cannot simulate the functionality and dynamic characteristics of the hypermedia software. Thus using the traditional method, one must wait for the completion of the production phase to evaluate the final product. By that time, it is usually too late or too costly to make changes.

When the conditions obtain, namely:

1) The technology is new.
2) The type of application under development is new or innovative.
3) The medium for development does not simulate well the functional characteristics of the final medium of production.

Then an alternative methodology is called for, combining elements of traditional ISD (including front-end analysis, especially) with rapid prototyping, a software engineering methodology, and concurrent engineering. A brief description of these follows.

- **Concurrent Engineering Approach**

When conditions 1) and 2) above obtain, it seems reasonable to try to link the analysis phase to the design of the production process more closely than is usually the case in conventional development methodology. In short, it seems necessary to borrow a concept from total quality management, namely, "concurrent engineering" (St Charles, 1990). Concurrent engineering originated in the field of manufacturing where it relates in particular to the linking of design and production engineering processes. It is now applied more generally in the literature of total quality management to refer to the use of cross-functional or multi-disciplinary teams to create more effective

product designs, and to reduce time to market by simultaneously designing products and production processes.

- **Rapid Prototyping**

The solution to problem regarding evaluation lies in an alternative approach. Rapid prototyping uses the medium to design and test development hypotheses from the outset. The development team can then evaluate the application from the first stages. This is actually the major justification of rapid prototyping.

At the same time, rapid prototyping answers production issues and ultimately facilitates the design of the final production process. Thus it also constitutes an application of the principle of concurrent engineering.

It is also important to understand that rapid prototyping relies on the expertise, talent and craftsmanship of every individual on the development team.

Final Development Process

The prototype was produced following the concurrent engineering model. The use of the rapid prototyping with a multi-disciplinary expert review team approach (Weston, 1986) provided an on-going formative evaluation. The multi-disciplinary team comprised an architect, engineer, graphic designer, instructional designer and programmer.

A separate formative evaluation was conducted at the end of the prototype production (see Chapter 4).

Chapter 3: Analysis and production phases

Introduction

This section will list and briefly explain the major steps taken toward the completion of the prototype (Okey, 1990). The production of educational courseware obviously begins with some analysis of the problem. The collected results are then taken into account during the actual design and production of the courseware.

Analysis

Front End Analysis

The purpose of the Front End Analysis is to find the possible cause of a performance problem. This analysis is important in determining if a training solution is required. Training assumes that people are not performing a job well because they lack the required skills. It is important to find out the real source of the problem. There are a number of causes that mimic a training problem: unmotivated people may have a performance problem even if they possess all required skills to do the job; environment can also affect performance.

The Front End Analysis for this project was performed by Siricon. The results pointed to a lack of skills and to some communications problems between the various parties involved.

Task Analysis

The goal of the Task Analysis is to identify and define the skills required to be taught in a program.

The Task Analysis was jointly performed by Siricon and the development team. A large number of behavioral objectives were listed. This list later served as the basis of our official content selection.

Courseware Design

The following steps are more or less sequential although some may exist concurrently at a given time. Design is also an iterative process which entails that many solutions may prove valid but that one must be selected as the most beneficial strategy. These frequent decisions and readjustments may require that certain revisions be performed on a previously completed step.

Selection of contents

This selection process helped determine which information and which sources should be used to produce the prototype. In this case, the Subject Matter Experts selected the contents from various sources such as government publications, engineering textbooks and existing training videos.

Teaching strategies and media selection

This step includes an analysis to ensure that the proper teaching strategies are utilized and a selection process to ensure that the proper medium is employed to suit any given strategy.

For example, computer animations were used to explain physical principles and illustrate their effects in the construction context, and video sequences were utilized to show construction and inspection procedures.

Basic structuring of contents

The basic structuring of contents refers to the grouping, ordering and sequencing of the information. An outline was created and became the basis of the CD-I prototype. (see Appendix C)

Flowcharting

Flowcharting proved to be an important and complementary step to help define the structure of the contents. Translating the outline produced in the previous step to a flowchart gave the production team a visual road map of the prototype.

User interface design alternatives

The software environment in which the learner will evolve has to meet a number of design criteria.

An excellent reference book produced by Apple Computer Inc. (Apple, 1987) lists ten fundamental principles for their own graphical interface;

> **Use metaphors from the real world:** Use concrete metaphors and make them plain, so that the users will have a set of expectations to apply to computer environments. Whenever appropriate, use audio and visual effects that support the metaphor.
>
> **Direct manipulation:** Users want to feel that they are in charge of the computer's activities.
>
> **See-and-point (instead of remember-and-type):** Users select actions from alternatives presented on the screen. Users rely on recognition, not recall.
>
> **Consistency:** Effective applications are both consistent within themselves and consistent with one another.

WYSIWYG (what you see is what you get): There should be no secrets from the user, no abstract commands that only promise future results.

User control: The user, not the computer, initiates and controls all actions.

Feedback and dialog: Keep the user informed. Provide immediate feedback.

Forgiveness: Users make mistakes; forgive them. The user's actions are generally reversible - let users know about any that aren't.

Perceived stability: Users feel comfortable in a computer environment that remains understandable and familiar rather than changing randomly.

Aesthetic integrity: Visually confusing or unattractive displays detract from the effectiveness of human-computer interactions.

These principles, although created for a specific computer interface, are easily applicable to the prototype. A great number of navigational interfaces were imagined for this case. We finally opted for a simple design with the important functionality available at all times to the user.

Storyboarding

The storyboard is an invaluable tool to the production team. It sums up graphically the whole prototype and helps in designing the screens.

Although some storyboards can exactly depict the actual final product in all its details, we chose to produce a simplified storyboard and leave it to the designer to refine the graphical appearance during the first few days of actual production. (see Appendices E and G for a comparison)

Production phases

The following steps are not necessarily sequential and may exist concurrently at a given time. As for design, production is also an iterative process which again entails that many solutions may prove valid but that one must be selected as the most beneficial strategy. These frequent decisions and readjustments may also require that certain revisions be performed on a previously completed step.

Shell and user interface development

The authoring software provided a customizable shell within which the user interface was created. Various functionalities for the developer were assembled into a production environment specific to this project. This was somewhat time-consuming at the beginning of the production cycle but proved to be worthwhile in later stages.

The user interface was then created following the previous choice of functionalities and the principles of design mentioned earlier. The user would be able to navigate freely by clicking on buttons located to the right of the screen. The metaphor of a brick wall seemed to be the obvious choice for this application.

Production of graphics

Graphics displayed on a television screen are quite different from those printed in books. They are formally bolder and simpler, yet they can be animated to convey progress.

The production of the graphics was done first on paper by a SME, than a graphic artist scanned the resulting artworks into the computer. The designer then redrew and simplified the graphics with the help of a drafting

software. Colours and textures were selected according to existing drafting codes such as using the colour pink for displaying wall insulation.

Production of the animations

The animations were produced using the graphics created by the designer. The graphics were modified and animated with the help of a 2-D animation package. Dynamic elements such as rain, wind, atmospheric pressure were superimposed on the graphics to create meaningful sequences.

Text editing and entry

In the meantime the text was being written and edited with the help of a word processor. The text files were later imported in the prototype and formatted according to the chosen design. To facilitate this process, a small interactive word processor was conceived and integrated within the prototype. The programming investment of including this module proved to be a great time saver since the raw text could be fed to this word processor and depending on its inherent functionality (title, subtitle, body text, and so forth...) would then be automatically formatted with the appropriate font, size and colour.

Digitizing of photographs

The photographs were scanned using two different pieces of hardware. A series of colour photographs were digitized on a colour flatbed scanner and edited with a specialized retouching software. Another series of colour and monochrome photographs were scanned with a 'continuous gray tone' unit. All the scans were later imported into the prototype and placed on their respective screens.

Video production

Although we had acquired video footage from an American institute describing the erection of a brick wall, we felt the need to produce a number of sequences that related more closely to our specific content.

A cameraman went to a construction site and recorded some specific steps of a procedure. It should be noted here that there were a number of problems with recording on site: the physical settings were less than practical for the cameraman; the weather was uncertain and the construction workers were on a tight schedule. If it had not been for the great collaboration of the workers and the contractor, this shooting session could have been even more problematic.

Video transfer to digital medium

The video footage was then transferred to the computer hard drive using the new Quicktime standard and a video capture board. This process, being fairly new at the time and taking into account the number of sequences to be processed, took a complete day.

We experimented with a number of compression schemes to get the best results with our limited palette of 256 colours.

Video editing

The digitized sequences were then assembled with the help of an editing software. The process was simple and all the sequences were assembled promptly.

Navigational board (Link)

The navigational board is an expert point of view of the logical links that are found within the various sections of the prototype. It is a completely non-linear navigational tool. It was created as a palliative to the lack of 'keyword search' facility. The user studying a particular concept would find all the logically related concepts by opening the navigational board.

Virtual Wall

The virtual wall gives the user the chance to create a brick wall by selecting options relating to a set of aesthetic alternatives. It is basically a matrix of options, that as a result of a particular set of choices, displays a given scanned photograph of a wall. This interactive module was very successful with the users. It is a good example of a dynamic and appropriate use of the technology.

Table of Contents

An interactive table of contents was added to the prototype as a way to randomly access any section of the compendium. It also provided an outline view of the entire prototype to the learner, thus enabling her to get a precise idea of the scope.

Glossary

An interactive glossary which linked the entire compendium to a set of technical definitions was designed and implemented.

Hot spot

Significant parts of graphics were covered with transparent buttons linking them to other and more detailed information.

Integration of all the parts

This process was concurrent during the entire production stages. When a particular module, sequence or s an was ready, it was integrated in the prototype and formatted or tested.

Revisions

Design and production, being iterative by nature, call for numerous revisions. They were done periodically to accommodate the SME, the graphic designer or the programmer himself.

Chapter 4: Evaluation

Introduction

The formative evaluation of the prototype has been carried out using two methods, namely a series of open-ended interviews and a structured questionnaire.

The open-ended interviews were carried out on the assumption that an interactive media package would be best evaluated from a multi-disciplinary point of view. Representatives of different populations were invited to give their feedback on the prototype after seeing a demonstration and experiencing it first-hand. I anticipated getting various points of view and opinions about the appeal, effectiveness, readability and acceptance of the tool by the industry, among others.

The structured questionnaire was aimed more precisely at our target audiences. This evaluation was conducted during a Construction Industry Trade Show: Construct Canada, Toronto, December 1992. After seeing a short demonstration and having the chance to interact with the prototype, seven general contractors and five architects were given a questionnaire in which they had to evaluate the prototype on issues of interface, aesthetics and to a lesser extent acquired knowledge.

Observations and interviews

Introduction to CD-I technology

Interactive technology not yet being a well understood concept by most people, the open-ended evaluation sessions usually started by an introduction to the concept of Interaction and of the CD-I technology. I summarized

interaction as the level of participatory and active involvement as opposed to the passive relationship one usually experiences in a movie theater or with the living room television set. I emphasized the user's freedom to access information relevant to him/her in particular. Most people are familiar with videotapes and CD audio, so I drew on the similarities to explained the physical aspects and audiovisual capabilities of an Interactive Compact disc. The interviewees would then often question me about its similarities to the videodisc technology. This was an opportunity for me to promote the compatibility and the ease of installation of a CD-I setup. I would tell them about the self-contained and universally compatible platform. I explained that although the prototype needed a computer to run, the final disc would simply have to be inserted in a VCR-like device connected to a normal television set. I illustrated my presentation by showing some pictures of the players and of the input device such as the VCR-like remote control.

After presenting the technology as consumer-oriented, and since exposure time was limited, I would proceed to give a short demonstration of the prototype before allowing the interviewee to proceed to interact freely with the prototype. I believe it was the fastest way to get my interviewee to understand the concept of interaction and navigation within the prototype. I was conscious that not all future users would have such a demonstration, but this seemed to be the most effective strategy to bring my interviewee to cruising speed. In this demonstration, I would highlight the different audio and visual components of the prototype and warn my interviewees of what is dissimilar with the final intended version of the CD-I. An example of this would be the relatively poor quality of the video sequences presented in the prototype, since they were stored in the Quicktime movie format.

Tools used during the observations

- **Computer trace**

For this study, I added a short program to the prototype. It enabled me to record chronologically every interactive transaction done within the program. The trace provided me with the time a particular screen was accessed, the number and name of that screen, as well as a record of which objects were clicked on.

- **Videotape recording**

I used a video camera mainly as a long term memory to transcribe the interviews. I also wanted to capture the behaviors and then relate them to the computer trace. This way if, for example, there was a no activity recorded on the trace for some time, I could go back to the video image and ascertain the situation. Was the pause caused by misunderstanding of some element or only a reflection of the amount of text to read? Since the type of behavior displayed by the users was often very subtle, the video image proved to be of limited help.

Interviews

The interviews lasted an average of an hour and were conducted in a quiet room at a time convenient to the interviewee. I should mention that the interviews were mostly conducted in French and that I have translated the discussion while trying to keep the same tone and level of enthusiasm recorded on the videotape.

- **Construction worker: Bernard**

Bernard is a 33 year old worker who has worked on and off on construction sites for three years and who also has an extensive work experience (nine years) in television and theater set design and construction. He is well-educated and has knowledge of computers as an occasional user. Since Bernard is also involved in set design, which requires a fair amount of artistic conceptualization, he was also able to comment on the aesthetic and formal aspect of the prototype.

- Demonstration

As with all the interviewees, I started the session by showing a series of photos of an actual CD-I player and with a short demonstration of the prototype contents and interactive features. I invited Bernard to comment out loud on anything that he wished. I started the demonstration by showing the 'Main Menu' and consulting the 'Help Screen'. We read together the various instructions and proceeded to continue the transaction. I used the 'Table of Contents' to randomly access a 'Brick Wall Simulator Screen' which deals with the aesthetics of the brick veneer. It is an interactive screen in which the user sees a brick wall transform itself according to the user's selection of colour, texture or pattern.

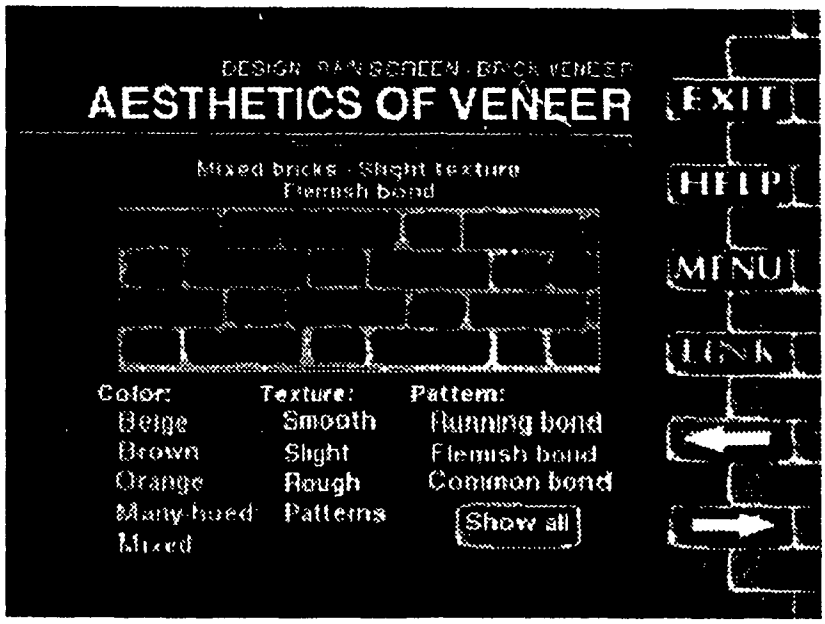

Figure 1. Aesthetics of Veneer

Bernard commented excitedly that this simulator was very interesting and provided the user with a way to visualize the aspect of a wall prior to its construction. He also added that it would be interesting to have the possibility to compare a few walls side by side since this is often a problem in real life. He went on to explain that the colour of the brick veneer is often selected by looking at the neighboring buildings. What usually happens is that the selected colour will be the exact same as all the other buildings for fear of taking a chance. This tool could help the user make a more inspired decision about this aesthetic issue.

Then, the demonstration focused on the video sequences available within the prototype. Bernard readily understood that the image quality would be better on the final CD-I.

After going back to the 'Main Menu', we experienced the menu-driven navigation based on a traditional branching model. When the destination was reached, I demonstrated the hypertext link available on some cards. I clicked on a green word and a glossary definition of the selected word came

up on screen. I then went back to the screen and demonstrated another tool available to the user. This tool comprises a network of topics logically related as seen and organized through the eyes of a subject matter expert. The user clicks on the button named 'Link' and a window opens displaying a series of topics related to the topic under examination. The user can then choose to stay and keep exploring the contents with the branching menus or select one of the available topics. When a topic is selected in this fashion, the user is transported to the appropriate screen. The user is free to link with other topics and could eventually cover most of the contents by following this linking strategy.

At this point, Bernard asked bluntly about the target audience. Who would use such a tool? Brick-layers already know all of this. I answered by giving some background about the problem in the industry and specified the target audiences as architects and general contractors.

I ended the demonstration by giving him some background information about the contents that would be covered in the CD-I. I explained to him that for the purpose of this prototype we had limited ourselves to cover one topic, namely, the 'Rain Screen Principle'.

• Hands-on experience

At this point, I suggested that he should try working with the prototype for some time. Since an annotated computer trace is available in Appendix H, I will only briefly summarize the interactive transactions and focus on the comments and the behavior observed during Bernard's exploration of the CD-I prototype.

The first noteworthy incident happened while he persisted in clicking on a bulleted list of items, thinking these were actually a sort of menu. It is

easy to understand his confusion since the layout of these items did, in fact, resemble the layout of the other menus. This problem should obviously be addressed by graphically restructuring the layout of this particular screen.

Later on, Bernard had a little problem remembering how to get back to the menu but did so after a little thinking.

Bernard spent a good time reading the information on the screen and consulted the glossary once in a while. He did so naturally, having understood the convention that a green word had a definition attached to it. I questioned him about the accuracy of the definitions and he commented that they were appropriate and precise.

At this point, I suggested to Bernard that he move on to another section so he could see some different screens. He started to navigate within a series of screens depicting 'Acceptable Materials for Flashing'. He liked the text formatting and layout which made clear the price, advantages and disadvantages of each material. Although one of the screens contained a button named 'Movie' he failed to see it. After suggesting to him to click on this button, I asked for his comments on the short movie presented. He clicked to play the sequence again, then apologized for not recognizing this specific material. The poor quality of the video image coupled with the dark color of the flashing material may be an explanation for his inability to recognize anything on the screen. During the editing stages, we did in fact suspect that since this particular material was black and that the surroundings were also quite dark, a contrast problem would arise, thus explaining the possible confusion. It was suggested that for the final CD-I we should use a different colour of the same material for those video sequences.

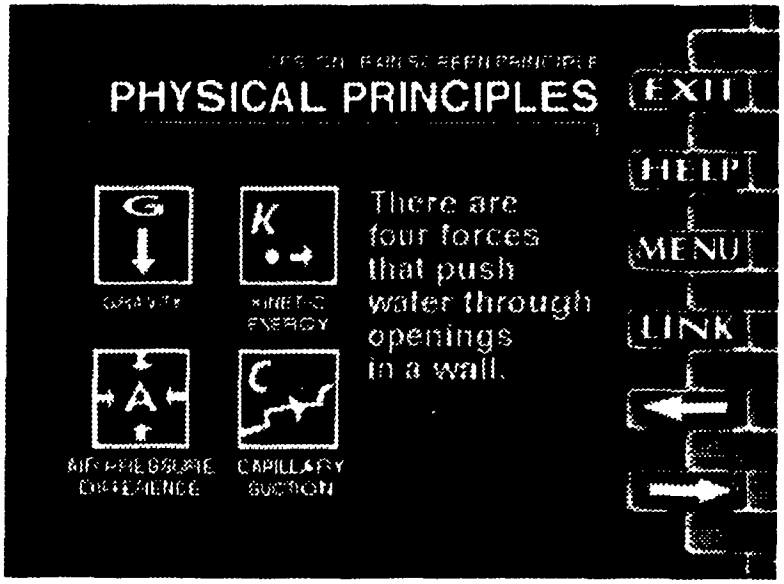

Figure 2. Physical Principles Menu

After going back to the 'Main Menu', Bernard decided to explore another section of the prototype. He went into the design chapter and chose to look at the 'Physical Principles' behind the rain screen principle. While looking at 'Gravity', Bernard was somehow surprised by the computer animation that played by itself. This occurred even though he had not clicked on the animate button appearing on the screen. I had to explain to him that we had decided to have the animation play by default every time this screen was consulted and that the animate button was in fact there to repeat the display of the computer animation. This problem could mean two different things: Our assumption that the animation should be displayed by default was wrong or there was a poor choice of word for the button. Perhaps it should read 'Replay' instead of 'Animate'.

He then selected another chapter and proceeded to go through a series of menus and then exited before getting to any meaningful information. He went on to another chapter and did exactly the same thing. At the moment, I suspected he had become irritated by so many menus, but later on when I

asked him why he aborted twice his exploration, he explained that the first time he remembered seeing this chapter during my demonstration and that the second time he felt pressed by time and, since he wanted to see the last section, decided to skip to that particular one.

Finally, Bernard looked at a series of photos while listening to an audio narration depicting a new technology. He then tried clicking on a grayed icon, forgetting that it meant this function was disabled. He finally decided to exit the last section. At this point he ended his exploratory session.

• Discussion

We went on to discuss some specific topics and to clarify some of my observations with his generous comments. Asked about the sound excerpts, he commented that the quality was fine but that they were a little monotone and the voice lacked enthusiasm. Asked about the general look of the prototype he said that the graphics were nice, simple and effective. He added that the brick side bar somehow felt game-like. He could not exactly point out the problem but suspected that the texture or color were not exactly right. This problem was amplified when a comparison was made to the bricks that are part of the icons from the main menu. He later added that the technical drawings were precise and that he only wished the connecting horizontal white arrows on one of the profile views of a wall could have been a little less bold. To this remark, I can only respond that bold lines are necessary in order to withstand the detrimental effect of interlacing on television sets.

Questioned about the clarity of the icons he answered that all were clearly identifiable and that one could do away with the text and they would still make sense. He added that he would keep the textual word anyway as an extra reminder. I share his view on keeping both the icon and the text.

Although it is redundant it insures that the interpretation is correct. I qualify these icons as hybrids since they are composed of both words and images.

I went on to ask Bernard about the different menus. I was especially interested in this issue since he had aborted some of his searches during his exploration of the CD-I prototype. He commented that because of the specificity of the contents many menus were in fact required. The access time between each menu bothered him most. He wished it could be instantaneous. He compared this type of search to a faster, more efficient way of looking up a word in an indented dictionary. In such a search you quickly find the starting letter and then look at a range of letters found at the top of a page and quickly access the desired information. Although this type of search is different from the branching model, I understand that Bernard meant the access time between screens should be minimal, especially when there is a lot of branching involved. I agree that the waiting breaks the rhythm and illusion of a seamless environment.

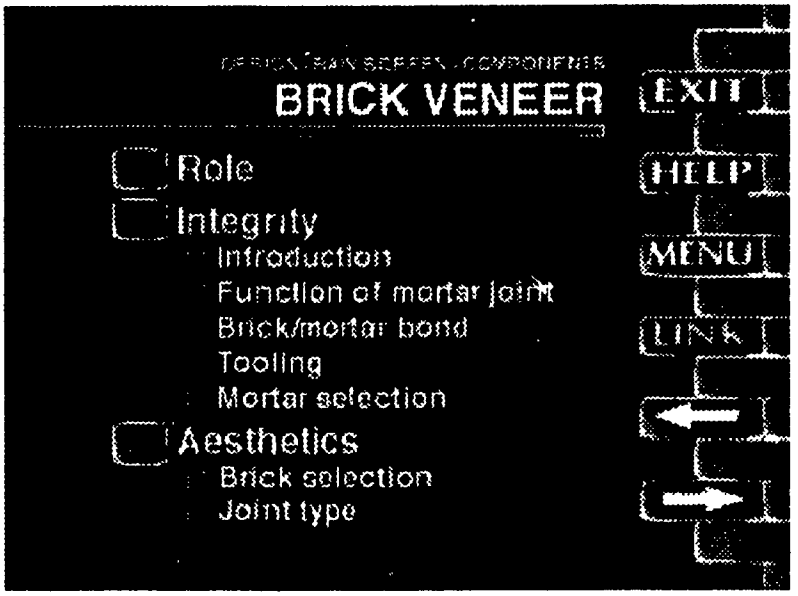

Figure 3. Brick menu

I decided then to show him a type of compounded menu that I had designed for one of the sections. This menu has a two-level hierarchy and

enables the user to jump over to a narrower subject matter without having to access the more general information. He thought it was a great idea but saw the same limitation I had seen with this type of menu. Namely, that it was not always possible to implement such a menu since it would mean too many lines of text on the screen. Since I sensed his concern about the type size, I questioned him about the readability of the text elements in general. He answered that it was fine, and that the dark background provided a more than adequate level of contrast to the lighter text.

To the question, "Did you feel lost at any point?" He answered: "No, on the contrary. I was trying to look at a lot of screens and was able to do so without any problems." He added that it might be a good idea to add F and R to the arrow icons which allow for movement one frame forward or backward. It would be more familiar to users of VCRs. With this I must disagree, since adding an 'F' for forward and a 'R' for reverse might in fact confuse the user even more. The user might be expecting wrongly a motion sequence instead of a still frame, which is more often the case than not.

I finally probed Bernard on the possible interest of the industry for such a tool. He answered both positively and negatively. The industry would say "yes", because there is a lot of information in a condensed and easy to access package. It would say "no", because he is not sure people would actually be bothered to put it in the player and consult it at home in their living room, traditionally a rest area were one becomes a passive individual willing to be entertained.

Would people in the construction industry bring the CD-I on site if a portable player was available to them? No, probably not. Bernard thinks it would be too late to be of any use. When a building is under construction most of the materials have already been ordered and most of the technical

decisions taken. Where, then, would people use such a tool? It would very nicely fit in the architect's office or in the workshop beside the drafting table. Imagine the ease of consultation! This is when choices are made as to what types of materials are used. It would be interesting to have a large collection of CD-Is covering all the major aspects of construction. It would also be a splendid tool in colleges where the new generation of masons are currently being trained.

Asked about using more voice-over segments instead of just plain text he responded that it would be interesting as an option only, since sound can be an irritant to other workers in the office. Imagine if everybody had a player on his desk and played different discs at the same moment!

To conclude our exchange I asked him if he thought it would be important for the product to be multilingual. "Yes, a very good idea," he responded.

- **Courseware developer: Robert**

Robert is a 39 year old courseware developer. He is presently completing a Master's degree in Educational Technology and has an extensive knowledge of the various optical disc technologies. He is presently working on a Medical CD-I project which will be one of the first non-entertainment CD-I products to be available in America.

It is understandable that I did not proceed exactly in the same fashion with Robert as with the other interviewees. My primary goal was to get some first-hand information about the look and feel of CD-I. I wanted Robert to compare the prototype with what he knew of real CD-I applications, limitations, advantages and qualities.

• Hands-on experience

Robert dived right in, refusing my offer for a demonstration. He first clicked on the 'Help' button, quickly glanced at the text and looked puzzled. He then when back to the 'Main Menu' and started exploring the first section. Interestingly enough, Robert did exactly what Bernard had done and clicked on the bulleted list, thinking it was a menu. Of course, this second instance confirmed the need to redesign this page.

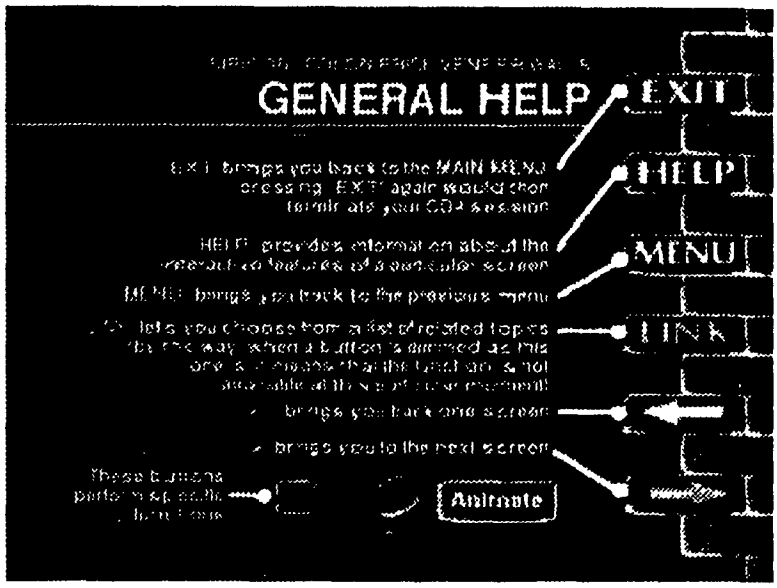

Figure 4. Help Screen

He explored some more and I have included his computer trace in Appendix H.

• Discussion

The discussion that followed proved to be very constructive. He mentioned that if we had gone as far as getting the actual CD-I developer's platform, we would have had access to an excellent development kit containing templates and ideas on how to address specific problems on the CD-I platform.

Robert said the weak part of the prototype was its Help section. He emphasized his point by adding that the help section should probably be the most important part of the program. The only reason a user goes to the help section is because she needs help. The user does not have a lot of time because she wants to get back to whatever business she was doing. In the prototype, the large amount of text demotivate the users, because they have to read all this text. A CD-I help section should not discourage the user but should use words as a navigational cue to move to other things. Robert strongly recommended that our prototype use a nice voice-over explaining the various functions of the navigational side bar. This nice, warm voice would make the user feel comfortable and reassured. Robert would also use voice when introducing new sections or to explain the icons on the 'Main Menu'. He would also have used icons on the side bar. The words could appear whenever the user asks for help. It is also noteworthy that the CD-I format will shortly have a standard power bar situated at the bottom of the screen which will provide all the navigational functions to the user.

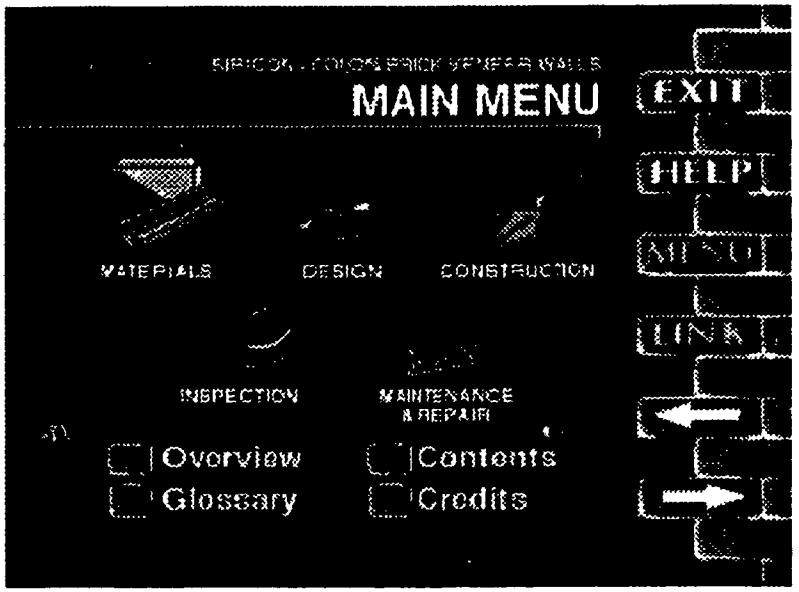

Figure 5. Main Menu

Robert also pointed out that there were three groups of menu items on the 'Main Menu' for a total of 15 buttons. He first saw a relationship between the icons and the other text-only items on the page. He thought there was a causal link between the two series of buttons. Looking at the 'Main Menu', I realize now that there are too many options available to the user. Robert added that the good design and layout made the page look simple at first glance but in fact it was or could be very confusing to a potential end-user.

He also mentioned that the 'Credits' button did not belong on the main menu since it was not as important as the other items. I understand the inherent hierarchy of relative importance, but since this was a prototype for which people invested their time or resources free or at substantial discount, I believe it was politically correct to put it on the main menu. I suppose the same might hold true for a list of industry sponsors in a commercial CD-I release.

It became apparent that the discussion focused on the end-user. But a special end-user, a CD-I end-user as opposed to a computer end-user. The relationship between the program and the user has to be much more nourishing than I expected. I should not take anything for granted. The user should be told where a section starts and when it ends and there should also be a clear warning. I was probably too subtle in using only the graying out of the disabled items. I should also have added a message when a user clicked on them anyway. This message could have been a popup window or a short voice-over segment. Of course what holds true here for the CD-I help interface can easily be applied to the computer world. This extra help does not mean that the typical CD-I user is less intelligent, but rather that the environment this technology is aimed at reflects the needs of the first time user as well as those of experienced ones.

Robert claimed that it would be feasible to include a short introduction on how to use the specific interface.

To summarize, it is critical to invest a fair amount of time in thinking about how the user gets in and out of the CD-I program. We should try to create a new world were the user feels secure and at the same time is willing to take risks.

I asked Robert about the use of textual information on CD-I. He answered that you should do away with as many text screens as possible. Text is not really a welcome addition to CD-I programs. We have to remember that we are not in the computer world but that CD-I is Television. Of course, it's impossible to avoid text all together, but good design practices will limit the amount of text on a screen to an absolute limit of 40 characters across and 12 to 14 lines vertically. I was well aware of those guidelines and had really tried to limit the amount of text per screen, which indirectly added more text-only pages to an already large numbers of screens.

Since the great majority, if not all, the CD-I programs produced or currently being produced are for entertainment purposes, I questioned Robert about the actual potential of CD-I to support any real heavy-duty training package such as this prototype or his own medical project. Robert is hoping that the entertainment value of television as the medium of choice within an optical disc technology will seduce and excite the user. It has been called 'Infotainment' or 'Edutainment' in the literature. Robert tried to reassure me that what we were doing as media producers was not really taking a quantum leap of faith since there have been numerous serious marketing studies conducted by the 15 major consumer equipment companies. These companies are betting hundreds of millions of dollars that people will want not only to be entertained but to entertain themselves. Television has

somewhat dulled our curiosity by making us passive observers. CD-I might succeed in bringing our curiosity back to a more active state.

I gave Robert a demonstration of the 'Brick Wall Simulator Screen' which deals with the aesthetics of the brick veneer. This is an interactive screen in which the user sees a brick wall transform itself according to her selection of a colour, texture and pattern. I asked for his comments. He said it would work absolutely well on CD-I and that is the kind of interactive transaction that makes CD-I a more enjoyable experience.

Although I believe firmly that a 'play' component makes learning much more efficient and effective, I was discouraged from applying this concept too much in the prototype for fear that it would not work with 'serious' architects. I believe this was a mistake on my part and that I should have defended my belief more strongly. I realize now that everybody loves to be challenged and entertained to a large extent and that I should have capitalized more on this fact.

Robert loved the computer animations and suggested that they could be superimposed on live-video on the final version of the CD-I. Since he talked about video sequences, I asked him if he liked the idea of giving the user some control over the way it is displayed. He answered affirmatively.

I asked Robert about the real storage capacity of a CD-I. Does it provide the developer with enough space to do any kind of extensive training course? He answered that it depended on the quality of the audio and graphics. For example, if you use CD-Audio quality there is no room left on the track for anything else, so you have to use a lower quality sound format if you want to have animation running at the same time.

He felt that the delays between screens were similar to the delays on the CD-I platform.

To conclude our discussion, I asked Robert about his feelings concerning the new video chip that will enable the players to have full-screen 30 frames per second video display. He said he could not wait to get one!

- **General contractor: Armand**

Armand is a 36 year old general contractor who specializes in small and medium size buildings. He has also previously worked in the pre-assembled home industry where new technologies are often welcomed years ahead of any other construction sectors.

- Demonstration and discussion

Since Armand is a very busy entrepreneur and I wanted to get the most from our meeting I invited him to comment on anything he wished and to interrupt my demonstration if he had a point to debate.

I started with my usual introduction about interaction and the CD-I technology. Armand looked at some pictures of the players and the remote control device. I then started my demonstration.

Armand asked if the prototype dealt only with ceramic bricks, to which question I answered affirmatively. He went on to say that one of the roles of the general contractor is to keep the construction price down and that this more than often governs the type of materials chosen. As long as the selected bricks meets the building codes standards it becomes a potential alternative if its cost is less expensive. Concrete bricks or bricks cut from stones are often more affordable and trouble free than their ceramic equivalent. If they meet the code standards, he was obviously inclined towards these less expensive options. I then questioned him about the differences between these types of bricks. Beside some physical differences, the most obvious one is aesthetic.

Ceramic bricks come in a wide variety of colors and textures. But, again, a general contractor may opt for a cheaper brick but a more original architectural detailing to give an aesthetic touch to the building. Depending on the project you will sometimes be required to use such or such materials. This, of course, might include ceramic bricks.

I then showed him the screens depicting acceptable flashing materials and asked for comments. Armand replied that it may be nice for an architect to know that stainless steel is recommended. However, if it is hard to form, expensive and so forth, then a general contractor does not even need to know about it. the contractor only needs what is recommended, available and cost effective. Moreover, most of the time the architect will have specified the type of flashing material that fits his or her design needs.

Later on, Armand brought up a very important issue. The on-going training in the construction industry is usually limited to safety issues. Most of the actual masons in Montréal have learned their trade on the work site, and this often in Europe (mainly Italy and Portugal). The Union's statistics describe the average Montréal mason as a 55 year old male with 20 to 30 years of experience in his trade and sometimes a limited knowledge of English or French. The younger generation of masons are coming from colleges. This creates some problems of communication since every technical word is learned in French and the older workers are still very much using the English construction vocabulary. There are also the problems of compatibility associated with teaming a young, educated mason with an older, more experienced but less educated mason. In this context, Armand has a difficult time imagining a CD-I training tool on the work site. It would also be costly and impractical for the general contractor to train his people himself.

To put the general contractor's business in context, Armand estimated the life expectancy of a company in this field to be five years. There are a lot of bankruptcies. People do start over again but they are then typically even less willing to invest in training their employees.

Armand went on to say that our assumption that the general contractor will get his people around for an hour and teach them with a CD-I is twenty years ahead of its time. It is simply not done at this point in time. Of course, it should be done: it would increase performance, among other things.

Armand commented he could see a place for CD-I technology in colleges and universities. It would be a fantastic reference and teaching tool. Actually, he could also see it on the construction site but it would have to be a concerted effort between the government, the unions and the industry. Some companies already have such a model to show off their new technologies and to teach workers how to use them.

From what I understood from the discussion with Armand, a training effort would have to be carefully planned and coordinated to really introduce this tool to the people in the construction industry. The government could decide to include this CD-I as part of a training program, and a series of trainers could go to construction sites to show the new CD-I technology. This would give an opportunity to general contractors and workers to have a look at it. The time-off needed for the introductory session could be reimbursed in some way to the general contractor. This would probably plant the seed and add a new dynamic to the on-going training in this industry. It is a good marketing strategy that may well decide the fate of such a tool.

I then presented some of the interactive video sequences to him. Excitedly, he answered that something visual and dynamic like this would definitively have an appeal. He reminded me that there might very well be a

problem with the masons' command of written English. This comment made by Armand made me think that it would probably be a good idea to have a multilingual disc including the more common languages: French, English, Italian, Portuguese.

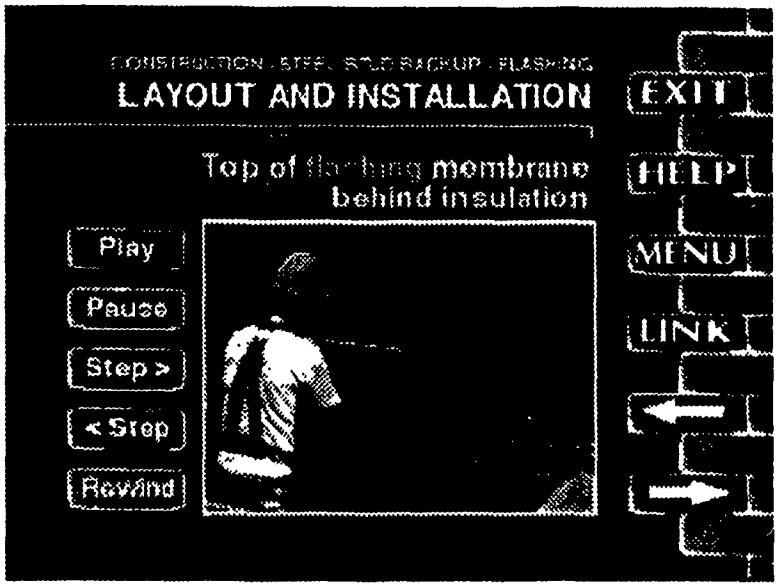

Figure 6. Video Sequence

We concluded our discussion by enumerating other possible contents such as electricity, plumbing and insulation, among others.

- **Architectural student: Jean-Louis**

Jean-Louis is a second-year architectural student in Montréal and is 24 years old. He previously also studied graphic design and has himself worked on some interactive media projects. He is computer-literate and has done some computer animation in the past.

- Demonstration

As remarked, our sessions started by a showcase of the CD-I technology and an account of the overall project. Since Jean-Louis was familiar with interactive media, I did not spend too much time explaining the concept

itself. I added that CD-I interaction was somewhat different from computer interaction, explaining that the CD-I could only be interfaced with an X, Y pointing device, and not with a keyboard.

I then proceeded to demonstrate some of the functionality of the prototype. Jean-Louis commented that he was familiar with the contents since he had taken a course on 'Materials and Construction Methods' offered in the first year at the university.

I went to the 'Brick Veneer Wall simulator' and gave a demonstration of its possibilities. Jean-Louis commented that it would be interesting to also have the option to choose the color of the mortar since this is often done in the construction industry. I believed it would be feasible to add this option and also probably to combine it with Bernard's suggestion concerning wall comparisons.

I finished the demonstration by showing him some of the video sequences and the video buttons' functionality.

• Hands-on experience

Jean-Louis started by going to the 'Materials' section. (For more details, please see annotated computer trace in Appendix H). At this point he asked me to translate the menu items, which I did promptly. Although he considers himself fairly fluent in English, these specialized words sounded foreign to him. He knew the French equivalent but had no idea of their English counterparts. I realized that the problem brought up by Armand about the language barrier was indeed very real.

Now understanding the meaning of the word, he went on to explore and landed on the exact same bulleted list as Bernard and Robert. I was anxious to see if he would also click on the list thinking it was a menu. He

indeed clicked, which of course proves without a doubt that there is a need to redesign this screen. Before exiting the screen, he tried clicking on a green word and read the definition. He suggested there could be an illustration together with the written text.

He then went back one menu level up, started exploring another topic and then commented that he wished there were more graphics displayed. I answered that in fact the first chapter on 'Materials' had no illustrations. This chapter being almost invariably the first consulted, it might have been a good idea to invest more time creating artwork. Since this is possibly the section in which people decide if they enjoy this CD-I experience or not, I would be tempted to redesign part of it to better represent the media mix available in the whole prototype.

The English technical vocabulary seemed to be a constant problem. Although the final version of the CD-I would also be available in French, there would still be a language problem between the older generation and the new breed of architects and construction workers. I would be tempted to suggest a bilingual tool that simultaneously displays the French and the English vocabulary. This would possibly become a design and developmental nightmare, but it may solve this particular problem. A good example of this kind of design is found in a fantastic visual dictionary, made in Montréal, called 'Le visuel' in which very elaborate illustrations are accompanied by their related terms and this is accomplished in several language combinations. (Québec Amérique, 1992)

While back on the 'Main Menu', he commented that the icons were easy to understand and that they serve their purpose well.

Confronted by a profile view of a wall, he commented that he was surprised that the foundation was also made of bricks. I did not understood

right away his confusion; I thought he was debating a technicality in the design of this specific wall. Of course, I am not qualified to respond to such issue. In fact, the confusion arouse from the fact that this wall profile does not illustrate a ground floor but a higher storey of a building. The bricks he saw as the foundation were in fact the continuation of the wall in the lower storey. When I explained this to him, everything in the illustration seemed to make more sense. This is a problem that neither the architect working on the prototype nor I had anticipated. But this is an example of a small detail that may create confusion in the mind of the user. A graphical solution could certainly be applied to clarify this situation.

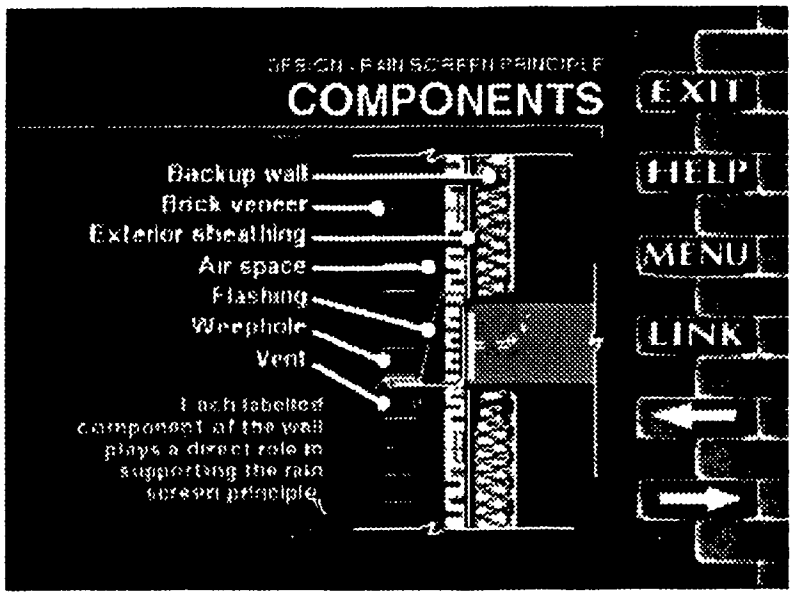

Figure 7. Components Menu

While we were still on this screen, he rightly guessed that the words describing the wall components were actually hot-spots leading to more information. It should be noted that this page has a special help dialogue explaining this function to the neophyte.

While reading about the 'Rain screen roles', he again came across some specialized terminology that he could not translate for himself. I translated these terms for him to the best of my knowledge.

On seeing computer animations explaining some abstract concepts, he credited the animation for clarifying enormously the written context. He also appreciated the feature that enabled him to replay the animations at will.

While exploring, he demonstrated that he understood the navigation tools very well and never actually got lost.

He repeated his comment that it would be popular at the university with both the teachers and the students. He cautioned that it would be important to implement a user-level function based on the user's need. These needs are quite different from one academic year to another and between individuals. Some of the contents are too technical for a young architect while others are probably too simple for a more experienced one.

He asked if some specific topics were covered, such as, e.g., 'first year bloom', to which I responded affirmatively. This probably could signify that the content analysis was appropriately done.

Seeing the word 'efflorescence' appearing on several successive screens, Jean-Louis wondered if there were several contextual definitions for a single word. I replied negatively and reminded him that as developers we had no way to predict where a user would enter a specific chapter, thus the glossary hot-spots had to appear on all the related screens.

- Conclusion

He ended his exploratory session and we concluded with some general observations. He summarized his thoughts by saying that the CD-I would indeed be useful for architects, general contractors and students but it had to be tailored to each group. He reaffirmed his belief that the ratio of text to graphical representation was too high.

General discussion

Since the four interviewees had different backgrounds and obviously different points of view, I was able to collect an impressive amount of feedback in a relatively short time. At this point in development, having access to qualitative data is critical. It will enable the team to strengthen some critical aspects of the tool before it is committed to its final CD-I format.

I personally wish that this type of evaluation could have been done at regular intervals during the production of the prototype. For reasons of confidentiality and security the client preferred not to show the project in its early production phases.

Questionnaire

The main objective of the questionnaire was to assess the degree of satisfaction of the target audiences towards the user interface. Our first plan was to invite a dozen architects to come to Siricon and experience the interactivity and the interface. It proved to be very difficult to find that many architects in a short time. Since they would not come to us, we decided to go to them. We waited for a large trade show where we could present and share the prototype with the construction industry.

Construct Canada '92 was held at the beginning of December at the Toronto Conference Center. Siricon had rented a small booth and was presenting two computer-based applications. An engineer and an architect from Siricon were on site doing the promotion of their newest computer-based tools and services. This gave us the opportunity to collect some information from both the architects and the construction contractors.

There are some problems associated with conducting a study in a trade show. First of all, the attendees were often in a hurry for fear of missing an

important exhibit. Secondly, the construction industry is also in a recession and this translated into a lower number of attendees at the trade show. Finally, due to the location of the Siricon booth at the extreme end of the showroom and within a subsection dedicated to computers, there were not that many people circulating around the booth. Those who were had almost inevitably a personal liking for technology.

However, their data should not be discarded for this reason, since they are often the individuals who will plant the technological seed in the industry.

It was also noticed that some of the major exhibitors were absent this year which may very well have been an explanation for the low attendance.

The questionnaire used for the purpose of this evaluation can be found in Appendix I.

Table 1 shows a breakdown of the 12 volunteers who agreed to complete the questionnaire. There were five architects and seven construction contractors. They had different levels of experience in their respective fields. An interesting fact is they all have a microcomputer at work, and some also had a computer at home.

	Architects	Contractors	Total
Less than 5 years	1	3	**4**
6 to 10 years	0	0	**0**
11 to 14 years	3	0	**3**
15 years and more	1	4	**5**
Total	**5**	**7**	**12**

Table 1. Job and years of experience

Table 1 shows that out of 12 people, eight had at least ten years of experience in their field, and five of those have over 15 years of experience.

The construction industry is still largely a man's world and it is interesting to note that no woman tried the prototype or completed the questionnaire.

A question about the mother tongue of the respondent was included in the questionnaire since the prototype is unilingual. The majority of respondents spoke English as their first language, and all were able to understand English very well.

Another important issue to probe was the frequency of use of reference materials such as the building code and other technical material. You will recall that one of the objectives of the CD-I project was to integrate a large number of such reference sources in one compact, easily accessible package.

Table 2 shows that a majority of the respondents are using reference sources on a very frequent basis. Independently of the frequency, they all use some sort of reference materials.

Frequency of use	**n= /12**
Often	**8**
Sometimes	**2**
Occasionally	**2**
Seldom	**-**
Never	**-**

Table 2. Use of reference manuals

The evaluation of the interface consisted of ten questions related to screen design, input device, iconic representation and interface principles such as consistency from one screen to another.

Table 3 summarizes the results. It should be noted that items followed by an asterisk (*) were originally negatively phrased to avoid answering bias and they have been converted to a positive direction, consistent with the other questions, for this table.

A five step Likert scale was used to gather the answers and the numbers from the top row of the table are interpreted as follows:

1 is equivalent to 'Disagree'

2 is equivalent to 'Slightly Disagree'

3 is equivalent to 'No opinion'

4 is equivalent to 'Slightly Agree"

5 is equivalent to 'Agree'

In general, the respondents enjoyed the interface very much. Questions were asked about the clarity of the icons and their level of realism, which are important in the recognition of a specific environment.

Interestingly enough, although the clarity of the icons was rated an average at 4.08 out of a possible five, the level of realism had the lowest mean of the ten questions, at 3.33 on a five-point scale. It should be explained that this is one of the negative questions designed to limit testing interference. The question itself is somewhat difficult since realism is not an easy concept and it is not defined in the questionnaire

The level of detail on-screen is also an important issue. It is important not only for technical precision but for achieving a high level of aesthetics. The great majority of respondents were satisfied with the prototype's level of precision.

Interface components	n=	1	2	3	4	5	Mean
Clarity of icons	12	1	2	-	1	8	4.08
Realism of icons*	12	4	-	1	2	5	3.33
Screen details*	12	2	-	-	3	7	4.08
Design consistency	12	-	2	2	1	7	4.08
Type size*	12	1	-	-	1	10	4.58
Colours	12	-	-	1	-	11	4.83
Details of technical drawings	11	-	1	-	5	5	4.27
Navigation buttons	12	-	2	3	-	7	4.00
Orientation*	12	-	2	2	1	7	4.08
Mouse	12	-	-	1	1	10	4.75
Total	12	8	9	10	15	77	4.21

Table 3. Frequency of answers on questions of interface

Next, the coherence of the design was probed and eight out of 12 participants agreed, or slightly agreed, that the interface was coherent. Coherence is a quality that is needed in an interactive media application, it helps the user to navigate or interact effectively and efficiently.

The next two items were rated highly. The size of the type is very important since its facilitates reading from afar which is the distance from which CD-I is likely to be viewed. Colour is a very subjective element to evaluate, but when good combinations are reached, it usually appeals to the public. In this evaluation, colours was the feature rated the highest with a mean of 4.83 out of a possible five.

The technical illustrations were deemed precise and appropriately detailed. This is an important aspect since we had to reduce the level of

precision to comply with the lower quality NTSC image of a television screen display.

Navigation and orientation did not seem to cause any serious problem for the respondents. It is, of course, essential to good interactive media. This question may be irrelevant due to the limited experience the participants could gain in such a short time.

The last item in the table deals with a pointing device used mostly with a computer. This device did not seem to cause any troubles to our participants. This is unusual since it requires the user to coordinate eye and hand movement in a very precise fashion. It is obvious that all of the respondents had a mouse available with their microcomputers at work or at home. The CD-I players will not be shipped with mice but rather with a remote control device that incorporates a miniature joy stick.

Differences between the architects and the contractors were not evident in the interface evaluation and so are not discussed in this section.

The knowledge gained through the very short exposure could not be easily measured since the users were free to explore on their own and may not have encountered the same parts of the compendium as their peers. On the average there is a large difference between the architects and the general contractors in the knowledge acquisition part of the questionnaire. But, due to the small sample, the short exposure time, unequal n and other uncontrollable circumstances, results like these should be interpreted with great care. At best they may indicate the need for a bigger and more controlled study of these two groups.

Conclusion

Several things were accomplished in the context of this project. First, the viability of a rapid-prototyping approach (Tripp & Bichelmeyer, 1990) to the design and development of a CD-I product, utilizing a computer-based platform emulating the constraints of CD-I, was established. Viability was established from the standpoint of effectiveness and efficiency as a medium for exploring and evaluating design decisions and also from the perspective of cost-effectiveness. Use of flexible computer-based authoring tools designed and assembled specifically for this project allowed maximum freedom and speed in implementing and exploring design options. It also allowed for what essentially amounted to an in-house approach to development for the client (we worked on site) with all the control over quality and cost this implies.

Secondly, the concept of an interactive multimedia compendium as a potential solution to a well-defined problem in the construction industry was proven, given the results of the evaluations recounted above. Granted, it appears that effective use of such technology-based solutions will depend on contextual factors that affect the extent to which on-going training and upgrading of skills and knowledge occurs at all in the industry. The lesson in this is that instructional systems designers must take the whole system into account when engineering solutions.

Thirdly, the decision to use a modified approach to development utilizing elements of rapid prototyping in conjunction with phases from conventional instructional-design based methods was justified. In the final analysis, some three hours of interactive computer-based multimedia were designed and produced to commercial standards in approximately 1000 hours encompassing design, development, production, evaluation and project

management tasks. This compares favourably with industry norms of up to 800 hours of development time per hour of interactive media produced.

Our approach was not without limitations. In particular, we were constrained by the client to forego extensive formative evaluation with some categories of end-users during the early stages of development and production. To some extent this defeats the strengths of rapid prototyping as a design/development methodology which come from extensive evaluation. In our case the implications were not so bad, since the final prototype, while finished to a high standard, is expected to be redeveloped on another platform in any event.

Finally, the experience of the project also seems to vindicate the arguments of Tessmer and Wedmen (1990), to the effect that success in instructional development depends on carrying out all phases of a validated ISD model, even if some phases are carried out in less detail than one might like ideally.

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Appendices

Appendix A: Glossary

A

Access*
To retrieve information from a storage medium, such as videodisc, videotape, computer disk or tape or videotape

Access time*
The total time required to locate, retrieve and display data after a retrieval command is given

Anti-Aliasing°
The process film recorders and video monitors use to blur a jagged line to give the appearance of a smooth line.

Analog*
The use of physical variables such as voltage or current to represent numerical values.

Analog video°
Video (and usually audio) stored or transmitted using an analog electronic signal such as s videotape, videodisc, the output format consumer camcorder, etc. As opposed to digital video, which is video stored or transmitted via a stream of digital data, such as DV/I.

Application*
The specific use of a technology to accomplish a task. Often used when referring to software programs that perform a specific task, such as word processing, database management or graphics.

ASCII*
American Standard code for Information Interchange (pronounced "ask-ee"); the standard, eight bit data character code-system that is used internationally to transfer information through the use of binary values between data processing systems. It is the most commonly used format for PC files.

Audio Track*
The section of a videodisc or tape that contains a sound signal. A system with two audio tracks can utilize either two independent sound tracks or stereo sound.

Authoring Language*
A high-level, usually English-like, computer programming language specifically designed to implement computer-based training (CBT) or interactive multimedia applications. Authoring languages allow users without formal training in programing to perform the programming functions of multimedia development.

B

Binary Code*
A coding system in which each element has one of only two possible values, which may be a one or a zero, the presence or absence of a pulse, or a high or a low state when applied to voltage or current.

Bit°
Contraction of binary digit.The smallest unit of information that a computer can hold. The value of a bit (1 or 0) represents a two-way choice, such a yes, not, on or off, positive or negative or something or nothing.

Bit-mapped Graphics*
A form of graphics that are defined and addressed on a bit-by-bit basis, thereby making all points on the screen display directly accessible.

Browsable Movie°
A normal movie plays straight out through from the he beginning to end at a constant speed. A browsable movie is a term for a sequence of related pictures (stills or motion) that you chose how to see. Using a video controller, you may be able to step through the pictures from frame a to frame b, go backwards or forwards or change speeds.

Byte°
The number of bits used to represent a character. For personal computers, a byte is usually eight bits.

C

CD*
Compact Disc; also referred to as compact audio disc. A 4.75 inch optical disc that contains information encoded digitally in the CLV format.

CD-I°
Compact Disc Interactive, a standard for a multimedia consumer electronic appliances, defined by N.V. Philips, Sony and other supporters of the format. The standard defines not only the data formats for text, graphics, animation, audio and video, but also the embedding of computer code to support the interaction by the user with the data. CD-I machines are based on the Motorola 68000 family of processors and the Compact Disc. The CD-I standard is also known as the "Green Book".

CD-I NVRAM**
CD-I Non-Volatile Random Access Memory - battery backed memory that can be used to store player-configuration and application-specific data that will not be lost even when the player is switched off.

CD-I NVRI**
CD-I NVRAM Interface - the software interface that provides a standard protocol for accessing and modifying the contents of CD-I NVRAM.

CD-ROM°
Compact Disc Read Only Memory, a standard for the storage of data on a digital optical disc derived from he consumer Compact Audio Disc. Defined by N.V. Philips, Sony and other supporters of the format, it is the basis for CD-ROM disc drives, CD-ROM data formatting systems and the Microsoft MS-DOS CD-ROM Extension software, or "MSDEX". The CD-ROM standard is also known as the "Yellow Book".

CLUT**
Color Lookup Table image encoding method. The numeric value of each pixel value in a table of color registers. This reduces the amount of data required to store an image by limiting the number of colors available (a maximum of 256 in the he case of CD-I). Usually used for 'computer style' or 'cartoon style' graphics and animation.

CLV*
Acronym for Constant Linear Velocity. Videodisc format that allows twice as much play time (up to one hour) per side as the CAV format but without many of the user-control capabilities. The CLV disc can be read in linear play only but can provide search by chapter. CLV discs range in speed form 1800 rpm at the center track to 600 rpm at the outer edge. playing time is 60 minutes per side on a 12 inch or 20 minutes per side on a 8-inch disc.

Compatible*
Term used to describe different hardware devices or software formats that can be utilized together without modification.

Computer Training (CBT)*
The use of a computer to facilitate training and/or instruction. Also known as computer-aided (or assisted) instruction (CAI).

Computer Graphics*
Visual images produced by a computer. Graphics standards for IBM compatible PC's include CGA, EGA, VGA and XGA.

Courseware*
Instructional software and support materials needed to deliver a course or instructional module.

D

Data*
A common term used to indicate any raw facts, numbers, letter and symbols that describe or refer to any elements such as images, objects, ideas or conditions. Basic components of information that can be computer-processed.

Delivery System*
The computer and media hardware components used to deliver a multimedia or interactive video program. Delivery systems range from a videodisc player with an on-board microprocessor, a monitor and a keypad to a personal computer, more than one monitor and a variety of peripheral devices such as a mouse, printer, a CD-ROM and so on.

Digital*
A method in which signals are represented by a set of discrete numerical values, as opposed to continuously fluctuating current or voltage.

Digital Video°
A category of data compression techniques that define the formats for computing and storing data derives from digitizing and reducing in size an analog video signal. Typically includes digital audio as well.

Digitize*
To convert analog information into digital information; to record a visual image or real object in a format that ca be processes by a computer.

Disk Operating System (DOS)*
A computer operating environment designed to use a disk. Languages, applications and utility programs can be transmitted quickly between the disk storage system and CPU memory. DOS stands for both the Microsoft Disk Operating System (MS-DOS) and IBM's Personal Computer Disk Operating System (PC-DOS).

Display*
A screen that electronically presents characters, numbers, graphics or other information transmitted form the personal computer.

Dithering°
A technique for alternating the values of adjacent dots or pixels to create the effect of intermediate values. In printing color images or displaying color on a computer screen, dithering refers to the technique of making different colors for adjacent dots or pixels to give the illusion of a third color; for example, a printed field of alternating cyan and yellow dots appears to be green. Dithering can give the effect of shades of gray on a black-and-white display or the effect of more colors on a color display.

Draw Program°
A type of graphics program that creates images using vectors (lines and curve segments) rather than a mass of individual dots.

DVI*
Acronym for Digital Video Interactive. A technology from Intel Corporation that displays digital graphics and full-motion video along with real-time compression and decompression. On a CD-Rom. it provides up to 72 minutes of full-screen video, 2 1/2 hours of half screen video, 40,000 medium-resolution or 17,000 high resolution images.

DYUV**
Delta-YUV image encoding method. A video compression technique that reduces the amount of data stored for the image by only representing the changes in brightness (Y) and color (UV) between pixels. In addition, the total amount of information stored for the UV channels is reduced relative tot he Y channel, which exploits the human eye's greater sensitivity to brightness than to color. DYUV provides the most natural-looking images for video data of any of the 'Green' image encoding methods but requires too large a volume of data to be read off the disc at a time to allow full-screen, full-motion video.

Electronic Mail*
A system for transmitting information or messages using an electronic communications network.

Environment*
A particular computer system's configuration, which sets the standards for the application programs that ca be used on it.

F

Flatbed Scanner°
A device that works in a manner similar to a photocopy machine; the original art is positioned face down on a glass plate. this design can accommodate thick objects such as books and allows for exact alignment for the original page. The scanner enables you to import graphics and images into a variety of software programs. With sheet fed scanners, the original is fed directly through rollers--a faster process for multiple pages.

Font°
A complete set of character in one design, size and style. In traditional typography usage, a font may be restricted to a
particular size and style or may comprise multiple sizes and styles of a typeface design.

G

Graphic User Interface*
A visual metaphor that used icons that represent actual items that can be selected or manipulated with a pointing device.

H

Hardware*
In computing, the electronic and mechanical components used for processing information. Any equipment that comprises the computer system.

Hypermedia*
An extension of hypertext that utilizes varied types of media, along with plain text. All the various forms of data are organized in such a way that a user can easily move from one to another.

Hypertext*
Linking information together through a variety of paths or connections Hypertext allows users to cross-reference related units of information in a manner similar to the human thinking process.

I

Icon*
A symbolic, pictorial representation of any function, task, application, file or document.

Information retrieval*
The ability to choose interactively any data segment and have a computer locate it.

Interactive*
Employing the active participation of the user in determining the flow of the multimedia program. An interactive system can exchange information with the user, process the user's input and act in response.

Interactive Video*
Combining video and computer technology under the control and direction of the user. In interactive video, the user's actions and decisions determine the sequences.

J

Jaggies°
A colloquial term for the jagged edges formed on raster-scan displays when displaying diagonal lines. See the definition of "anti-aliasing" for more details.

JPEG°
Joint Photographic Experts Group, a committee of the International Standards Organization (ISO) chartered to define a compression standard for grayscale and color images. The standard is essentially complete and software and hardware (silicon chip) implementations are already available commercially.

M

Megabyte (MB)°
A unit of measurement equal to 1,024 kilobytes or 1,048,576 bytes.

Memory*
The location in the computer's main unit that stores information, both permanently (hard disk memory) or temporarily (random-access memory).

Menu*
A list or display of available options that can be selected.

MPEG°
Motion Picture Experts Group, a committee of the International Standards Organization (ISO) chartered to define a compression standard for color motion pictures and sound. The standard is in draft proposal form, but not yet complete. Hardware (silicon chip) implementations are expected out in the next six to twelve months.

Multimedia*
Combining different elements of media (text, graphics, audio, still images, animation, motion video) for display and control from a personal computer.

Multimedia Platform*
An integrated collection of computer and sound and image-based systems that provide access to multiple formats including text, graphics, still images, animation and motion video.

N

NTSC*
Acronym for National Television System Committee. The television standard for the United States, administered by the federal Communications Committee (FCC). NTSC is 525 lines of resolution transferred at a rate of 30 frames per second.

O

Object-Oriented Programming (OOP)*
A method of programing where every element in a program is self-contained, having within itself all the data and instructions that operate on that data and that are appropriate for that object. One element transmits a message to another and the recipient of that message carries out the instruction. OOP is generally more flexible or adaptable than standard programming.

Optical Memory*
A generic term used to describe technology that deals with information storage devices that use light, usually in the form of a laser to record, read and decode data.

Optical Read-Only Memory (OROM)*
A 5.25 -inch laser-encoded optical memory storage medium, used primarily to store digital data, as opposed to audio or video data, which features a concentric circular format and constant angular velocity (CAV). OROMs have a faster access time than that of a CD-ROM disc, but with about half the storage space (250 megabytes for an OROM disc compared to 500 megabytes for a CD-ROM disc)

Overlay*
The capability to superimpose computer-generated graphics and/or text on motion or still video.

P

Palette*
In digital video and computer graphics, the total number of colors available for use in a presentation or program.

Pixel**
The smallest unit of video screen, on the the colored dots that compose the image. The term 'pixel' is a contraction of the phrase 'picture element'. CD-I provides a number of pixel resolutions,t he most commonly used of which in the US is 384 x 240.

Pointing Device°
An input device, such as a mouse, tablet or joystick, used to indicate where an on-screen pointer or tool should be placed or moved.

Post-Production*
Editing or assembling a film or a video program from raw footage.

Preproduction*
All design tasks that occur before the actual production of a film or video program/presentation. This stage include budgeting, flow-charting, story-boarding, script-writing and so on.

Processing*
The manipulation of data from on state to another.

Production*
The stage when video, film or software is actually shot or created.

Program*
A set of instructions or steps that tells the computer specifically how to react to a certain situation.

R

Random Access*
The ability to retrieve any piece of data on a storage medium in very little time.

Random-Access-Memory (RAM)*
The largest part of a computer's used in most daily tasks; can both read and write information and be amended or updated by the user.

Read-Only Memory (ROM)*
A computer storage medium that allows the user to read or retrieve and use information but not write or record to it.

Real Time*
The transfer of data that returns results so quickly in actual time that the process appears to instantaneous.

RGB**
The canonical representation representation of video images which defines the Red, Green and Blue color components of each pixel.

RLE**
Run Length Encoding - a 'Green' image encoding method that further compresses CLUT images by reducing 'runs' of pixels of the same color to just two bytes, a byte representing the color and another byte representing the number of pixels of that color.

S

Script*
Written instructions for visuals and audio in a video program multimedia presentation.

Simulation°
Creating computer models of physical process or natural phenomena.

Software*
The programs, routines, subroutines, languages procedures and other non-hardware information used in a computer system.

Still Frame*
One film or video frame (1/24 or 1/30 of a second, respectively) presented as a single, stationary image.

Sub Menu*
Menu(s) that enable the user to branch to a new information location without returning to the main menu.

T

Touchscreen*
A display screen that acts as an input device by responding to the touch of the user.

U

User*
Term used to describe the operator or user of a computer program or system.

User Interface*
The software that allows communication between the computer user and the computer.

V

Validation*
The measurement and evaluation process followed to verify courseware requirements before replication and distribution.

Video*
Visual or picture information. A process of recording and transmitting information that is primarily visual, by translating moving or still images into electrical signals. These signals, typically include audio signals, can be broadcast (live or prerecorded) using high frequency carrier waves or sent through cable on a closed circuit.

Videodisc*
A read only storage medium that uses a laser light beam to read information from the surface of the disc. The pits or small holes modulate the laser in a manner that can be decoded by the videodisc player. Information stored in these pits is read by the laser beam and transmitted to the decoder inside the videodisc player.

W

Window*
A defined portion of the computer screen in which a video image or other information is presented. In graphical interfaces, a rectangular portion of the display in which you view a document or application.

Y

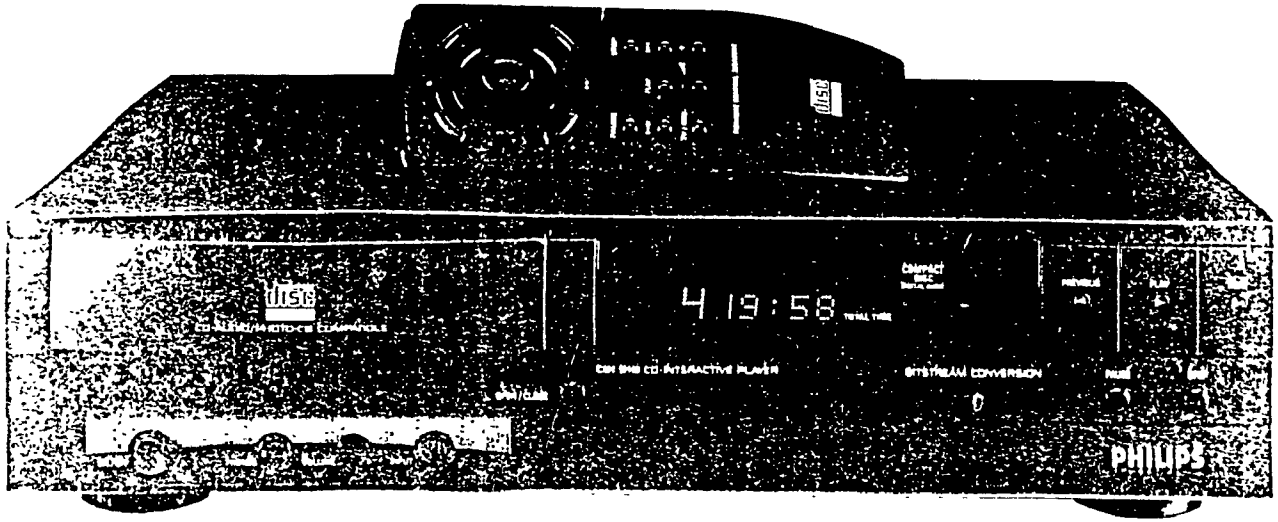
YUV**
The industry standard way of transmitting and storing video information. The RGB data for each pixel is converted to a format that uses one channel (Y) to represent the luminance or overall intensity of that pixel and two channels (UV) to represent the chrominance or color. The advantage is that it is possible to reduce the overall volume of data required for a video image by lowering the UV resolution relative to that of Y,, because the human eye is less sensitive to color than to brightness.

Glossary entry followed by an * (Floyd, 1991)
Glossary entry followed by an ** (Siggraph, 1991)
Glossary entry followed by an ° (Philips, 1991)

Appendix B: CD-I platforms

Philips Electronics

CD-INTERACTIVE



COMPACT disc Interactive

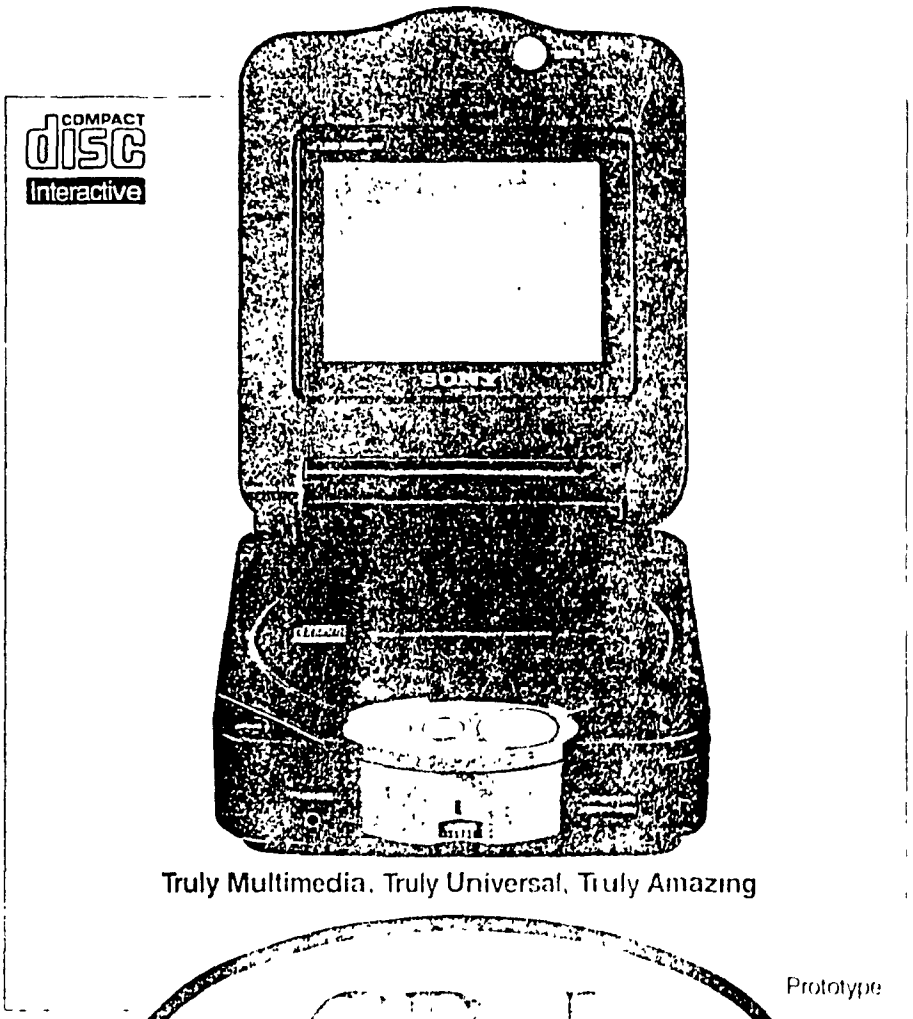
PHILIPS

SONY

New Technology Report

New Multimedia World Standard

From Entertainment to Electronic Publishing
A Global Vision of Personal Information Access



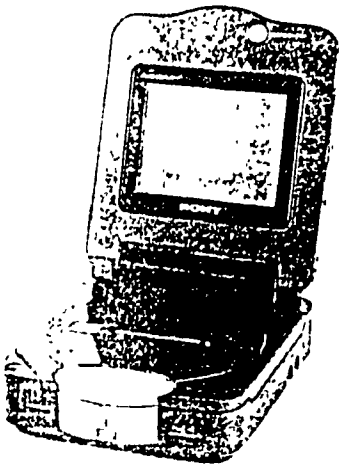
Truly Multimedia, Truly Universal, Truly Amazing

Prototype

CD-I

CD INTERACTIVE

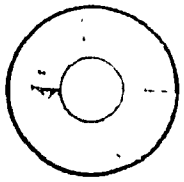
Take a 12cm CD, add digital graphics, text display, computer control data, and long playing audio... The result? CD-I!



A Truly Universal Standard for Personal Entertainment and Information

CD-I [illegible] compact disc. But it [illegible] a vast new world of possibilities. CD-I [illegible] massive data storage capability to include long playing audio (ADPCM), digital graphics (DYUV, CLUT, RGB, RL), text and computer programs. All this in addition to the CD's 16 bit digital audio.

CD-I is a true world standard format for efficient mass market distribution of multimedia products, from entertainment software to electronic publishing. The data on a CD-I disc is compatible with all current TV standards.

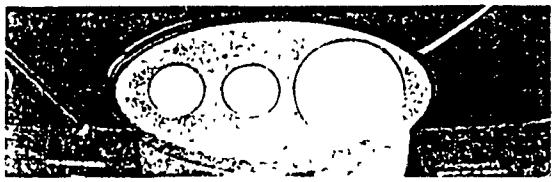


World's First Portable CD-I Player—from the World Leader in Digital CD Technology

Once again, Sony has taken a dream and turned it into practical reality. Sony's CD-I player is the world's first fully functioning portable—for go anywhere multimedia entertainment on site reference and interactive training.

Lift the top on its elegant, streamlined body and you have a full color 4 inch display. Three simple controls are all it takes to give you interactive control with the intuitive ease of a game machine.

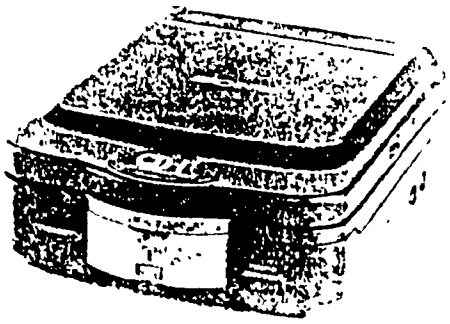
You can even play CDs and hook up to your home entertainment system for display on a TV monitor and sound reproduction through hi-fi speakers.



Ultra User Friendly Computing Brings Out Full Media Performance Potential

With a capacity exceeding 600 megabytes, a single CD-I disc can store over 100 million words, or more than an [illegible] 20 volume encyclopedia. Advanced data compression techniques also enable soundtracks of a maximum of 16 hours.

The CD-I Player's 16 bit microprocessor and a [illegible] memory, let it bring out the full potential [illegible] various graphics display modes [illegible] effects [illegible] applied to match the program [illegible]. This makes the CD-I player a kind of computer, [illegible] user [illegible] the World's simple pushbutton control [illegible] to develop programs [illegible] software, you could even [illegible] two [illegible] three [illegible] application.



Limitless Applications—From Entertainment to Electronic Publishing

[illegible] significant CD-I applications haven't been invented [illegible] software gives a hint of CD-I's entertainment potential. Imagine being able to instantly interact [illegible] entertainment in a multimedia [illegible] sound, video clips, fully [illegible] —everything is on the disc—and the [illegible] video [illegible] put to you.

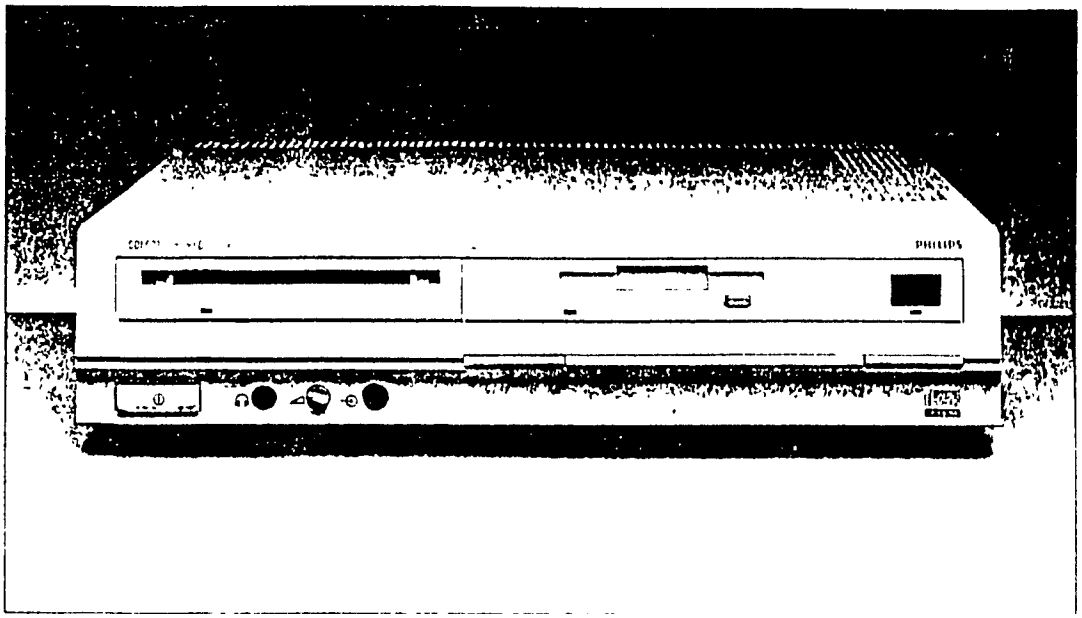
[illegible] are also in store for [illegible] reference works with [illegible] and sound as well as text—all accessible at the touch of a finger. Interactive multimedia also [illegible] educational and training applications. CD-I [illegible] designed [illegible] toddler to [illegible] situations from [illegible] to business.

Interactive
Media
Systems

CD-I




CDI 602



PROFESSIONAL CD-I SYSTEM

- CD-I multimedia system with real-time interactivity
- Plays all CD-I and CD-DA discs, extendable for CD ROM
- Digital video and audio processing
- Motion video and high-quality still pictures
- Multistandard TV in RGB, Y/C or CVBS for PAL and NTSC
- Very easy control (through resident "user shell")
- Floppy disc drive for auxiliary software support
- Extension slots for adding memory and communication facilities
- Two standard CD-I I/O ports plus two RS232C serial communication ports
- Caddy loading
- Complete with standard CD-I mouse

FROM PHILIPS A SINGLE UNIT CD-I SYSTEM FOR PROFESSIONAL AND INSTITUTIONAL APPLICATIONS

PHILIPS

PHILIPS

with their unique ability to present video, audio, text and graphics, interactively in real time. Largely because of this real-time ability, CD-I is fast coming into use in education and training, in Point of Information and Point of Sale (POI and POS) techniques and reference information systems.

The CDI 602 is fully self-contained and as a CD-I system designed primarily for stand alone applications, extended as well as base case. Nevertheless, there is ample provision of I/O ports and extension slots to permit server applications too.

With its principal components of Compact Disc Drive and Multi Media Controller/Processor, the CDI 602 will run all CD-I discs produced in accordance with the world-wide CD-I standard. In addition to the standard CD-I motion video capabilities the system is prepared for optional updating to full-screen, full-motion video by an extension kit. In line with the CD-I concept, the CDI 602 is also fully compatible for playing CD-DA discs, or CD-DA tracks on other discs, such as CD-I or 12cm LaserDisc. For CD-ROM discs, additional hardware and/or software can also be incorporated. The CDI 602 then acts in the same way as a CD-ROM drive, peripheral to a computer system.

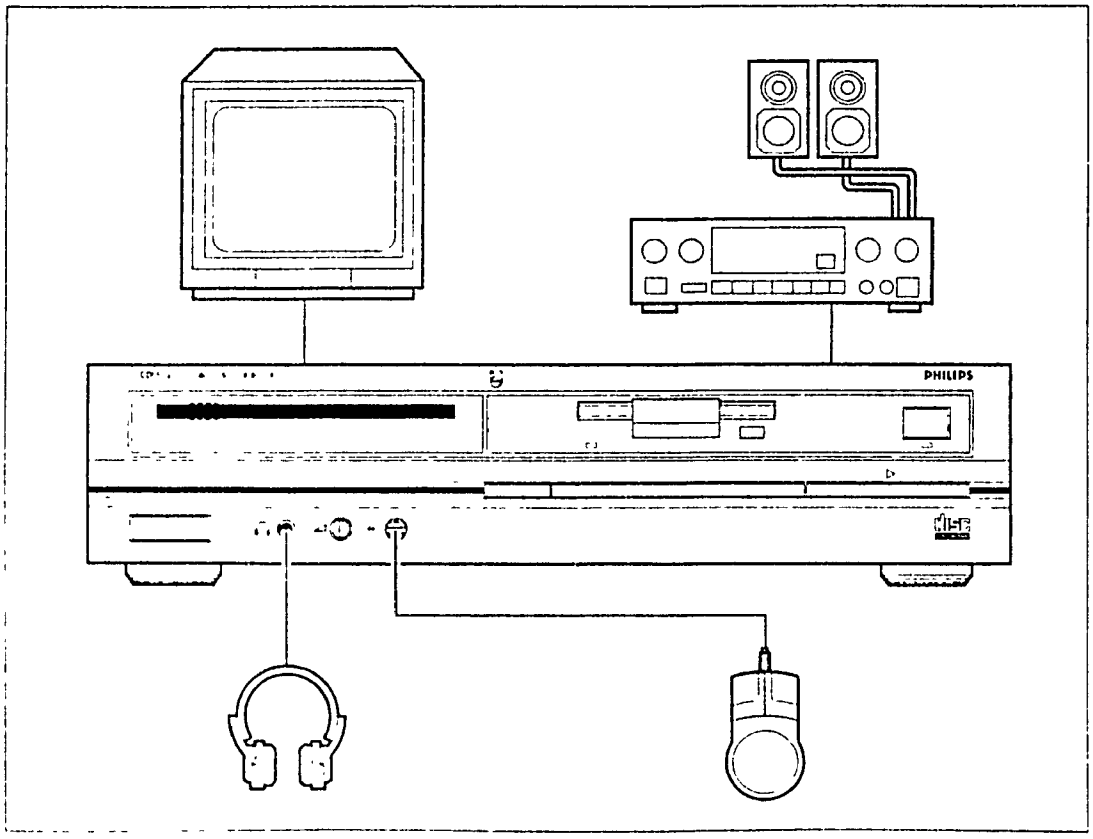
A resident- "User Interface", in conjunction with the mouse supplied, make [illegible] surprisingly easy. The [illegible] of dynamic pointing device action and immediate (real time) visual feedback makes even sophisticated operations perfectly easy to follow. No technical skills are required to use the system.

CD-I: THE WORLD-WIDE STANDARD FOR REAL-TIME INTERACTIVE SYSTEMS

The CD-I system is defined in a comprehensive standard supported world-wide by the major suppliers of electronic products. It is thus a guarantee of compatibility. CD-I offers multi-media application programs which interact instantaneously (in real time) with the user, in a way which is not available through any other medium. CD-I programs are optically recorded on the universally accepted 12cm (5-inch) format used for CD-Digital Audio.

Audio Quality Options

CD-I offers a range of ADPCM sound qualities from HiFi stereo to quality speech (equivalent to AM broadcast quality). The sound quality can be matched to the type of sound recorded; HiFi stereo, for example, is not the best mode for spoken commentary, because its wide band-



Appendix C: Contents of the CD-I

Table of contents

1. MATERIALS

- VENEER MATERIAL
  - Brick
    - Raw material
      - Clay & shale
    - Manufacturing process
    - Brick properties
      - Strengh durability
      - initial rate of absorption
      - absorption florescence
      - thermal/moisture expansion
      - frost resistance
      - thermal resistance
      - fire resistance, noise resistance
        color
    - Brick selection
      - types
  - Mortar
    - Mortar properties
      - bond, water retention, air content, permeability
      - strengh
      - workability
    - Composition of mortar (properties)
      - cementitious materials (strengh)
      - lime (workability, water retentivity, elasticity)
      - aggregate
      - water (workability, hydration of cement, carbonation of lime)
    - Types of mortar & properties
      - types M,S,N,O,K
        portland cement-lime,
        masonry cement and ready mix mortars
- BACK-UP MATERIAL
  - Flashing
    - General type
    - Material
      - metal, membrane, composite
  - Drywall
    - Types
      - Gypsum board
      - Glass fiber coating
      - Foil back
  - Air seal membrane
    - Types
      - Peel of, adhered
  - Insulation
    - Types
      - rigid
      - batt
    - Fastening
  - Ties
    - Types
    - Coating

2. DESIGN

- RAIN SCREEN PRINCIPLE
  - overall view of the interaction of the components
  - **Components**
    - **Veneer**
      - Brick size, compatibility brick/mortar
    - **Air space**
      - Cavity size
    - **Weep hole**
    - **Vent**
    - **Exterior sheathing**
    - **Flashing**
      - location, suitability, details
- AIR BARRIER PRINCIPLE
  - overall view of the interaction of the components
  - **Components**
    - **SS back up**
      - Caulking at track
      - Dry wall
      - Membrane
      - Steel
    - **CM back up**
      - Membrane
- VAPOUR BARRIER PRINCIPLE
  - overall view of the interaction of the components
  - **Components**
    - **Poly Sheet**
    - **Membrane**
- THERMAL MASS RESISTANCE
  - overall view of the interaction of the components
  - **Components**
    - **Rigid insulation (CM)**
      - Possible locations, benefits/disadvantages, details
    - **Rigid & batt insulation (SS)**
      - Possible locations, benefits/disadvantages, details
- DIFFERENTIAL MOVEMENT
  - overall view of the forces at play
  - **Components**
    - **Movement joints** (vs control and expansion joint)
      - Space below shelf angle
    - **Double Uppertrack (SS)**
      - Studs to ceiling track connection
    - **Ties (SS)**
      - Suitability, corrosion protection
    - **Ties (CM)**
      - Suitability, corrosion protection
- STRUCTURAL BEHAVIOUR
  - overall view of the forces at play
  - **Components**
    - **SS back-up**
      - Steel stud design - stud size & spacing, around window & openings details, corrosion protection
      - Ties
      - Shelf angles - corrosion protection, structural reqts, location, deflection
    - **CM back-up**
      - Design
      - Ties
      - Shelf angles - structural reqts, location, deflection
    - **Floor to wall connections**

3. CONSTRUCTION

- WORK SEQUENCE. standard & special considerations
  - Shelf-angle, anchors
  - Back-up wall
    - SS
      - ties
      - insulation
      - interior finish & V B &/or air seal
      - exterior sheathing & air seal
    - CM
      - ties
      - insulation
      - air seal
      - interior finish
  - Brick veneer
  - Special details

For each of the above points:

1) material handling & preparation
2) tools and equipment
3) layout & installation
4) hot & cold weather construction
5) safety code requirements

Also whenever appropriate:

1) right and wrong approach shown

4. INSPECTION

- INSPECTION PROCEDURE AS CONSTRUCTION GOES
  - Shelf-angle anchors
    - procedure
    - detect consequences
    - remedial measures
    - maintenance
  - Back-up wall
    - SS
    - CM

    Ties

    insulation

    interior finish & VB &/or air seal

    exterior sheathing & air seal
    - procedure
    - quality assurance and control
    - detect consequences
    - remedial measures
    - maintenance procedure
    - defect consequences (efflorescence, cracking, spalling flashing, surface coating)
    - remedial measures
    - maintenance
  - Brick veneer

Appendix D: Contents of a CD-I encyclopedia

COMPTON'S INTERACTIVE ENCYCLOPEDIA

Compton's Interactive Encyclopedia (CIE) is the first encyclopedia available on CD-I and is a leap forward from the currently available CD-ROM versions. CIE offers many exclusive features, making it the most attractive and advanced encyclopedias on the multimedia market.

Produced by Compton, adapted to the CD-I format by Interactive Support Group, and distributed by Philips Interactive Media of America, the CD-I version of Compton's Interactive Encyclopedia includes the following features:

- 1.4 million lines of text compiled from all 26 volumes of the original encyclopedia,
- Over 6,000 article entries with an average access time of less than two seconds,
- The Webster Intermediate Dictionary, with more than 35,000 entries and a definition access time of less than two seconds,
- Fact Finder containing over 65,000 entries;
- Over 5,700 color and B&W photographs, maps, schematics, many with interactive hot spots and captions,
- Thirty video clips on subjects ranging from microbiology to space flight, totaling more than 17 minutes of video at 18.5 frames/sec ;
- Over 130 montages using 900 full screen pictures;
- Over 30 minutes of B-mono quality music,
- Dynamic atlas covering more than 1,000 locations throughout the world;
- Time Machine containing more than three minutes of animation

Development Path

Both the schedule and the production path adopted in the development of Compton's Interactive Encyclopedia make this one of among the most aggressive titles ever developed.

CIE was produced in nine months, including specification design, testing and debugging.

CIE was developed entirely on the Cassiopée board created by I.S.G. Two Cassiopée boards were used by Compton to review all the converted images and to construct the montages. The CD-I version of the Encyclopedia was written in C++ code, and Think C v5.0 was the principal compiler used in this application.

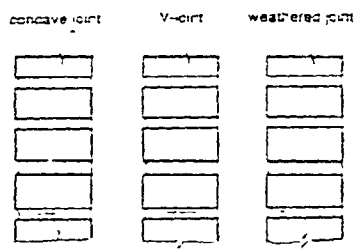
Appendix E: Storyboard examples

DESIGN

RAIN SCREEN PRINCIPLE
COMPONENT . BRICK VENEER
AESTHETICS OF VENEER
~~DESIGNING THE JOINT~~

2. joint types

The selected joint type should not encourage water retention as when the water "sits" on horizontal surfaces



recommended

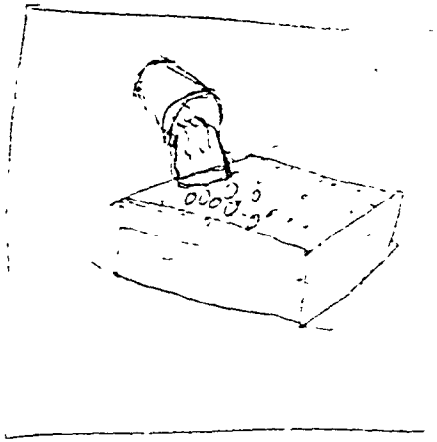
Nb ? Q M

DESIGN

RAIN SCREEN PRINCIPLE
COMPONENT : BRICK VENEER
~~DESIGNING THE JOINT~~

3. brick/mortar Bond -

If the brick has a high suction [> 30 g/min/200 cm²]
the brick should be pre-wetted and the mortar should have a high water-retention rate

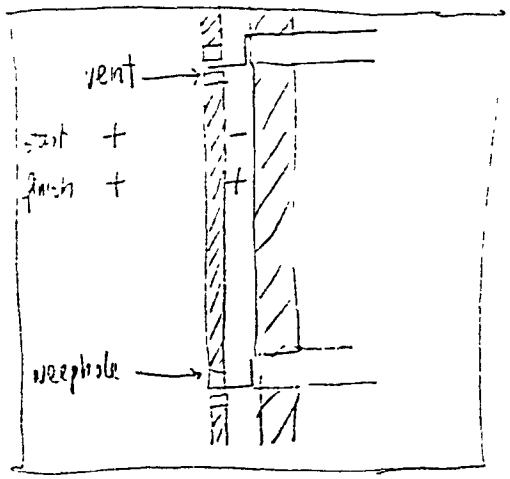


I'm still not convinced that this is a design concern.

DESIGN

– RAIN SCREEN PRINCIPLE –

PRESSURE EQUALIZATION



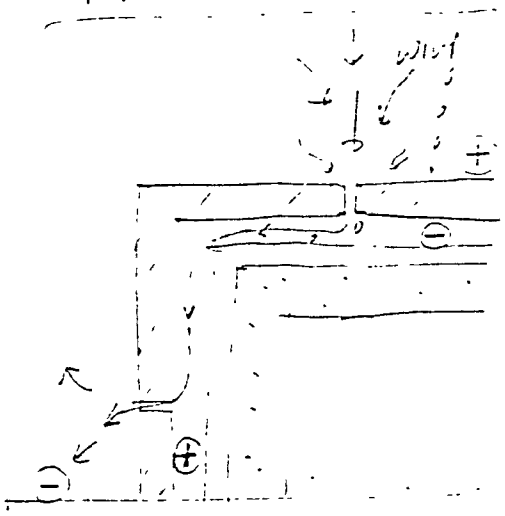
The openings in the veneer are used to allow equalization of the cavity air pressure with outside air pressure. Therefore, there is no air pressure difference to push water across the cavity.

MB ? Q M

DESIGN

RAIN SCREEN PRINCIPLE
COMPONENT : AIR SPACE
ROLE OF COMPARTMENTATION

This pressure differential may cause rain to be drawn through the air space as air flows from the point of higher pressure to the point of lower pressure.



NB ? Q M

Appendix F: Final media-mix of the prototype

Final media-mix

Menu screens	27
Text and menu screens	10
Text-only screens	135
Text and illustration or photo	60
Text, video and sound	8
Text and animation	28
Full-screen animation	1
Interactive module (Wall)	1

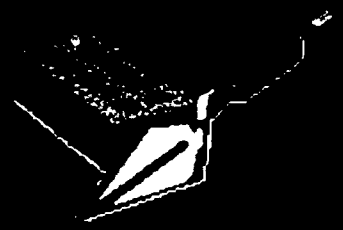
Appendix G: Images from the prototype

SIRICON - CDI ON BRICK VENEER WALLS

MAIN MENU

MATERIALS

DESIGN



CONSTRUCTION

INSPECTION

MAINTENANCE
& REPAIR

Overview

Contents

Glossary

Credits

EXIT

HELP

MENU

LINK

SIRICON

Materials Design Construction

BRICK VENEER WALLS

Inspection Maintenance & Repair

CD·I

SIRICON - CDI ON BRICK VENEER WALLS

MAIN MENU

MATERIALS

DESIGN

CONSTRUCTION

INSPECTION

MAINTENANCE & REPAIR

Overview

Contents

Glossary

Credits

EXIT

HELP

MENU

LINK

SIRICON - CDI ON BRICK VENEER WALLS

GENERAL HELP

"EXIT" brings you back to the MAIN MENU, pressing "EXIT" again would then terminate your CD-I session

"HELP" provides information about the interactive features of a particular screen

"MENU" brings you back to the previous menu

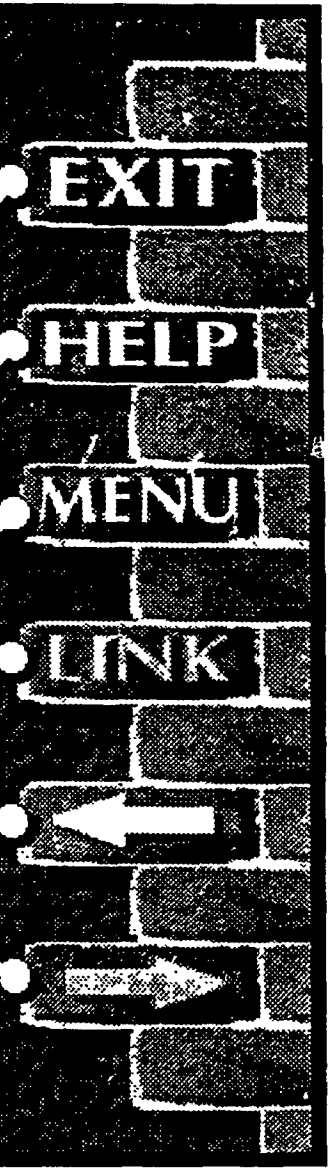
"LINK" lets you choose from a list of related topics (by the way, when a button is dimmed as this one is, it means that the function is not available at this particular moment)

"<--" brings you back one screen

"-->" brings you to the next screen

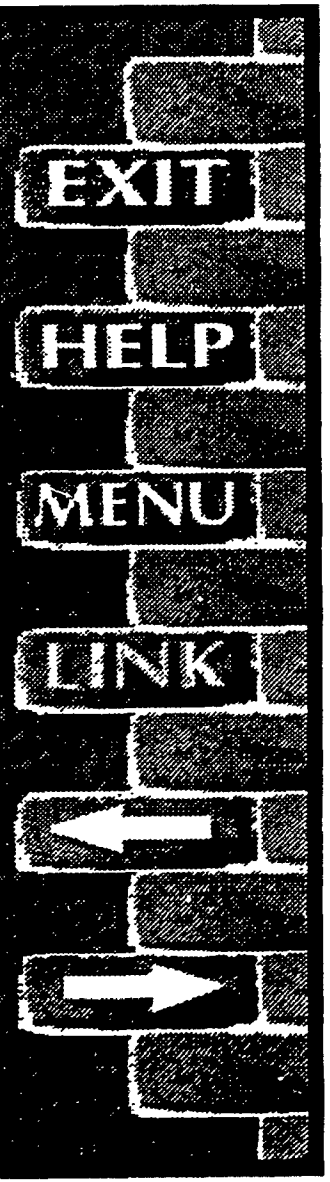
These buttons perform specific functions

Animate



SIRICON - CDI ON BRICK VENEER WALLS

TABLE OF CONTENTS



MATERIALS - ACCEPTABLE MATERIALS

MEMBRANES

PVC* Movie

TYPE: Min. thickness 1mm
Installed cost 25%

ADVANTAGES: Easily formed and joined; impervious when new.

DISADVANTAGES: Aging deterioration and hardening; easily punctured and cut; weak.

* Requires metal flashing for exposed drip edge

EXIT

HELP

MENU

LINK

MATERIALS - ACCEPTABLE MATERIALS

MEMBRANES

PVC* Movie

Play

Pause

Step >

< Step

Rewind

EXIT

HELP

MENU

LINK

SIRICON - CDI ON BRICK VENEER WALLS

DESIGN

- Rain Screen Principle
- Air Barrier Principle
- Vapor Retarder Principle
- Thermal Mass Resistance
- Differential Movement
- Structural Behavior
- Fire Safety

EXIT

HELP

MENU

LINK

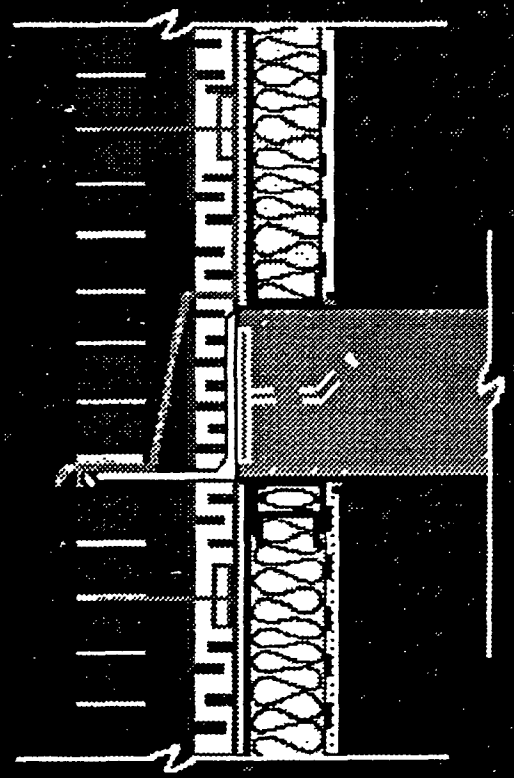
DESIGN - RAIN SCREEN PRINCIPLE

DEFINITION

By introducing an air space, the four forces can be controlled and rain penetration prevented.

This is the application of the rain screen principle.

Animate



EXIT

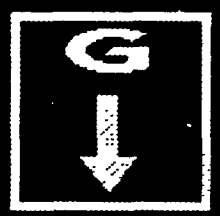
HELP

MENU

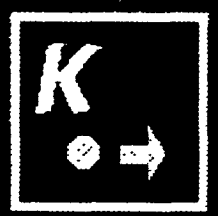
LINK

DESIGN - RAIN SCREEN PRINCIPLE

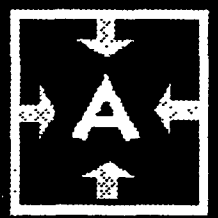
PHYSICAL PRINCIPLES



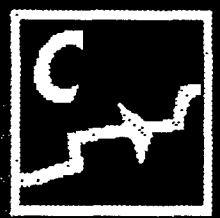
GRAVITY



KINETIC ENERGY



AIR PRESSURE DIFFERENCE



CAPILLARY SUCTION

There are four forces that push water through openings in a wall.

EXIT

HELP

MENU

LINK

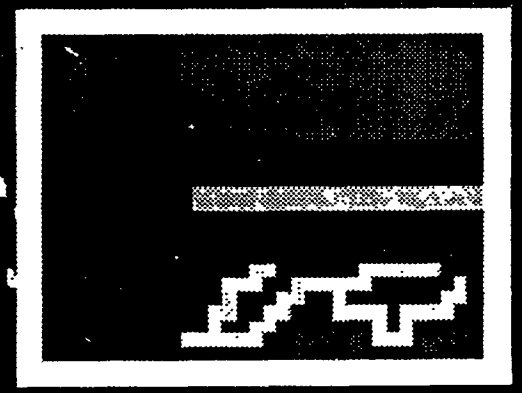
DESIGN - RAIN SCREEN PRINCIPLE

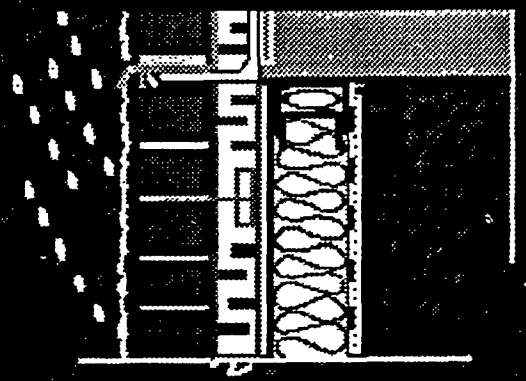
CAPILLARY SUCTION

The fine pores or cracks present in the wall material draw water into the pores.

This process is known as capillary-suction and is independent of gravity. Under the force of capillarity, water can flow in any direction.

Animate





EXIT

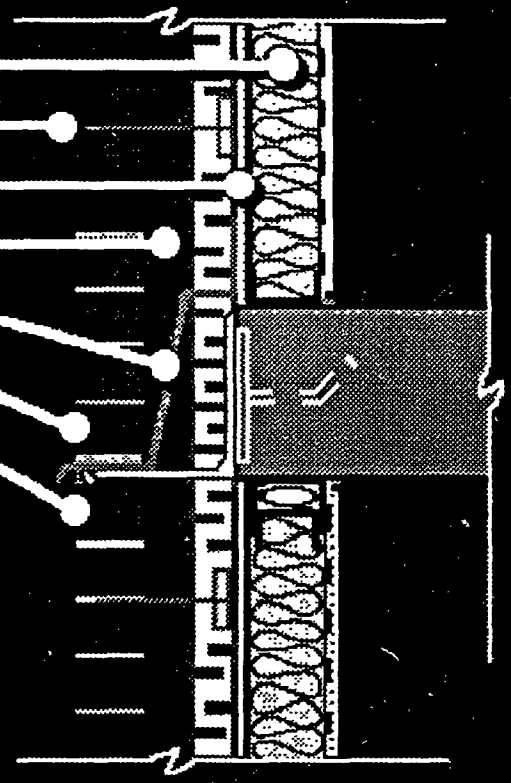
HELP

MENU

LINK

DESIGN - RAIN SCREEN PRINCIPLE

COMPONENTS



Each labelled component of the wall plays a direct role in supporting the rain screen principle.

EXIT

HELP

MENU

LINK

DESIGN - RAIN SCREEN - COMPONENTS

BRICK VENEER

- Role
- Integrity
  - Introduction
  - Function of mortar joint
  - Brick/mortar bond
  - Tooling
  - Mortar selection
- Aesthetics
  - Brick selection
  - Joint type

EXIT

HELP

MENU

LINK

DESIGN - RAIN SCREEN - BRICK VENEER

AESTHETICS OF VENEER

Mixed bricks - Slight texture
Flemish bond

Color:	Texture:	Pattern:
Beige	Smooth	Running bond
Brown	Slight	Flemish bond
Orange	Rough	Common bond
Many-hued	Patterns	Show all
Mixed		

EXIT

HELP

MENU

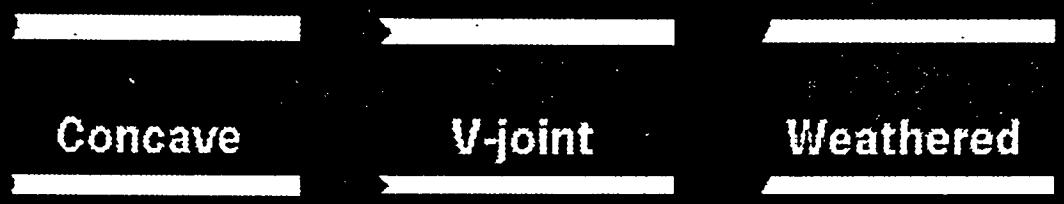
LINK

DESIGN - RAIN SCREEN - BRICK VENEER

JOINT TYPES

The selected joint type should not encourage water retention as when the water "sits" on horizontal surfaces.

Recommended



EXIT

HELP

MENU

LINK

DESIGN

To achieve drainage of water, the flashing must be designed according to the following requirements:

- Frequency
- Location
- Continuity
- Drip Edge

DETAILING

The attachment methods have an impact on detailing:

peel and stick: the membrane is adhesive at normal temperatures

torch applied: the membrane is surface melted and applied

glued: an adhesive is required between the substrate and the membrane

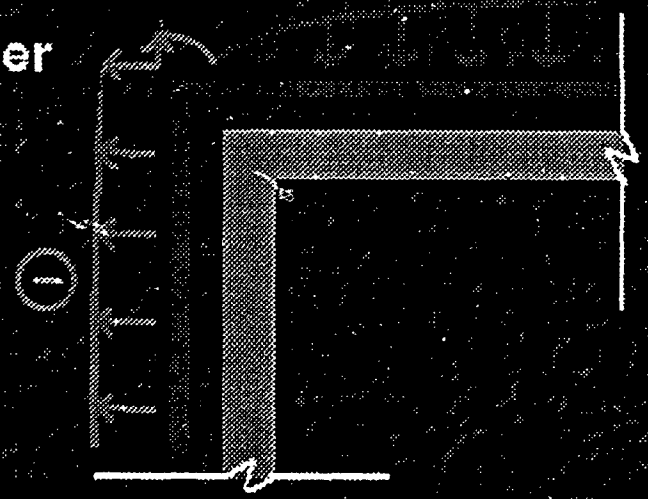
batten: use of linear mechanical attachment
nailed and sealed: use of nails

DESIGN - RAIN SCREEN - AIR SPACE

ROLE OF COMPARTMENTATION

... the positive pressure caused by wind stalling against the wall and the negative pressure of wind suction around the corner of the wall produces an important differential.

Animate



EXIT

HELP

MENU

LINK

CONSTRUCTION - STEEL STUD BACKUP - FLASHING

LAYOUT AND INSTALLATION

Flashing must be securely and continuously attached to the backup. Here, a metal protrusion interrupts the flashing.

Play

Pause

Step >

< Step

Rewind

EXIT

HELP

MENU

LINK

CONSTRUCTION - STEEL STUD BACKUP - FLASHING

LAYOUT AND INSTALLATION

Top of flashing membrane behind insulation

Play

Pause

Step >

< Step

Rewind

EXIT

HELP

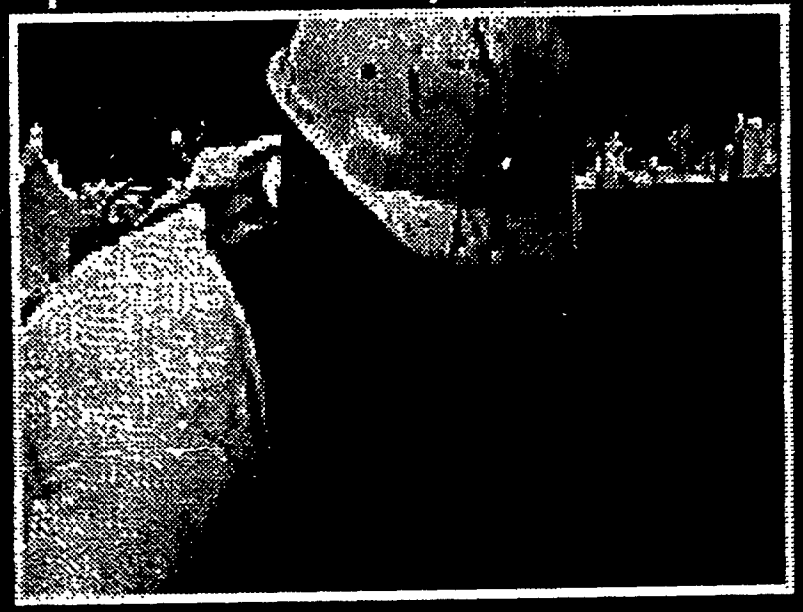
MENU

LINK

CONSTRUCTION - STEEL STUD BACKUP - FLASHING

LAYOUT AND INSTALLATION

Flashing must be securely and continuously attached to the backup. Here, a metal protrusion interrupts the flashing.



Play

Pause

Step >

< Step

Rewind

EXIT

HELP

MENU

LINK

REMEDIAL PROCEDURE

Because flashing is positioned within the cavity, any remedial procedure requires the removal of the brick veneer to reach the flashing.

Therefore, remedial procedures are expensive. If the flashing fails, a new one must be installed.

INSPECTION - STEEL STUD BACKUP - FLASHING

REMEDIAL PROCEDURE

EXIT

Links Click on topic to go to that screen

- Materials / Flashing / Selection: High quality

STAY

DEFINITION

Efflorescence is usually a whitish deposit of salt crystals on the face of brick masonry.

It occurs when water soluble salts (originally present in the wall materials) are brought to the surface by water and deposited there by evaporation of the water.

MAINTENANCE & REPAIR - SOURCES OF SALTS

GROUND WATER

Water which penetrates the ground dissolves the soluble salts present in the soil. Without proper protection, ground water can move into building foundations and subsequently flow upwards into the masonry by capillary suction. The soluble salts are deposited on the masonry surface as the ground water evaporates.

Animate

EXIT

HELP

MENU

LINK

MAINTENANCE & REPAIR - SOURCES OF SALTS

BUILDING TRIM

Water can get into the brick wall through faulty joints between the building trim and the brickwork.

The efflorescence mostly appears in the vicinity of the underside of the joints which have allowed the penetration of water.

EXIT

HELP

MENU

LINK

MAINTENANCE & REPAIR - SOURCES OF SALTS

BUILDING TRIM

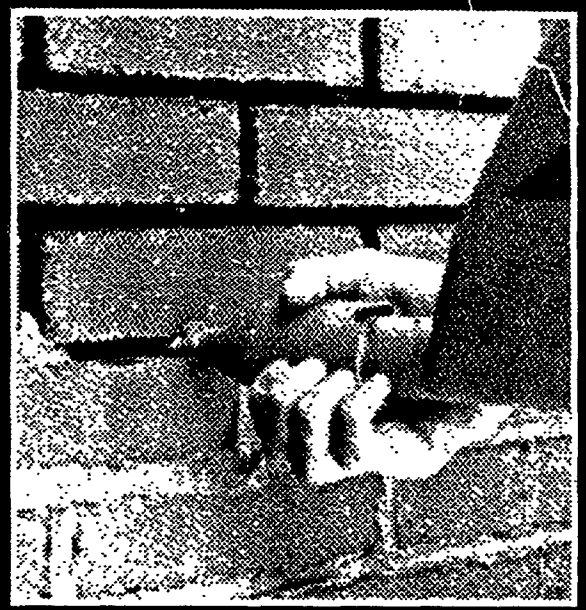
Water can get into the brick wall through faulty joints between the building trim and the brickwork.

The efflorescence mostly appears in the vicinity of the underside of the joints which have allowed the penetration of water.

MAINTENANCE & REPAIR - NEW DEVELOPMENTS

THE MORTAR GUN

The mortar gun by Quickpoint Inc.



EXIT

HELP

MENU

LINK

SIRICON - CDI - GLOSSARY

FLASHING

A thin impervious material placed in mortar joints and through air spaces in masonry to prevent water penetration and/or provide water drainage.

SIRICON

Team
SIRICON

Dominique Derome	Expert consultant Content designer
Maria Corsi	Project coordinator
Stanley Hason	Project captain

External Consultants (Curvet Information Systems)

Steven Shaw	Educational technology consultant
Geneviève Légaré	Instructional designer
André Plante	Interface designer & programmer
Hung Truong	Graphics & scans
F. Roop & T. Ota	Video & Quicktime capture

SIRICON

Acknowledgements

Dr. Paul Fazio, director of Center for Building Studies

Mortar gun photos provided by:
Quickpoint Inc. 1-800-368-2292
Canadian distributor: Paragon Network (519) 749-1338

In-house flashing video sequence provided by:
Brick Institute of America (703) 620-0010

On-site flashing video sequence done at the phase IIA of l'Université du Québec à Montréal, 1205 St-Denis.
Our thanks to:
Mr. Jean Barattin, general foreman, M.R.C. Inc.

Appendix H: Annotated Computer Trace

Construction worker
Bernard
33 year old
Fluent in English

Time \ Card I.D. \ Object clicked on

9:34:48 PM \ 0.002 mmL Main_Menu \ card button "item 3"

9:34:57 PM \ 1.001 m Mat_Menu \ card button "Item 1"

9:35:10 PM \ 1.002 y0L Mat_veneer \ bkgnd field "m4"

9:35:13 PM \ 1.002 y0L Mat_veneer \ bkgnd field "l4"

9:35:15 PM \ 1.002 y0L Mat_veneer \ bkgnd field "m4"

9:35:19 PM \ 1.002 y0L Mat_veneer \ bkgnd field "t2L"

9:35:21 PM \ 1.002 y0L Mat_veneer \ bkgnd field "t2L"

9:35:21 PM \ 1.002 y0L Mat_veneer \ bkgnd field "t2L"

••• Bernard confuses the text field "t2L" for a menu and clicks on it 3 times

9:35:33 PM \ 1.002 y0L Mat_veneer \ bkgnd button "ClickbackB"

9:35:39 PM \ 1.001 m Mat_Menu \ card button "item 2"

9:35:46 PM \ 1.003 m Mat_bup_Menu \ card button "item 2"

9:36:04 PM \ 1.003 m Mat_bup_Menu \ card button "item 4"

9:36:15 PM \ 1.003 m Mat_bup_Menu \ card button ID 269

9:36:23 PM \ 1.004 mL Mat_bup_flash_Menu \ bkgnd field "m1"

9:36:38 PM \ 1.005 y1L Mat_bup_flash_Performance \ card button "ClicknextB"

9:36.49 PM \ 1.0051 yL Mat_bup_flash_Performance \ card button "ClicknextB"

9:37:00 PM \ 1.0052 yL Mat_bup_flash_Performance \ card button "ClicknextB"

9:37:29 PM \ 1.0053 yL Mat_bup_flash_Performance \ card button "ClickmenuB"

••• Bernard hesitates as to how to go back to the previous menu and takes the right decision

9:37.40 PM \ 1.004 mL Mat_bup_flash_Menu \ card button "item 3"

9:37:55 PM \ 1.013 yL Mat_bup_flash_Selection \ card button "ClicknextB"

9:38:11 PM \ 1.014 y Mat_bup_flash_Selection \ card button ID 342

9:38:33 PM \ 6.008 yL glossary \ bkgnd button "ClickbackB"

••• Bernard uses the glossary

9:38:55 PM \ 1.014 y Mat_bup_flash_Selection \ card button ID 342

9:39:16 PM \ 6.008 yL glossary \ bkgnd button "ClickbackB"

••• He goes back after I asked him a question about the vocabulary used in the glossary

9:39:27 PM \ 1.014 y Mat_bup_flash_Selection \ card button "ClicknextB"

9:39:46 PM \ 1.015 yL Mat_bup_flash_Selection \ card button "ClicknextB"

9:40:03 PM \ 1.016 y9L Mat_bup_flash_Selection \ card button "ClickmenuB"

9:40:11 PM \ 1.004 mL Mat_bup_flash_Menu \ card button "item 2"

9:40:22 PM \ 1.006 m Mat_bup_flash_Accept_menu \ card button "item 3"

9:40:52 PM \ 1.009 yL Mat_bup_flash_Accept \ card button "ClicknextB"

••• Bernard does not use the "movie" button" so I tell him to try it

9:41:21 PM \ 1.0091 yL Mat_bup_flash_Accept \ card button "Clickshowb"

9:41:29 PM \ 1.0091 yL Mat_bup_flash_Accept \ card button "Clickplayb"

9:41:41 PM \ 1.0091 yL Mat_bup_flash_Accept \ card button "Clickplayb"

••• Bernard plays the sequence twice

9:42:50 PM \ 1.0091 yL Mat_bup_flash_Accept \ bkgnd button "ClickbackB"

9:43:09 PM \ 1.009 yL Mat_bup_flash_Accept \ bkgnd button "ClickbackB"

9:43:15 PM \ 1.006 m Mat_bup_flash_Accept_menu \ card button "item 3"

9:43:22 PM \ 1.009 yL Mat_bup_flash_Accept \ card button "ClicknextB"

9:44:36 PM \ 1.0091 yL Mat_bup_flash_Accept \ card button "ClicknextB"

9:44:56 PM \ 1.010 yL Mat_bup_flash_Accept \ card button "ClicknextB"

9:45:02 PM \ 1.011 yL Mat_bup_flash_NAccept \ bkgnd button "ClickexitB"

••• I suggested that he select another section of the prototype

9:45:09 PM \ 0.002 mmL Main_Menu \ card button "item 4"

9:45:21 PM \ 2.000 mL Des_Menu \ card button "Item 1"

9:45:31 PM \ 2.007 mL Des_RS_Menu \ card button "Item 1"

9:45:51 PM \ 2.008 m Des_RS_Phys_Menu \ card button "ClicknextB"

9:46:10 PM \ 2.009 y1L Des_RS_Phys_Gravity \ bkgnd field "m7"

9:46:17 PM \ 2.009 y1L Des_RS_Phys_Gravity \ card button "ClickanimateB"

••• Bernard is somehow surprise that the animation plays by itself

9:46:36 PM \ 2.009 y1L Des_RS_Phys_Gravity \ card button "ClicknextB"

9:46:54 PM \ 2.010 y Des_RS_Phys_Kinetic \ bkgnd button "ClickexitB"

9:47:01 PM \ 0.002 mmL Main_Menu \ card button "item 5"

9:47:09 PM \ 3.001 m Cons_Menu \ card button "item 2"

••• Since "item 1" is disabled

9:47:15 PM \ 3.002 m Cons_SS_Menu \ card button "item 2"

9:47:21 PM \ 3.003 mL Cons_SS_Buw_Menu \ bkgnd button "ClickexitB"

••• After going through 3 levels of menus he exits without having reached any information

9:47:30 PM \ 0.002 mmL Main_Menu \ card button "item 6"

9:47:46 PM \ 4.001 m Insp_Menu \ card button "item 2"

9:47:51 PM \ 4.008 m Insp_SS_menu \ card button "item 2"

9:47:58 PM \ 4.009 mL Insp_SS_Buw_menu \ bkgnd button "ClickexitB"

••• After going through 3 levels of menus he exits again

9:48:08 PM \ 0.002 mmL Main_Menu \ card button "item 7"

9:48:15 PM \ 5.000 mL Maint_Menu \ card button "item 6"

9:48:28 PM \ 5.060 yL Maint_eff_cont_sol_coat \ card button "ClickmenuB"

••• Bernard mistakenly clicks on the menu button

9:48:36 PM \ 5.000 mL Maint_Menu \ card button "item 6"

••• He goes back to the desired screen

9:48:41 PM \ 5.060 yL Maint_eff_cont_sol_coat \ card button "ClicknextB"

9:49:01 PM \ 5.061 yL Maint_eff_cont_sol_coat \ card button "ClicknextB"

••• He clicks twice on a disabled menu item

9:49:40 PM \ 5.062 y9L Maint_eff_cont_sol_coat \ bkgnd button "ClickbackB"

9:49:49 PM \ 5.061 yL Maint_eff_cont_sol_coat \ bkgnd button "ClickexitB"

Courseware developer
Robert
39 year old
Fluent in English

Time \ Card I.D. \ Object clicked on

12:49:52 PM \ 0.002 mmL Main_Menu \ bkgnd button "ClickhelpB"

••• Robert goes first to the "Help" screen

12:50:25 PM \ 9.000 y9L Main_help \ card button ID 422

••• He is surprise by the amount of text

12:50:35 PM \ 0.002 mmL Main_Menu \ card "0.002 mmL Main_Menu"

12:50:45 PM \ 0.002 mmL Main_Menu \ bkgnd button "ClickbackB"

12:50:52 PM \ 0.002 mmL Main_Menu \ card button "ClicknextB"

12:51:04 PM \ 0.003 mL Main_TOC \ bkgnd button "ClickhelpB"

12:54:47 PM \ 9.000 y9L Main_help \ card button ID 422

12:54:55 PM \ 0.003 mL Main_TOC \ card button "ClickmenuB"

12:55:11 PM \ 0.002 mmL Main_Menu \ card button "item 3"

12:55:17 PM \ 1.001 m Mat_Menu \ bkgnd button "ClickbackB"

12:59:04 PM \ 0.002 mmL Main_Menu \ card button "item 3"

12:59:11 PM \ 1.001 m Mat_Menu \ card button "Item 1"

12:59:22 PM \ 1.002 y0L Mat_veneer \ bkgnd field "t2L"

12:59:26 PM \ 1.002 y0L Mat_veneer \ bkgnd field "t2L"

••• Robert confuses the text field "t2L" for a menu and clicks on it 2 times

12:59:27 PM \ 1.002 y0L Mat_veneer \ bkgnd field "m4"

12:59:27 PM \ 1.002 y0L Mat_veneer \ bkgnd field "m4"

1:00:18 PM \ 1.002 y0L Mat_veneer \ bkgnd field "t2L"

1:00:28 PM \ 1.002 y0L Mat_veneer \ bkgnd button "ClickbackB"

1:00:36 PM \ 1.001 m Mat_Menu \ card button "Item 1"

1:01:06 PM \ 1.002 y0L Mat_veneer \ bkgnd button "ClickbackB"

1:01:10 PM \ 1.001 m Mat_Menu \ card button "item 2"

1:01:26 PM \ 1.003 m Mat_bup_Menu \ card button "Item 1"

1:01:31 PM \ 1.004 mL Mat_bup_flash_Menu \ card button "Item 1"

1:01:38 PM \ 1.005 y1L Mat_bup_flash_Performance \ bkgnd button "ClickbackB"

1:01:49 PM \ 1.004 mL Mat_bup_flash_Menu \ card button "Item 1"

1:02:27 PM \ 1.005 y1L Mat_bup_flash_Performance \ bkgnd button "ClickbackB"

Architectural student
Jean-Louis
24 year old
Fluent in English

Time \ Card I.D. \ Object clicked on

9:34:35 AM \ 0.002 mmL Main_Menu \ card button "item 3"

9:35:04 AM \ 1.001 m Mat_Menu \ card button "Item 1"

9:35:19 AM \ 1.002 y0L Mat_veneer \ bkgnd field "t2L"

••• Jean-Louis confuses the text field "t2L" for a menu and clicks on it

9:35:49 AM \ 1.002 y0L Mat_veneer \ card button ID 342

9:36:08 AM \ 6.008 yL glossary \ bkgnd button "ClickbackB"

••• He tries the glossary

9:36:14 AM \ 1.002 y0L Mat_veneer \ bkgnd button "ClickbackB"

9:36:21 AM \ 1.001 m Mat_Menu \ card button "item 2"

9:36:39 AM \ 1.003 m Mat_bup_Menu \ card button "item 2"

9:36:47 AM \ 1.003 m Mat_bup_Menu \ card button "Item 1"

9:37:24 AM \ 1.004 mL Mat_bup_flash_Menu \ card button "Item 1"

9:38:22 AM \ 1.005 y1L Mat_bup_flash_Performance \ bkgnd button "ClickexitB"

9:38:28 AM \ 0.002 mmL Main_Menu \ card button "item 4"

••• Since he find this section too text-oriented, I suggest that he tries another section

9:38:40 AM \ 2.000 mL Des_Menu \ card button "Item 1"

9:38:48 AM \ 2.007 mL Des_RS_Menu \ card button "item 3"

9:42:17 AM \ 2.019 m Des_RS_comp \ card graphic ID 376

9:42:23 AM \ 2.048 ML Des_RS_comp_AS_Menu \ card button "Item 1"

9:42:58 AM \ 2.049 mL Des_RS_comp_AS_Role_menu \ card button "item 2"

9:43:40 AM \ 2.050 y Des_RS_comp_AS_Role1 \ card button "ClickanimateB"

••• He really appreciates the animation

9:44:08 AM \ 2.050 y Des_RS_comp_AS_Role1 \ bkgnd button "ClickexitB"

9:44:43 AM \ 0.002 mmL Main_Menu \ card button "item 7"

9:44:48 AM \ 5.000 mL Maint_Menu \ card button "Item 1"

9:44:58 AM \ 5.001 mL Maint_eff_Menu \ card button "Item 1"

9:45:19 AM \ 5.002 y1 Maint_eff_def \ card button ID 360

9:45:40 AM \ 6.011 yL glossary \ bkgnd button "ClickbackB"

9:45:44 AM \ 5.002 y1 Maint_eff_def \ card button "ClicknextB"

9:45:49 AM \ 5.003 y Maint_eff_def \ card button "ClicknextB"

9:46:07 AM \ 5.004 y Maint_eff_def \ card button "ClicknextB"

9:46:34 AM \ 5.005 yL Maint_eff_occ \ card button "ClicknextB"

9:46:50 AM \ 5.006 yL Maint_eff_occ \ card button "ClicknextB"

9:47:10 AM \ 5.0061 yL Maint_eff_occ \ card button "ClicknextB"

9:47:39 AM \ 5.007 y Maint_eff_mech \ card button "ClicknextB"

9:47:57 AM \ 5.0071 yL Maint_eff_mech \ card button "ClicknextB"

9:50:02 AM \ 5.0072 yL Maint_eff_mech \ card button "ClicknextB"

••• He navigates with the "Next" button for quite a while

9:50:35 AM \ 5.008 y Maint_eff_src \ bkgnd button "ClickhelpB"

9:50:57 AM \ 9.000 y9L Main_help \ card button ID 422

9:51:01 AM \ 5.008 y Maint_eff_src \ card button "ClicknextB"

9:51:11 AM \ 5.009 mL Maint_eff_src_salts_menu \ card button "item 6"

9:51:23 AM \ 5.021 y Maint_eff_src_salts_trim \ card button "ClicknextB"

9:51:32 AM \ 5.0211 yL Maint_eff_src_salts_trim \ card button "ClicknextB"

9:51:50 AM \ 5.022 yL Maint_eff_src_salts_trim \ card button "ClicknextB"

9:52:42 AM \ 5.023 y Maint_eff_src_salts_water \ card graphic ID 393

9:52:49 AM \ 5.023 y Maint_eff_src_salts_water \ bkgnd button "ClickbackB"

9:52:55 AM \ 5.022 yL Maint_eff_src_salts_trim \ card graphic "zoomin"

9:53:19 AM \ 5.022 yL Maint_eff_src_salts_trim \ card graphic "zoomout"

9:53:24 AM \ 5.022 yL Maint_eff_src_salts_trim \ card graphic "zoomin"

••• Jean-Louis plays with the zoom function on one of the photo

9:53:54 AM \ 5.022 yL Maint_eff_src_salts_trim \ card button "ClicknextB"

9:54:02 AM \ 5.023 y Maint_eff_src_salts_water \ card button "ClickanimateB"

••• He watches an animation.

9:55:08 AM \ 5.023 y Maint_eff_src_salts_water \ card button "ClicknextB"

9:55:19 AM \ 5.024 m Maint_eff_src_moist_menu \ bkgnd button "ClickexitB"

9:57:43 AM \ 0.002 mmL Main_Menu \ bkgnd button ID 337

Appendix I: Questionnaire

Evaluation Questionnaire: Siricon CD-I Project

The goal of this questionnaire is to gather your comments regarding the CD-I prototype presented to you. The prototype is about the design, the construction and the inspection of brick veneer walls.

- The compiled results of the questionnaire will be used to improve the final version of this reference tool.

- Anonymity will be observed.

- The questionnaire is composed of three sections (24 questions in total) and requires approximately five (5) minutes to complete.

- Your participation in this evaluation is on a voluntary basis. If you do not wish to complete the questionnaire after trying the prototype, simply tell the evaluator.

- Please read the questions carefully. It is essential to answer all questions.

Instructions: Unless indicated otherwise, circle the number that best reflects your opinion:

Disagree	Slightly disagree	No opinion	Slightly agree	Agree
1	2	3	4	5

Thank you for your collaboration.

For the evaluators:
Participation #:_____

SECTION 1: Questions 1 to 10 are related to the entirety of your exploration. The questions refer to the visual aspects of the prototype.

1- The icons (images) of the Main Menu are clear.

Disagree	Slightly disagree	No opinion	Slightly agree	Agree
1	2	3	4	5

2- I think that the icons are unrealistic.

Disagree	Slightly disagree	No opinion	Slightly agree	Agree
1	2	3	4	5

3- The screen is overloaded with details.

Disagree	Slightly disagree	No opinion	Slightly agree	Agree
1	2	3	4	5

4- In general, the graphic design is consistent.

Disagree	Slightly disagree	No opinion	Slightly agree	Agree
1	2	3	4	5

5- The size of the characters used in the texts is inadequate.

Disagree	Slightly disagree	No opinion	Slightly agree	Agree
1	2	3	4	5

6- I find that the colours used in the prototype are attractive.

Disagree	Slightly disagree	No opinion	Slightly agree	Agree
1	2	3	4	5

7- The graphics depicting cross sections of the walls are detailed.

Disagree	Slightly disagree	No opinion	Slightly agree	Agree
1	2	3	4	5

8- The navigational buttons allowed me to explore the content as I wished.

Disagree	Slightly disagree	No opinion	Slightly agree	Agree
1	2	3	4	5

9- I felt "lost" while using the computer.

Disagree	Slightly disagree	No opinion	Slightly agree	Agree
1	2	3	4	5

10- The mouse is easy to use.

Disagree	Slightly disagree	No opinion	Slightly agree	Agree
1	2	3	4	5

****

SECTION 2: TRUE or FALSE (Questions 11 to 15): For the following section, circle the right answer.

11- There are five (5) main chapters in the prototype.

a) TRUE
b) FALSE

12- I can go back one menu level from any location within the prototype.

a) TRUE
b) FALSE

13- The physical principles are used to introduce design requirements

a) TRUE
b) FALSE

14- After using the Link button, I can return to the previous screen (point of departure).

a) TRUE
b) FALSE

15- I can access the "Help" device at any given time while using the prototype

a) TRUE
b) FALSE

****

SECTION 3: (Questions 16 to 24) Circle the appropriate answer. Don't forget to answer all questions.

16- My mother tongue is:

a) English
b) French
c) Other: _____ (Please specify)

17- I am between:

a) 20 and 30 years old.
b) 31 and 40 years old.
c) 41 and 50 years old.
d) 51 years old and over.

18- I have already taken a computer course before.

a) YES
b) NO

19- I use a computer:

i) At home	ii) At work
a) YES	a) YES
b) NO	b) NO

20- I have worked in the field of **architecture** or **construction (circle one)** for:

a) Less than 5 years
b) 6 to 10 years
c) 11 to 15 years
d) More than 15 years

21- I have my own business:

a) YES
b) NO

22- I use the Building Code and other reference manuals

a) Never
b) Seldomly
c) Occasionally
d) Sometimes
e) Often

23- I liked this reference tool.

a) YES
b) NO

24- I would recommend this reference tool to my fellow workers.

a) YES
b) NO

Thank you for your participation in the evaluation of the prototype.

****