INTERACTIVE MULTIMEDIA DESIGN:

Operational Structures and Intuitive Environments for CD-ROM.

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Abstract. This paper presents practical design concepts for the production of CD-ROMs or on-line media projects which are intended for scholastic and professional use. It is based on the experience and knowledge which has been gained while developing a multimedia package here at the Department of Architecture at CUHK. The package deals exclusively with the technical issue of vertical transportation in buildings, and is intended to be used as a design tool in professional offices, as well as in classroom settings. The required research and production for the development of the structures, formats, and interfaces of this project, along with the consequential evaluation and revision of this work, has led to a greater understanding of appropriate applications for interactive multimedia designs.

Specifically, the paper addresses the fundamental issues of 'user-format', and a distinction is made between applications which operate as 'tools' and those which operate as 'resources'. Descriptions are provided for both types of operational formats, and suggestions are made as to how one might decide which format would be appropriate for a specific project.

Briefly, resource procedures imply that a user actively pursues information in a relatively static environment, while tool procedures imply that a user works jointly with the software to process information and arrive at a unique output.

This distinction between the two formats is mostly grounded in the design of the structure and user-interface, and thus the point is made that the material content of the application does not necessarily imply a mandatory use of either format. In light of this observation that an application's format relies on the appropriateness of operational procedures, rather than on its material content, further discussions of the implications of such procedures (using a 'resource' vs. using a 'tool') are provided.
1. Introduction

1.1 BACKGROUND

In 1993, I began to study how film or video could be used to represent the architectural project. Not just in terms of the physical manifestations of a building, but in terms of the literary or social construction of the project as well. The use of film for this investigation has become very tectonic and structural, often employing several camera and editing techniques in order to lay a series of formal codes over the content of the film. The agenda of this work is to construct films which can be understood for the content of their images and text, but also read simultaneously for the implications of their structure or organization.

Although this work continues to study the capacity of film to be constructed and read as a tectonic object, it has nevertheless led to the understanding that film as a representation device, is generally a static model or construction. While it may be temporal in the way that it uses time as an aspect of its construction, the viewer is not given control to manipulate the outcome of the film, or even navigate their position within the film. How does this understanding of film as a representation technique affect an approach to interactive multimedia? Is digital media a representation, or is it an architecture?

1.2 RECENT CONTEXT OF DIGITAL MEDIA DESIGN

The widespread availability of software and hardware for the production of CD-ROMs has promoted the significant growth of "in-house" productions. This greatly increases the opportunities for critical design work, some of which may seek to develop optimal structural organizations with respect to material content, or perhaps with respect to the use of material content.

Unfortunately, institutional and corporate sponsors often mistakenly assume that the value of interactive multimedia rests on its capacity for audio and animated graphics, and thus its ability to entertain. Clearly, this view overlooks the two fundamental values of digital media; the same two values which differentiate digital media from filmic media. The first value is its ability to organize data and to provide a dynamic method for the user to navigate through that data. The second value is its additional capacity to act as a software; as something which can accept input from a user and subsequently provide a unique output.

While it might not be important for a CD-ROM production to fully take advantage of every aspect of digital media, it would seem unfortunate if a producer was to proceed without an awareness of those aspects, or without deciding which of those aspects are relevant to the goals of the project.
1.3 THE PROJECT

The Department of Architecture at the Chinese University of Hong Kong prepared to undertake its fifth CD-ROM production early in 1996. However, unlike the previous CDs which had been by-products of research studies, this CD was intended to be the actual subject of the work. In other words, this project was not intending to use digital media simply as a format for publishing the results of some other study or investigation.

This project was entitled: *Vertical Transportation Planning Guide: A CD-ROM for Architects in Asia*. Although the goal of the project was to produce a professional *guide* based on a manufacturer's existing publication, the word "guide" proved to be a bit ambiguous. The ambiguity is not related to the material content of the CD, but rather the method in which the content will be addressed by the user.

This paper will approach this ambiguity by discussing the various problems or questions which were inherent in the project, and the various means which were undertaken to resolve them. This discussion does not reflect a chronology of the project's development, rather it is constructed as a logical or instructional discourse of the fundamental issues.

2. Operational Structures

The problem is essentially an issue of "use". How will the application be *used*? Once this question is answered, an appropriate structure or organization for the material might be implied. But before the issue of "use" is clearly defined for a project, it would be helpful to have a general knowledge of the structural strategies which are available, and how they might be used most effectively. These strategies have been called *operational structures* because they are only concerned with the structures which are apparent to the operator or user. These structures are not necessarily related to the actual software or scripting which is necessary to run the application.

The most fundamental organization for digital media would perhaps be the *linear* path. This could be in the form of a slide-show, or even a continuous video. The interactive aspect of this organization would simply be the potential to control one's position along the path. This linear organization would be a temporal or sequential arrangement of information.

A more complex version of the linear path would be the *multitrack* organization. While the linear or sequential aspect of the organization remains the same, the actual content is additionally divided into parallel bands or tracks. Here, the viewer has the ability to turn 'off' certain aspects of the presentation, yet the events or sequence of the presentation still remain unchangeable.

An expanded degree of control could be obtained by allowing for decision-making. Conceptually, there are two types of decision-making:
navigation-based and process-based. If navigation-based decision-making is employed, the result could be a series of linear tracks which might no longer be parallel. In other words, the sequence of events might begin from the same point, but end at a variety of points as a result of the user's decisions. This organization is essentially a hierarchy or tree structure, and is sometimes referred to as an 'interactive story'.

On the other hand, process-based decision-making might lead to other types of organizations, such as constructive models or simulation environments. However, it can also be applied in the simple framework of the hierarchy or tree structure. Such models are often computational, and might involve input rather than just binary decisions.

When deciding which of these various structural strategies might be most appropriate, the issue of 'use' becomes central. Earlier it was stated that digital media offers two fundamental advantages over other media. First, it allows a user to navigate through a field of organized data. And secondly, it has the capacity to act as a software or processor. These two advantages were alluded to again with the reference to decision-making, both navigation-based and process-based. In order to approach the issue of 'use', it might be helpful to discuss a navigation-based (data field) model in terms of a resource application, and to discuss a process-based (processor) model in terms of a tool application.

Given these two types of applications, and the variety of operational structures which are available, how should a project proceed? The most common organization for digital media productions is probably the hierarchy structure, especially with respect to in-house projects. Although it might not be the best solution for a project, why is this structure so ubiquitous? Quite simply, the hierarchy structure can be seen as the most fundamental formal model for both types of projects; resources and tools.

3. Resources and Tools

3.1 RESOURCE APPLICATIONS

With respect to resources, the hierarchy organization is often used because it is understood as a direct translation of the traditional text outline. In other words, it is understood as a simple model for organizing static information with respect to headings. Many digital media projects begin with a predetermined body of information which is intended to be the material content. Since this body of information is typically organized through the use of a written text outline, the new digital version of the material will quite often rely on a very literal translation of the original outline format. How is this translation achieved? (figs. 2 and 3.)
Simply stated, the original text outline is turned onto its side, and then redrawn as a hierarchy structure. The primary headings (Layer 1.) are seen as branches from a central title page, and the topics (Layer 2.) under each heading become another group of branches. Lastly, there are branches which lead down to the details (Layer 3.) of each topic. The items in this final layer are usually treated as terminations of a navigational path.

There are some obvious advantages associated with this procedure. Since the original outline structure is retained, there's no need to design a new organization for the material. Additionally, due to the simplicity of the navigational decisions, there is very little scripting required, and very few graphic user-interfaces.

However, while this may be a convenient model for the organization of a resource material, it isn't necessarily effective. The first problem is that the user has no indication of how far a particular path might go. The tree of options could continue for several unknown layers, forcing the user to
investigate numerous tributaries in order to find the desired data, or to determine for certain that the data is not there.

Another problem of the hierarchy diagram is the inherent method of navigation. In order to get from item II.A.1 over to item III.B.1, the user will first need to step back to II.A, and then to II, and then again to the 'contents' page. At this point the user can then begin stepping forward to III, then to III.B, and then finally to III.B.1. In addition to being inconvenient, the process is also disorienting. Each step requires the user to evaluate the options which are available from that page and then decide how to proceed. Since the user is only presented with a limited scope of options at each location, it becomes almost impossible to retain a conceptual image of the material content.

Given the inherent problems of directly applying the hierarchy structure to resource materials, how could a hierarchy be re-conceptualized in order to retain some of the advantages while also eliminating the faults?

A premise of the hierarchy system is that the primary subjects I, II, and III do not need to be revealed in a sequential manner. Since each of the subjects is available from a contents page, then each can potentially be accessed "first". This implies that the information could be handled as a database / matrix structure, rather than as a sequential tree structure. How can the original outline and the subsequent hierarchy be redrawn as a matrix?

3.2 THE MATRIX

The first step is to add a third dimension to the hierarchy. The subjects in the second layer need to be rotated beneath the headings in the upper layer so that the two layers are now perpendicular to each other. (fig. 4) If this new composition is observed in plan, it could be read as a matrix, where the primary headings act as a series of bands, while the subject headings create a series of columns. (fig. 5)
This formal manipulation is only successful if the subject headings are identical under each of the primary headings. This might only rarely be true with the original text outlines, but usually the subject headings can be reconsidered or generalized in order to be consistent from one primary heading to the next.

Now that the hierarchy has been reconfigured as a matrix, what does it mean? In the matrix configuration, the first two layers of the outline (or hierarchy) are compressed into a single plane, and the headings are indicated along two margins as bands or columns. This is quite different than the previous models of outlines or navigational trees. There, the information was geographically located according to a certain quantity of directed steps away from a starting point. Here, in the matrix, information is located according to a simple set of planar coordinates. Thus, the method of navigation has been substantially reconfigured into a coherent structure.

![Figure 6. Matrix version - Three lower layers of content accessible at a single location.](image)

Secondly, since the upper two layers have been compressed and indicated in the margins, it becomes possible to have them remain on-screen at all times. Thus, the indexing or selection process which is required to access the data at the lower layers of a hierarchy is no longer a series of visual screen changes. Rather, the indexing is always on screen, framing the lower layers of data which are visible at any selected coordinates.

If the top two layers of the hierarchy are treated as on-screen navigation, how might the lower layers of content be addressed? Although there might be several solutions, these lower layers might be similarly compressed into a single visible plane. However, rather than being reconfigured in some manner, they are simply stacked, and treated transparently so that they can be seen simultaneously. In order to be legible, the upper most item is fully rendered, while the others are ghosted. (fig. 6)

It is also worthwhile to note that the matrix configuration allows the data to be cross-referenced more easily. In fact, the primary headings could now be understood as secondary, and the content could now be re-associated with respect to the second layer of headings instead. Previously, all of the subjects and details under a primary heading such as "T", were understood as being a body of information.

However, given the matrix version, all of the information under a secondary heading such as "A", can be compiled as a body of data without
regard for the primary headings "I", "II", or "III". This ability to reconceptualize the inter-relationships of the data might prove useful to the user as well as the authors. (fig. 7)

These structural and graphic modifications to the hierarchy format have resulted in a composition which might support a resource application quite well. Fundamentally, the matrix embodies one of the primary attributes of interactive multimedia; the capacity to clearly organize data and to provide a dynamic method for the user to navigate through that data. But what about the other attribute of interactive multimedia; the capacity to act as a software or processor?

3.3 TOOL APPLICATIONS

As indicated earlier, the hierarchy structure can be seen as the most fundamental formal model for both applications; resources and tools. Given the case of resource applications, it has been discussed that the hierarchy structure is a technique of geographically locating static information with respect to headings or sub-headings. It was also discussed that this strategy requires substantial revision in order to operate effectively. But if the hierarchy system can be applied as a geographic strategy with resources, how can it be applied to tools?

With respect to tools, a hierarchical structure can be understood as a decision tree, which is the fundamental model for processing or decision-making. Here, the decisions are process-based, and the hierarchy structure becomes a temporal model, rather than geographic. While the unmodified
hierarchy might not have been well suited as a resource, there doesn't seem to
be much translation required in order for it to be used as a tool.

In a temporal or sequential model, the requirement to create a logical
framework for navigation is nearly eliminated. This is due to the fact that
navigation has become an internal or invisible element, which relies solely on
the user's decisions or input. While this relieves the designer of the need to
create a comprehensible environment, it greatly increases the demand for
strategically choreographing the sequence of events and interactions.
Essentially, the designer now assumes responsibility of navigating for the
user, according to their selections or input.

This begins to imply that the user might not experience the tool
application as a decision tree. It is quite possible that when the user is asked
for input, it might be the software which makes the actual evaluation and
decision. Thus, the organization which is apparent to the user might seem to
be more linear than tree-like, despite arriving at a unique output for each
variation of the input.

3.4 THE DIALOG

Concerning the CD-ROM project which was undertaken here at CUHK, the
initial prototype was thought of as a resource. The content was centered
around the planning process for designing elevator systems in buildings, and
the associated knowledge and data which was needed for that process. Thus,
the resource was going to describe the process in its three different phases,
and supply a database of knowledge as it applied to each step in the process.
This agenda directly led to the design and construction of the matrix
prototype.

However, this portion of the project was also being paralleled by an
investigation into the users and their specific needs. As construction was
developing on the matrix version, it became clear through various interviews
and field visits, that the users needed an application which functioned as a
tool, not as a resource. Both applications were capable of sufficiently
educating the user, but the resource application assumed that the user would
have a high degree of directed ambition.

In other words, the resource required the user to actively study a very
difficult and in-depth subject, while the tool application allowed the user to
teach through experience. Part of the implication here is simply a practical
issue: the user will still have a learning curve with the tool application, but
since it is the application itself which is making the decisions, the user's
learning curve should not affect the quality of the results. This would clearly
not be true in the resource application, which would require the user to fully
internalize all of the knowledge, prior to producing quality results.

The tool application which was subsequently pursued for this project was
referred to as a Dialog. This evolved as a discussion between the user and
the application. Within the dialog, a series of questions are posed, and the
users selections or input allow the application to proceed to the next appropriate step. The questions and input requests have been orchestrated to facilitate a computational process which can actually provide multiple options for the output. Additionally, each set of numeric output is accompanied by a series of drawings which indicate the various architectural implications of each solution. Such drawings provide important design decisions which have been performed by the application, but only provides the user with information which is immediately useful.

![Figure 8. Dialog progression which indicates a series of selections in the right column.](image)

At this point, a concern should arise that the user might never become aware of the underlying concepts which are allowing the application to make the relevant decisions. The fear would be that the user might develop an intuition for anticipating certain results, but never truly understand the actual reasoning. Thus, the entire dialog is backed up by a lengthy series of appendices, which make themselves evident each time that a decision is occurring within the application. This might be thought of as providing information at the "point of need". If the user chooses to jump out of the dialog momentarily, they can briefly investigate how (or why) a specific decision was made, and then easily jump back into the dialog. (fig. 7)

This organization accommodates three very specific users. The absolute novice will probably not use the appendices in order to avoid being overwhelmed by the process. At an introductory level, the novice will concentrate simply on answering the questions and attempting to apply the output to their current work task. The more advanced user will feel very comfortable with the application, and become curious about the decisions which are being made. This person will use the appendices thoroughly in order to understand the subject matter which is intricately connected with their everyday professional work. Lastly, the expert user will already fully understand the subject matter, and will have no need for the appendices. By not using the appendices, the user can streamline the use of the application, and allow it to function strictly as a tool.

4. Intuitive Environments

The primary agenda of an intuitive environment is to provide a clear and continual reference within the application. This system of reference can be
geographic (locational) or temporal (sequential), but it must be applied to
the organization of the material content or perhaps the material itself.

In the matrix application, the compression of the upper layers of a
hierarchical structure allows a finite grid to always appear on-screen. This
on-screen frame acts as a map or indicator which continually shows the
location of the content currently being framed.

Additionally, any screen changes which happen at a single site in order to
access the lower layers of the hierarchical structure are not treated as
locational changes. Rather the content itself changes its position within the
stacked environment, and simply floats to the surface where it becomes
gleible.

With respect to the dialog version, the application assumes a temporal
series of changes, rather than working with a geographical model. This is
primarily achieved by maintaining a consistent visual screen, and only
changing cast members as needed to produce the sequence. Thus, there are
no literal screen changes unless the user momentarily switches out to an
appendix mode for further information.

These appendices are treated geographically, as static fields of
information which can be accessed at will, but they are most commonly
accessed directly from the dialog only as needed - and in this case it is the
software itself which cues the user to potentially look at a specific piece of
relevant information.

5. Conclusion

With respect to the work which is presented here, a design process could be
outlined as follows: While both resource and tool applications might contain
tools and resources as components, the designer needs to identify an
application's fundamental intent, and thus its predominant structure. Intent is
clearly different from content, such that intent is referring to the user and the
process of using. Once this is established, a designer can proceed with
exploring the possible structural arrangements, and how they might impact
(or be impacted by) the content. Furthermore, this design work can lead to a
serious exploration or development of user interfaces.

In light of this description, it should be noted that the terms which have
been used for this project (resource / tool, locational / sequential, navigation-
based / process-based, etc.) are not intended to represent the range of
possibilities. They were used to develop an internal discourse for the project,
and it is assumed that if they were applied to a new project, they would need
to be altered or expanded.
Lastly, it is important to note that the field of architecture is especially well-equipped to contribute to the larger development of digital media. It seems that the design of interactive digital media applications can be an architectural endeavor. This is not implying that digital media is necessarily analogous to buildings, but rather that digital media and architecture share many of the same conceptual agendas. Indeed, the architect is trained in areas of expertise which seem highly applicable: First, they continually deal with the conceptual organization of materials, space, and structures. Second, they work with the design of forms which serve to accommodate specific activities and programs. And third, architects are responsible for the creation of built environments for habitation or use.

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