Making Space Content Specific
Interactive Architectures for Information Presentation

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Abstract

This paper examines the connections between digital architectures and interaction design with an emphasis on how the latter informs the former. Digital spatial interfaces have been in development for well over a decade. However there is still a distinct and problematic separation between the function of these spaces architecturally and the functional use of architectural concepts in the design of these spaces. The research presented here outlines an approach to interface design that promotes an architecture that is temporal, interactive and sonic, and is defined explicitly by a functional relationship to its informational content. In particular this research reports on the design of a software prototype that incorporates spatial concepts of interactivity, visualization and sound to assist in the navigation of presentation information, promoting space as a primary interface to an information collection.

Introduction

The discipline of architecture is founded on the interpretation and understanding of space, and in turn, spatial information. Architects have explored the connections between digital information spaces and physical space. These relationships in general follow advancements in representational technologies from the broader computing domain, for example the use of VRML in the mid nineties as an architectural modeling language. Realtime three-dimensional visualization techniques offer an innovative space for combining extant architectural knowledge with the additional dimensions of hypermedia, interactivity, and streaming information. The Virtual New York Stock Exchange by Asymptote is a well known precedent of a virtual environment that mimics a physical real world space (Couture and Rashid 2002). The project synthesizes the physical trading floor with a digital trading floor where users can view the information of the NYSE environment in realtime via a digital interface. The development of realtime visualization software and graphic engines that represent spatial environments continue to furnace architectural
explorations. A collection of applications is available to the architect to explore this domain, some of which are: Virtools™, MaxMS/Jitter, Macromedia Director™, Adobe Atmosphere™, Blender, and various game engine technologies, Unreal, ORGE, Torque, etc. For example Dutch architect Kas Oosterhuis is a designer who creates digital spaces (utilizing Virtools) that interact and control physical architectures (Oosterhuis 2003). The argument of this paper is not surveying, validating or judging the novel use of these technologies by architects. It is interested, however, in how architects can be assisted by the field of interaction design when designing for the digital domain, and this is examined through the development of an experimental software prototype described later in this paper.

Shneiderman in his essay “Why Not Make Interfaces Better than 3D Reality?” discusses the development of 3D interfaces (Shneiderman 2003). Shneiderman, an important figure in interface design and Human and Computer Interaction (HCI), is interested in the advantages and disadvantages of 3D displays over traditional two dimensional computer interfaces. Shneiderman presents a survey of attempts to render information spatially, and specifically within spaces that mimic real world conditions. For example, Win3D (Clockwise) uses the analogy of rooms for various computer applications, and Task Gallery (Microsoft) software applications are located and accessed via the floor, walls and the ceiling of a generic office room. Architecture in these examples is a backdrop, or stage, for the interaction. This is a symbolic representation of space, rather than space designed as a result of function; the architecture is static and has the appearance and arrangement of a space designed for the real world. What this paper is arguing is that in the digital domain we should consider architecture not as a frame, but as the spatial experience that reconfigures to the actions of the user. Thus avoiding the mimicking of a real-world space, and focusing on the advantages of a space that is defined specifically by the nature and quantity of its information. The software prototype presented in this paper embodies an attempt to move towards a digital architecture that is temporal, reconfigurable, and inherently functional.
Eureka Prototype

Background

The Eureka prototype is a spatially adaptive hypermedia. This is a combination of adaptive hypermedia (Brusilovsky 2001), where content is reconfigured by user input, and spatial hypermedia, where spatial relationships make new connections between previously unrelated content (Marshall and Shipman 1995). Eureka, as a digital environment, locates informational assets within a digital space that can be interacted with and navigated by a user via an OpenGL graphics display, keyboard and mouse. Eureka allows for the user to compile presentation content from a database, alter elements, present, and retain information about the presentation. The space of Eureka as an information rich environment incorporates various modes of user interaction and content arrangements, and the software prototype has been produced with the authoring software Macromedia Director™.

In contrast to other presentation software (for example Microsoft PowerPoint), where elements are placed into linear lists for presenting, Eureka allows the user to arrange information into sets (compositions) within space, which can be traversed in a linear or nonlinear sequence. Given the computational and multimedia ability of a consumer grade laptop, it is difficult to understand why we traditionally resort to a linear style of presenting via 2D representations of our information assets. As illustrated in Figure 2, the main difference between Eureka and other presentation software is that Eureka locates all presentation information spatially. This spatial arrangement creates a 3D interface within which one can interact with presentation content. This allows for easier recognition of the lecture content by the user and the ability to use perspective as a means to arrange and collate information.

In Eureka navigation is achieved by the user ‘clicking on’ items, upon which the user’s point of view is moved through space to address the newly selected item. The user is able to move freely around the content with an interaction model of clicking on objects to navigate. When an item is ‘double clicked’, then the...
image is shown in full screen mode, like a traditional slide show. A presentation is a mixture of navigating the space, and showing content as full screen images, allowing for both linear transversal and the nonlinear jumping between content.

**Architectures Defined by Information**

Eureka relies on content to generate space. For example a presentation with a limited set of content (e.g. 30 items), will have a less expansive sense of space than one with a larger collection of items (e.g. 200 items). This is a key difference between Eureka and interfaces that try to mimic real world space; here space is adaptive to the content, so there is a direct relationship between the content and the spatial experience it creates. To manage the interaction within space the design of Eureka engages two main principles: first, arranging elements in space relative to varying modes of interaction; and second, that space is reconfigurable, so change to the information set transforms the spatial configuration of the information. These concepts embrace three key characteristics that advanced 3D interface designs have: rapid situation awareness through effective overviews; reduced numbers of actions to accomplish tasks; and prompt, meaningful feedback for user actions (Shneiderman 2003). The information modes allow for different types of interaction to occur with the collection set, the use of perspective and camera controls allow for rapid situational awareness, and the animated transitions and sound-scapes give feedback to the users’ interactions.

To facilitate the control of the informational assets Eureka offers the user a selection of information modes. These modes allow the user to switch between different configurations of the information space, entitled *presentation*, *plans*, *library*, *agent response*, and *history*. For example the *history* mode reconfigures every slide that has been shown in a presentation into a linear sequence, spatially moving them out of a relationship with the images not shown. The *library* mode exposes all library assets for viewing and selection. Each information mode can have a unique spatial configuration, user interactions, environmental conditions, and the arrangements can be designed to dynamically reflect the quantity and type of information being presented. Figure 3 represents an abstraction of how the collections are spatially related.

Eureka presents an animated realtime information environment. All user movements, interactions, and spatial transformations of the information are animated, so the environment is constantly adapting as the user interacts with the content. Decisions have been made to rationalize the location and placement of

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*Figure 3. Diagram of the spatial arrangement of information sets in Eureka. Depth in the space connects past and present action, moving from left to right denotes sequence and sorting of information, and height from bottom to top, represents a transition from static to temporal collections of information.*
Information elements as digital spaces are somewhat limitless. In Eureka, as illustrated in Figure 3, the current spatial model positions content relative to temporality, so metaphorically the higher the object within the space, the more temporal its nature, and vice versa. So the library components (permanent collections of images) are located at the apparent bottom of the information space, the current presentation in the middle, and the traced history of the content appears to float above this presentation content. The system distributes content in a dynamic manner, relocating elements in ways to avoid collision and spatial redundancy. Here space is arranged to facilitate the tasks of the user, not to mimic a sense of a physical space or recreate a real-world condition.

**Editing and Tree Structures**

Eureka is a space that is used for composing and presenting information. As an editing tool Eureka works by selecting items from image libraries, which are placed into a presentation list, reordered, discarded and recorded for future use. At the start of a presentation the environment is generated from this recorded plan of information items. To allow the user to structure the presentation, new elements are defined as either a ‘composition’ or an ‘item’. A composition is a container that can include lists of items (images), and also contain additional compositions. This is a nested or tree hierarchy approach to information organization that intuitively allows the linear and nonlinear transversal of its material. The ‘plan’ of a presentation is recorded in an XML schema. It is from this schema that the imagery of the presentation is located and spatially distributed. Other aspects of the prototype design also rely on this schema, specifically the intelligent agent support (see section 4), and the integration of a spatial sound component, summarized in the following section.

**Extending the Interface through Spatial Sound**

The following section of this paper briefly outlines the spatial sound design of the Eureka prototype. During the development of the prototype, five sound designers have been engaged to consider the implications of dimensionality within presentation environments. This research is developed from several key themes presented in the International Community for Auditory Display “Sonification Report: Status of the Field and Research Agenda” (Kramer et al. 1997), with additional reference to extant research on the role of non-speech audio for the representation of data dimensions (Walker 2000). The research focuses on...
the premise of creating sound fields within physical presentation environments that relate to the digital space presented on the screen. These sound fields are achieved by using four channel audio, as opposed to two channel audio (stereo), positioned around the audience. As part of this research sound designers have considered and designed soundscapes that explore the concepts of user coordinates and positional sound generators; nesting of compositions as a way of nesting sound files; and meditation and theatre as methods of considering presentation as a performance that has a beginning, middle and end.

The most recent development of the sound work is relating a positional sound in real space to the virtual position of the presentation compositions in digital space, meaning that when the user is located within the information space of Eureka, they receive audio clues to whether the surrounding compositions are in front, to the sides, or behind. For the sound design the Eureka prototype utilizes the software application Max/MSP (figure 4). A communication protocol has been established to allow the Eureka application to control the parameters of the Max/MSP environment. In the Eureka project, with its unique spatial conditions, sound is considered as an integral extension, or dimension, to the concept of an interface. Here the digital architecture is also a generator of sonic environments. As with the ability to adapt space to content, sound is also adapting to the parameters of the presentation, and the manner in which it is arranged spatially.

Prototype within a Research Project

This paper is concerned with advancing the concept that digital architectures should be adaptive, responsive, and sonic. The Eureka prototype is part of the greater federally funded grant exploring unorthodox presentation formats for situational awareness. The project team spans three disciplines: architecture, sound design, and computer science. The objectives of the larger research effort in this project are the human and social issues affecting decision making processes informed by spatial visualization and sonification with integrated computational support, especially in complex systems environments such as design collaboration, weather prediction, and disaster management situations.

As such, Eureka has evolved to accommodate a series of key research components beyond just the visualization of space; one is spatial sound, and the other is the integration of intelligent agent support for decision making processes. This paper has focused on the spatial and interactive components of the work. The intelligent agent support utilizes the XML schema of the presentation plans (as outlined in section 2.3) to make editing suggestions about the presentation content during the duration of the presentation. Rather than discuss this in detail here, it is argued that forms of decision support offer ways of informing architecture, as external influencing forces. For the Eureka prototype, space is adaptable. So as with the information modes, for example of history and presentation, one can consider additional modes that alter the manner of the space.
The current prototype features an Agent Response mode, which allows the user to retrieve a selection of images from the intelligent agent system. Through a combination of spatially arranging assets, spatial sound and intelligent agent support, the Eureka Prototype suggests a digital architecture that doesn’t mimic physical architectures. It presents, however, a digital space and an architectural experience, based on the concepts of space being adaptive and interactive.

**Future Work**

As this research is being reported the current phase of the project is developing an approach to undertake user testing of the prototype. A social scientist is part of the research team and is developing a series of questionnaires and presentation scenarios to test the software, the interface, and the success of the integration of spatial sound within presentation environments. This will focus on the actual user of the software prototype and its effectiveness as a presentation compiler. Following this testing phase the results will be used to develop the prototype further incorporating suggested improvements and ameliorating any problematic issues raised by the testing phase.

**Conclusions**

Within the digital domain the function of architecture is difficult to define, as the intrinsic physical world needs for structure and materiality are omitted. However there is an important relationship between the concepts of architecture and those of interfaces. Here it has been argued that a potential for digital architectural spaces is for them to be defined specifically through a relationship between content and user functionality. This is presented here by considering the temporal, sonic and interactive potentials of digital architecture in the design of information environments. Form in this space can follow the functional needs of the user. As can be learned from interaction design, rather than consider digital spaces as poor replications of physical spaces, we can promote new methods of space making by relating form to informational content.
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References


