Implications of Representation-Presentation Distinction in Developing a Presentation Environment for CAAD

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Computer mediated environments are increasingly used for design communication to bridge the gap between geographically and temporally separated stakeholders. We look at the design process, its communication through computer mediated environments, and stress the need to recognize the subtle distinction between representation and presentation in this process. Building on representation-presentation distinction, the case for a multi-modal design presentation environment is made and the challenges involved in developing such an environment are discussed. We conclude by demonstrating a prototype of such a presentation environment.

Keywords: *Design presentation; representation-presentation distinction; digital design presentation environments; hypermedia.*

Nature of architectural design process

Architectural design is an iterative visual process that involves thinking and exploration using pictorial or symbolic representations, which can be referred to as the "language" of the architect for communication (Bijl, 1989). Language, through use of expressions, allows people to reach into and interact with each other's "unique" knowledge conditioned by their individuality. In the case of architecture, these expressions are graphical in nature and aimed at communicating spatial properties and relationships. All computer tools aimed at supporting the design process can be considered simply as expressive environments that help us evaluate our designs and/or share our design knowledge with others. These environments inform others about our design process and thereby help evaluation, which in turn helps to further improve the quality of design. For these tools to be successful, they should be able to direct attention to the nature of a particular design and be able to reveal the unique set of combinatorial rules developed by the designer in response to the context of the design project.

Representations and architectural design process

During the design process, one works on a non-existent product, conceived in the mind and communicated only through representations (Porter, 1995). Seeking an appropriate form of representation for this "virtual object" has always been important for designers. Representations signify a world of objects

through a series of established conventions (Akin, 1984; 1986). The quality of design, it can be argued then, depends on the ability of a designer to select useful abstractions, use them to simulate the performance of the design, and use the result of the evaluation to guide further refinements (Akin, 1984; 1986). Thus representations are critical to the design process for two reasons: to overcome the cognitive limitations and to facilitate the collaborative process (Akin, 1984; Markman, 1999). Markman (1999, pp. 5-8) defines representation as consisting of four components: *a represented world* – the external (physical) or internal (mental) world that forms the domain for the representations, *a representing world* – the domain containing the representations which presents selective information about the represented world, *representing rules* – which define the relationship between the elements of the represented world and the representing world and *a process that uses the representation*.

The potential of the representation lies in the difference between the represented world and the representing world (Markman, 1999). Abstraction allows a representation to leave out irrelevant information, permitting one to focus on the issues relevant to the task (Laseau, 1980; Lawson, 1980). Usefulness of any representation therefore lies in the balance it achieves between inclusion of relevant information and exclusion of irrelevant information. Representations are less complex (in terms of the amount of information) than the represented world and lend themselves more to manipulation, which helps in understanding the structure or organization of the represented world, in evaluating it and refining it further (Markman, 1999).

Mental model of the creative process

While attempting to create a medium for design representation and communication, it is important to look at the behavior of the human mind during the creative process. Design is not linear problem solving with a definite starting point. In fact, the designer's focus of attention shifts between different aspects of the design problem. Takala (1993) refers to the focus of attention as a *view*, and each *view* is evaluated for discrepancy by comparing with other views. The design process ends successfully when a number of different views can be taken without discrepancy. The progressive overlapping of a number of views also should not reveal any discrepancy (Takala, 1993). The distinction between general problem solving, which requires logical deductive reasoning, and creativity is in the movement of *views*. In general problem solving, there is a specific starting point from which the view expands gradually in a definite direction and a node or link once included is never discarded. However, in creative thinking the focus moves spontaneously from one portion of the network to another (Takala, 1993).

Distinctions between *representation* and *presentation*

With architectural design becoming more collaborative and projects as well as teams more geographically distributed, design communication becomes as critical as the design process. We believe that fundamental to understanding design communication is the need to make a distinction between *representation* and *presentation*. In fact, many a times these terms are used interchangeably, adding to the confusion. Carpendale and Montagnese (2001, p.61) define r*epresentation* as the act of creating an image that corresponds to the information. Thus *representation* involves developing a mapping from the information to a structure that can be displayed visually. Representations are primarily a visualization tool to aid reasoning and creative process. *Presentation* is the act of displaying this image, emphasizing and organizing areas of interest (Carpendale and Montagnese, 2001; p.61). This distinction is important especially when the audience is not trained in the representational conventions of the designer.

The representation-presentation distinction is complicated by the fact that they lie in a continuum.

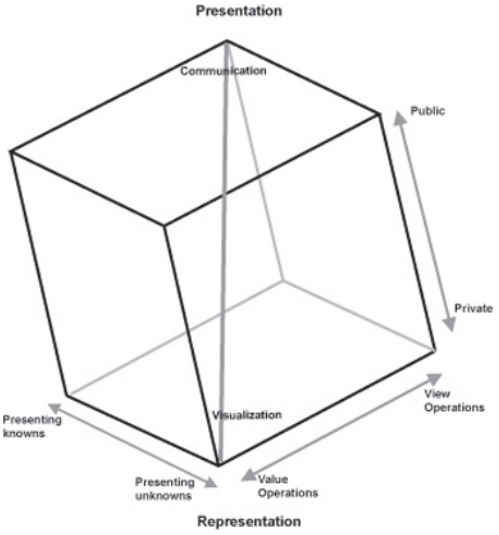

Figure 1
Representation–Presentation / Visualization–Communication cubic space. Adapted from MacEachren (1995)

This is analogous to MacEachren's (1995) depiction of cartography as a cubic map-use space with visualization and communication occupying opposite poles. In design process and communication, representation and presentation can be respectively mapped on to the visualization – communication poles (see figure 1). This also will help to clarify distinctions between the two such as the *level of interaction* (at value level for representation – at view level for presentation), *purpose* (exploration of unknown–communicating known) and *intended domain* (private-public).

Chi and Riedl (1998) sums up the difference succinctly – representations involve value operations, whereas presentations involve view operations. Changes in representations involve value operations and thus modify the nature of the artifact under design, whereas changes in presentation primarily affect how it is viewed or perceived. In this regard, scaling (especially non-uniform scaling) a building to make it longer or bigger would be a value operation, which changes the nature of the artifact. We can present the same building from different points of view within the geometric space, which communicates the nature of the building. Here the term presentation is used to mean more than different geometric perspective and includes other operations such as translation, zooming, show-hide layers etc.

For the same information or representation, the presentation strategies can vary depending on the type of task, nature of information and skills of the user (Carpendale and Montagnese, 2001). This distinction will allow us to explore the presentation space independent of information specification. The nature of presentation can play a critical role in the design process at two very important stages. The first stage is before the designer even attempts to solve the design problem. Carroll and Malhotra (1980) have shown that how the design problem is presented, strongly influences the space in which the designers search for solutions. Another stage in the design process where the presentations can play a major role is during the evaluative stage of the design process. By their choice of areas for emphasis and the organization of various representations, the presentation of the design solution can affect how it is evaluated. While most CAAD applications incorporate tools for both representation and presentation, it still is not quite analogous to the mental model of design thinking outlined by Takala (1993). Designers rely on multiple tools to explore different aspects of the design and what is needed is a tool to bring these together at the meta-level. This point is best illustrated by comparing the traditional design critique 'pin-ups' with digital ones as detailed in the next section.

Need for a presentation environment for design communication

Traditionally, the tool kit of the designer, particularly architects, included a wide repertoire of media: pencil and paper, cardboard and rubber cement, foam core, wire and clay among other things. The only limit was the designer's imagination. These tools had a common characteristic in that they were flexible enough

to encourage exploration and each was particularly suited for exploring a specific aspect of the design problem. When it comes to digital media, a variety of tools, that support drawing and 3-dimensional modeling are available. With their emphasis on precision and finality computer-aided design tools are seen as rigid and inflexible when compared to traditional media and are unable to support a broad range of functions in the early stage of the design process. However, they also come with many advantages in overcoming perceptual limitations, especially when it comes to visualizing 3-dimensional space and permitting a greater perceptual range of experience. This is particularly so in the 'propose' stage. When it comes to the 'evaluative' stage, the nature of difficulty is slightly different, which is best illustrated by drawing a comparison between the traditional "pin-up" critique in the design studio and the presentations in the "digital studio".

In a traditional design pin–up, the design presentation involves 'pinning up' a variety of media and modalities including a collection of drawings: plans, sections, elevations, perspectives and axonometric, the site photographs, foam core models of massing, detailed models of interiors and sometimes even working models of an exciting detail. Each of these reveals a particular aspect of the design. Everything is on display simultaneously and presents the critics an excellent context within which to evaluate. Many times, this simultaneous display of representations in diverse media encourage easy cross-referencing and help critics see new connections that may have not even been thought of before. This is of tremendous importance to the evaluative stage of the design process, whether it involves just the designers or includes others. In most digital presentations, this simultaneous presentation is replaced by a sequential presentation, whether it is navigating through a virtual building model, an animation or even PowerPoint slides. Here, the emphasis of the critique is shifted from an analytical and analogical perspective to an experiential one. Due to the cognitive limitations imposed by the presentation medium, critics are robbed of an opportunity to cross-reference, make connections, or many times even fully understand the context. It is therefore critical to disseminate information in different modalities and present those in a variety of flexible and interactive formats. Organization of multiple abstractions in multiple modalities is an important issue worth our attention. Though progress has been made in the search for a computing media, which can generate multiple abstractions in different modalities, there is much to be done on developing a medium for design presentation that brings together these multiple representations in multiple modalities. In this regard hypermedia environments are potentially the best bet, and many including Mitchell (1995) have made suggestions along this line for a design presentation environment. A recent finding by Eveland et al. (2004) that hyperlinked environments improve knowledge structure density, i.e. the forming of associations between related chunks of information, is particularly promising in this light.

Qualities needed in a hypermedia environment for architectural design presentation

An interactive presentation system for architectural design should help explore the relationship among representations, their meanings and their effects. This is important for the evaluation stage of the design process, especially in a collaborative design environment or in an educational setting such as the design studio. The presentation medium should ideally amplify the representational talkback (Nakakoji, 2000). Nakakoji & Yamamoto (2001; p. 449) define representational talkback as "a perceptual feedback from the externalized artifact (representations) to the designer; in other words, how the designer or the design team interprets what he or she has just represented".

Orland, Budthimedhee and Uusitalo (2001) tracing the evolution of forms of communication between the designers/planners and the public, point

out that current technology offers the potential to examine the visual information in a more interactive manner, manipulate the particulars, compare alternatives side by side, and play "what-if games." The need for an integrated multimodal environment is even more important larger design projects especially publicly accountable planning projects where the flow of information helps inform the public of complex environmental contexts and allows for an exchange of ideas with the planners (Orland et al., 2001).

Orland et al. (2001) point out that Design support systems (DSS), which consist of integrated software tools, allow access to data represented in different modalities (charts, text, audio and image files, interactive 3D-models, and animations) through different tools such as hypertext/hypermedia or GIS according to hierarchical, topical, spatial, or temporal references. DSS in their opinion should ideally combine the abilities to visualize, do predictive modeling and act as a communication medium between the designers and public and among designers themselves. While predictive modeling is important for more complex urban and environmental planning projects, it is of lesser significance for most of the basic design projects where visualization and communication are relatively more important.

In a presentation environment aimed at aiding the evaluation stage, view operations as discussed earlier should be given priority. Focus on constructing efficient metadata is crucial for data retrieval. Metadata is conceptualized as structured data about data. Previous work on metadata, such as those by Hwang and Choi (2002) and Khemlani, Timerman, Benne, and Kalay (1997), deal with spatial information both in terms of its attribute data, and in terms of its semantic and structural content. The implementation of these earlier systems consists of three component modules for modeling (structuring data object), indexing (generating metadata), and searching and browsing (exploiting metadata and finding data) (Hwang and Choi, 2002; p. 200).

Whereas most knowledge base systems deal primarily with syntactical information (such as cost, materials and dimensions), it is important especially in a presentation environment to focus on semantic information, which explains contextual relevance (Carrara et al., 1992). The decision-making process in design is hierarchical in nature, with broad general solutions explored first and the focus gradually shifted to the details. Also at times, designers start with the details or the parts and move up to the whole. In both cases, Carrara et al. (1992) point out that decisions are propagated up and down across abstraction levels of different hierarchies. Higher-level organizational decisions might restrict lower level details, and lower level decisions may result in inconsistencies at the higher organizational level. This is also reflected in the evaluation during a design pin-up or a presentation where the focus continuously shifts between different levels and kinds of abstraction, comparing and searching for inconsistencies.

Multi-modal environments for design presentations

Carrara, Kalay, and Novembri (1992) recognize that the design knowledge is multimodal in nature, an aspect that has received little attention in the research on knowledge representation in design, over the years. While using traditional media to communicate architectural design, the choice of specific media (and the level of abstraction) to present particular information is guided by the designer's judgment based on the nature of the information to be conveyed and the expectations of the audience. This judgment is acquired as part of the training imparted in the design studio.

In developing a multimodal environment for architectural design presentation, the main challenge is how to integrate and organize multiple representations and modalities in a single presentation environment and allow interactions among these representations. Building on the discussion on representation-presentation distinction, we conceived and

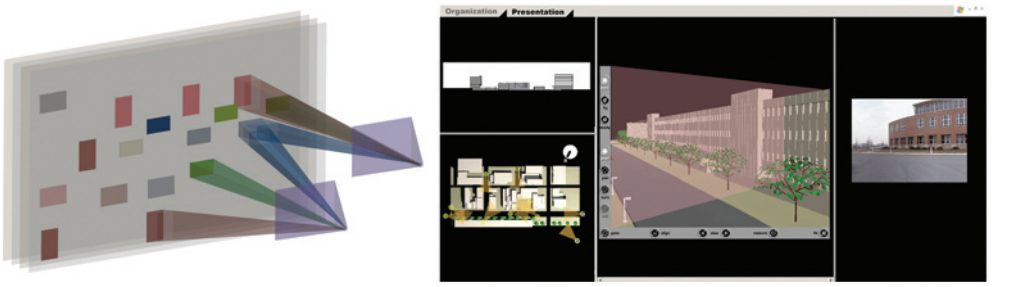

Figure 2
Nested-view metaphor of the MVE and the presentation environment incorporating digital artifacts in multiple modalities including immersive, interactive 3d models

built a prototype for a multimodal design-presentation environment (a sort of 'digital pin-up' board). This environment, called the multimodal virtual environment (MVE) is a presentation environment for design critiques in our undergraduate digital studio. Figure - 2 shows the nested view metaphor of the MVE as well as the screenshot of one view configuration from the presentation tool. Various design artifacts can be organized into different layers according to any logic decided by the presenter. Within an all-encompassing *main view*, any number of sub-views can be included. These sub-views can dynamically enlarge or shrink and move across different layers. These views can also accommodate different modalities and allow interactions among different artifacts. Details regarding the user interface features of MVE and findings from the usability study are elaborated in Balakrishnan et al. (2006).

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