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Carol Strohecker

TR99-07 December 1999

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TOWARD A DEVELOPMENTAL IMAGE OF THE CITY

Design through Visual, Spatial, and Mathematical Reasoning

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Abstract. Nearly forty years ago, Kevin Lynch (1960) described the environmental image in terms of five structural features: districts, edges, paths, nodes, and landmarks. Though the work has been much criticized, even by Lynch himself, it may provide a basis for a computational tool useful both in design and in research on spatial cognition. This paper revisits Lynch's responses to criticisms as a means of ascertaining the potential merit of the prototypical tool, called "WayMaker." In addressing Lynch's concerns about his own method and results, we see that WayMaker and tools like it may support Lynch's value of participatory design, while enabling extension of his efforts to understand how people think about the spaces they inhabit. The paper includes discussion of methods for research in spatial cognition and potential use of WayMaker within graphical environments supporting virtual communities.

1. What is WayMaker?

Using WayMaker, people position representations of Lynch's elements to form two-dimensional diagrams of spaces remembered or imagined (Strohecker and Barros, 1997, in press; Strohecker, Barros, and Slaughter, 1998; Strohecker and Slaughter, 1999). In the manner of a drawing tool, the elements are malleable. They can be easily placed, stretched, and scaled. The resulting maps have topological integrity moreso than geometric – that is, the relative placement of the elements is more important than measurements and proportions.

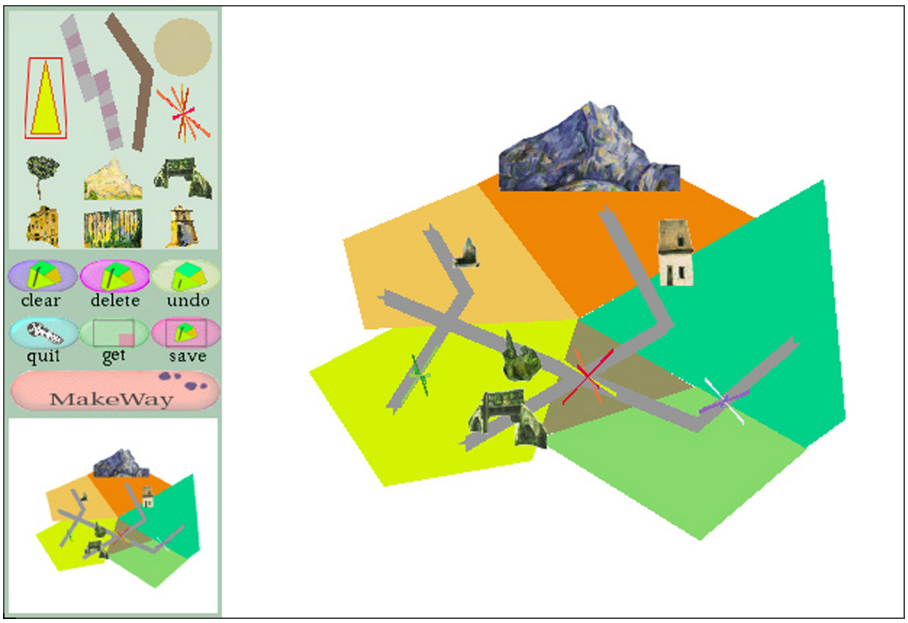

Figure 1. *A WayMaker composition screen. The five element symbols are at upper left: a triangle for landmarks, lines for paths and edges, a circle for districts, and a starburst for nodes. The viewer drags an element to the right, and manipulates and combines it with other representations to form a map. Specifications add interest: a landmark can take the form of a house or tree, an edge can take the form of a mountain, and so on. At lower left, a miniature copy of the map echoes the construction.*

When signaled, WayMaker changes the display from the user-constructed map to a series of ground-level views along a chosen pathway. In the preliminary prototype, these views are two-dimensional scenes that represent a virtual world through illustration rather than physical simulation.

As the display changes, the miniature map maintains its position and indicates the location of each scene within the design. Users can easily refer to the map when considering the changes of view, scale, and representation.

Figure 2. *A WayMaker view screen. The red dot on the miniature map indicates the viewer's location within the mapped "place." Cézanne paintings are the basis of imagery for the composited scenes.*

Bundled with WayMaker is a database of images that we excerpted from reproductions of paintings by Paul Cézanne (Machotka, 1966). The database is organized according to scene and building parts: sky, ground, facades, etc. These parts fit into a perspective-style grid that creates an illusion of depth in the two-dimensional interface. A different grid is associated with each district, and within a district the grid alters as a pathway changes direction.

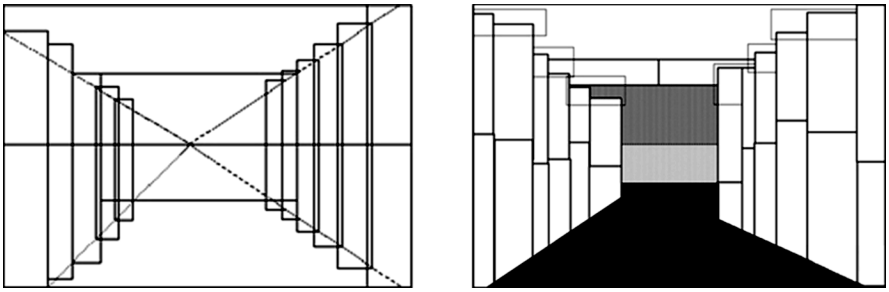

Figure 3. *A perspective-style framework and its adaptation for a WayMaker district.*

At each "step" along a path, the software detects which district contains the view, assembles a corresponding framework, places image parts appropriately within the framework, and displays representations of edges, nodes, and landmarks according to their positions on the map.

This process repeats as a dot on the miniature map moves along the chosen path, indicating the position of the current frame. The software adjusts image selections and placements appropriately in each new frame, until the dot arrives at the end of the path. The result is a series of views simulating a stroll through the environment.

The viewer can allow WayMaker to automatically determine a route, by clicking on the miniature map to indicate a general direction for travel.

Figure 4. *Making a way from one district to another. Nodes are represented as starbursts that appear, disappear, and reappear as the viewer "traverses" the area of the node. This treatment whimsically reflects Lynch's definition of nodes not just as strategic foci to and from which people travel, but as concentrations of human activity.*

At any time, the user can view another pathway or return to mapmaking. Maps can be saved for later viewing and refinement.

Figure 5. *By adding an edge and specifying it as a mountain, the viewer augments the sense of place. In the next version of WayMaker, environmental sounds will accompany node and edge displays.*

It is important to note, as Lynch reminded his readers, that the five elements of the city image are only structural. His focus was particularly on the "imageability of city form."

> There are other basic properties in a beautiful environment: meaning or expressiveness, sensuous delight, rhythm, stimulus, choice. Our concentration on imageability does not deny their importance. Our purpose is simply to consider the need for identity and structure in our perceptual world, and to illustrate the special relevance of this quality to the particular case of the complex, shifting urban environment.
>
> (Lynch, 1960, p. 10)

2. Premises of WayMaker's Design

Urban planners have demonstrated pitfalls of using the elements of the city image in generative fashion. Why should we risk once again inverting Lynch's analytic process?

2.1. CONCEPTUAL ELEMENTS AS BUILDING BLOCKS

We are a long way from knowing how people spawn and develop their understandings of places in particular and spaces in general. Lynch's efforts to understand people's knowledge of space were both partial and incomplete. Nevertheless, his analytic process yielded a well-formed premise that can be compared with other efforts to study the nature and processes of spatial cognition.

> Researchers in spatial cognition focus on two kinds of conceptual growth: …development of fundamental concepts of space, and the further differentiation and elaboration of these concepts into the development and representation of large-scale environments.
>
> (Hart and Moore, 1973, p. 248)

In their efforts to understand how people's thinking grows from infancy to adulthood, Piaget et al.[1] took an approach that was both epistemological and psychological (Beth and Piaget, 1966; Piaget, 1971; Gruber and Vonèche, 1977). That is, in order to study how human

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[1] *Contemporary researchers have reformulated aspects of Piagetian theory, on the assertion that the data are useful, but the interpretations may have been premature or too narrowly focused. Moving beyond stage theory, they posit a plurality in conceptual development, which accounts for varied styles of thinking among different individuals and demographic groups (Turkle and Papert, 1990).*

understanding of something develops, we need to examine the something as well as the person in the process of understanding it (Papert, 1980, p. 158). In Piaget's "genetic epistemology," ideas can be broken down into component elements, and conceptual structures reflecting the elements grow from one another.

For example, in studying how children come to understand mathematical ideas, such as what a number is, Piaget et al. articulated three "parent structures" having to do with algebraic relations, order, and topology. Algebraic structures include classificatory and number structures; order structures include series and serial correspondences; and topological structures are based on notions of neighborhood, continuity, and limit (Piaget, 1970).

Piagetians are not the only researchers to have arrived at this formulation of an "architecture of mathematics." At first independently and later in collaboration with the genetic epistemologists, Bourbaki mathematicians described in their own way how the domain of mathematics stems from the same three "mother structures," each of which comprises constituent substructures (Beth, 1966; Bourbaki, 1966; Lane, 1970; Piaget, 1970). Conversely, through combination or interaction with other structures, the basic structures give rise to more complex structures. For example, topological structures and algebraic structures together can give rise to the notion of measurement.

Topological structures have to do with relations of proximity. In order to study people's understandings of these spatial relations, researchers use different means and media. Some studies have employed the variable complexity and malleable quality of string and knots to see how the notions of *neighborhood, continuity,* and *limit* translate as *over, under, between, around,* and so on (Piaget and Inhelder, 1967; Strohecker, 1991). In these studies, a shift of scale has proven helpful in reducing the daunting opacity of complex configurations. Responding to suggestions that they imagine themselves to be a "tiny ant" walking along the surface of the knot, children have been able to maintain a sense of its continuity as they describe the proximal relations of different parts.

Can Lynch's formulations be seen as differentiation and elaboration of the fundamental concepts of space that the Piagetian and Bourbaki schools described? Although Lynch and these researchers worked at different scales and in different domains, they shared an interest in how individuals' conceptions of space grow through interactions with the physical environment. Piagetians emphasize "the part played by overt activities in building up the conceptual machinery of thought" (Beth and Piaget, 1966, p. xvi). Lynch (1960) focuses on the everyday act of moving through space and the associated problems of orientation and

wayfinding. With interactive computer technologies we can simulate contained physical worlds and study people's actions within them.

2.2. PARTICIPANT DESIGN OF VIRTUAL ENVIRONMENTS

Much of the work employing virtual environments for research on spatial cognition begins with a model of an existing physical space. Researchers ask people who interact with the virtual environment to become familiar with the layout of the model. Then the researchers ascertain how the subjects' conceptions of the model help or hinder orientation within the actual physical space (e.g., Darken and Sibert, 1996). Variables in this process include decisions about representation and rendering strategies for the model, and whether and how the subjects use a map to assist their wayfinding through the model and/or the physical space.

This genre of work poses the modeled world as a pre-existing condition, and researchers ask the subjects to find a pre-determined route through the space. Researchers base the studies on the assumption that people can acquire knowledge if it is well represented. The representational variables are extremely complex, though, and the studies' results reflect this dilemma (Darken, 1998). What if, instead, we assumed that people *construct* rather than *acquire* knowledge? What if, for example, the subjects made notations on their maps, customizing and personalizing them as they made their way through the space? What if the subjects made their own maps to begin with? Further, what if the subjects helped to build the model?

Such approaches are appearing in another milieu, which has roots in text-based MUDs[2] and MOOs.[3] In these domains, participants typically interact with each other, but also with the environment. Using an associated programming language, participants create characters, objects, and spaces within the world. By adding to the existing environment, visitors develop senses of place ownership and community (Morningstar and Farmer, 1991; Rheingold, 1993; Mitchell, 1995; Turkle, 1995). Indeed, Lynch's (1984) presumption that "a powerful place image can … buttress group identity" is borne out in this milieu. The so-called "inhabitants" become participant designers and builders of the virtual domain. If the concern is orientation, this context suggests a shift of focus from way*finding* to way*making*.

Image-based multi-user environments are beginning to emerge, but the important constructive capability is not easily transferred to graphical

[2] "Multi-user domains," originally dubbed "multi-user dungeons"
[3] "MUD object-oriented"

domains. Computational tools for developing images tend to be complex and sophisticated, often requiring professional expertise in order to produce a satisfying result. We need to develop easily usable tools to support participants' interactions, including world construction and navigating.

WayMaker is an early example: it is a prototypical tool for generating the structure of graphical virtual domains. As part of a larger system supporting such a domain, WayMaker would complement tools for creating characters and other aspects of the world. The current prototype uses a particular set of images and techniques to simulate a world that does not really exist, even in the virtual domain. However, with proper development, the mapmaking features could be associated with imagery for any number of graphical virtual environments. Our purpose now is to explore the usefulness of Lynch's elements in a constructive design tool and to study people's conceptions of space as represented in images of large-scale environments.

2.3. LEARNING THROUGH DESIGN

WayMaker is a "microworld"-style learning environment (Papert, 1980). In developing WayMaker and using it to encourage creative work with basic spatial structures, we are conducting learning research in a tradition originally developed by Papert et al. (Harel and Papert, 1991; Kafai and Resnick, 1996). This tradition focuses on people's construction of their own knowledge, as a parallel to constructing their own creations in the social, physical world.

Learning researchers in the growing "constructionist" tradition design and develop environments and affordances for particular kinds of constructions. People who use the tools become engaged in their own processes of designing and of realizing their designs. The researchers share Lynch's value of participant design. In one sense it takes the form of "participant observation" – that is, the researcher's direct involvement with the community or person being studied (Turkle, 1984). In another sense, subjects become partners in studying their own learning, and they help to design the environment in which the research takes place.

Constructionists emphasize the value of self-awareness of one's own learning processes. This awareness can be supported by seeking the learners' contributions to environments, both computational and physical, in which the learning activities occur. Indeed, as learners become partners in conducting research on their own learning, learning itself can become a beneficial side effect of creative activities within and upon the environment. Researchers have begun exploring these principles

in the context of computational multi-user domains (Bruckman and Resnick, 1995; Shaw, 1995; Strohecker, 1995; Turkle, 1995; Bruckman, 1997; Strohecker, 1997; Evard, forthcoming). Graphical domains may lend themselves particularly well to studies of spatial relations.

WayMaker users create their own maps to reflect memories of places they have been or designs for places they would like to be. The activity is conducive to thinking and learning about spaces and spatial relationships. WayMaker, like any microworld, must be used in social contexts over relatively long periods of time in order for self-reflective learning to occur and for trusting relationships to develop among the participants (including researchers), so that learning processes can become evident.

3. Criticisms of Lynch's Study

Following publication of Lynch's (1960) study, critics questioned its sample size, the research method, a perceived threat of cognitive research to designers' creative potential, and the premise of wayfinding as the primary concern in people's knowledge of urban spaces. Later there were other criticisms: that Lynch and his colleagues had neglected individual differences among observers, that they had elicited a static image rather than a sense of the dynamism in people's experience of space, and that the focus on structure left out a sense of the "meaning" inherent in that experience. Lynch (1984) addressed these critiques along with one of his own, that the studies proved difficult to apply to public policy.

Here we examine each criticism and address its potential relevance to studies conducted with WayMaker.

3.1. SAMPLE SIZE

Many felt that the sample size – just thirty people – was too small to warrant generalization of the results. In the years following publication of the study, however, researchers replicated it in different places, with many people over time. Researchers found that place images are modified by culture and the observer's degree of familiarity with the environment, but the basic elements of the image hold. Furthermore, a broad range of people responded well to the techniques of eliciting and analyzing the environmental image: people enjoyed talking about their mental images, representing them through map drawing, comparing them with photographs, and walking with researchers through the physical spaces they had described.

Qualitative research methods are often criticized because they defy the objectivist position of the "scientific method." In qualitative research, the relationship between the researcher and the subject is of key importance: the data emerge through their interactions. The researcher has to assume a certain humility and self-critical pose in order to achieve sufficient distance to analyze the data, and this analysis is nearly synonymous with interpretation – another process fraught with subjectivity.

Mitigating these dilemmas are modes of practice that help to gauge appropriateness of problems and approach (Piaget, 1951; Berg and Smith, 1985; Turkle, 1984; Turkle and Papert, 1990; Strohecker 1991). It is important to remember that qualitative and quantitative methods are appropriate tools for different purposes. Qualitative studies often identify proper questions, which once formulated can fuel quantitative studies that yield measurable results. Well-grounded qualitative studies have been characterized by:

> (1) direct involvement with and/or observation of human beings or social systems;
> (2) commitment to a process of self-scrutiny by the researcher as he or she conducts the research;
> (3) willingness to change theory or method in response to the research experience *during* the research itself;
> (4) description of social systems that is dense and thick and favors depth over breadth in any single undertaking; and
> (5) participation of the social system being studied, under the assumption that much of the information of interest is only accessible to or reportable by its members.
>
> (Berg and Smith 1985, pp. 24-25)

Small sample sizes lend themselves to frequent, open-ended encounters between researcher and researched, their development of trusting relationships, and production of "dense and thick" descriptions. Studies employing WayMaker, at least at first, will rely on relatively small numbers of participants. The studies require well-selected, well-tended user groups. Among the participants may be neighborhood or town groups interested in issues of zoning, construction, and the like; Lynch's own (1984) pairing of low-income teenagers and middle-class professionals living in the same urban setting; inhabitants of virtual communities; and SimCity players, whose observations of differences between the software construction kits can elicit thinking about the spatial relationships each helps to represent.

3.2. TECHNIQUES

Some critics claimed that the techniques of office and field interview, of photo recognition, and of map drawing were inadequate to get at the true mental image. Furthermore, they pointed out that drawing is difficult for most people, so many attempts at representing the image would not be able to capture it. Lynch replied that

> …although each method may elicit only a piece of the internal picture, and that may be distorted as well as partial, yet, if a sufficient array of probes is employed, a composite picture develops that is not very far from the truth. Of course, it may only be the tip of the iceberg, whose base is hidden far below, but the tip is the tip of a real iceberg, nonetheless. Luckily for us, the environmental image is usually not a painful subject for most people, something to be defended by unconscious barriers. People like to talk about it.
>
> (Lynch, 1984, p. 154)

WayMaker is an addition to the repertoire of tools that researchers can use in eliciting images and other data on people's conceptions of space. People who do not like freehand drawing may prefer WayMaker's CAD approach, but even for those who do like to draw, the tool can become another "probe" to reveal, record, and animate an environmental image.

Like Lynch's studies, ours will supplement imaging techniques with verbal comments and discussion. Photographs and walks through a represented physical space continue to be appropriate. Even knot-tying may augment the repertoire. Changes of scale will be important in elucidating consistencies in individuals' thinking about space.

WayMaker is limited by the number and kind of built-in choices for representing detailed characteristics of elements. However, the tool enhances the imaging process with simultaneous displays of the aerial-view map and associated ground-level scenes. The dynamic "you are here" map, which tracks the viewer's location as the scenes play out, should help to focus discussions on expectations of proximities between image elements. Furthermore, the ability to go back and forth between mapmaking and viewing modes may help people to generate a more deeply refined image. Beyond modifying a sketch on paper, this back-and-forth between scales, views, and representations provides rich opportunities for comparisons and adjustments.

3.3. USURPING DESIGNERS

Some designers feared that the knowledge of psychological processes in perceiving and representing cities would somehow usurp their creative skill. Such anxieties recall the proverbial caterpillar whose reflections on how his own legs coordinate rendered him unable to take a step.

This sort of fear tends to emerge wherever psychological work is done: at first the mystique surrounding human expertise seems somehow sacred, preferable to articulations of the gritty, complex, behind-the-scenes processes that motivate the work and get it done. Gradually, though, the unfolding understandings help to improve practices. This was Lynch's intuition; he claimed that perception studies could support and enrich design.

He hoped, however, that the studies would indeed change the way urban designers went about their creative work. By demonstrating that inhabitants of a place were conceptually and emotionally bound to it, he hoped to impress designers with the need to include inhabitants as participants in the design process. He saw this aim as enrichment rather than usurpment. WayMaker's designers have the same aim.

3.4. WAYFINDING AS THE FOCUS

Lynch's study focused on wayfinding, but many said that this is a secondary problem for most people, who if lost would simply ask the way or consult a map. Even if the study adequately analyzed the nature of the images based on wayfinding, said these critics, it only assumed their importance but did not demonstrate it.

One might argue that people who rely on others for directions or refer to maps solely prepared by others would not develop as clear a mental image as those who connect, test, and adjust their conceptions through actions in the world. Lynch accepted the criticism that his work never demonstrated the importance of wayfinding, without explaining his implicit assumption positing actions as the means through which conceptual structures grow. The Piagetian literature could have provided evidence and language supporting this assumption.

Lynch did, however, cite the subjects' expressions of delight in working with the researchers and talking about their mental images, as affirmation of his belief in another basic assumption: that recognition and knowledge of place are pleasurable, that self-identity is important in psychological development, and that "self-identity is reinforced by a strong identity of place and time" (Lynch, 1984, p.155). Examination of these ideas with respect to Winnicott's (1965) notion of the "holding environment" in emotional development is beyond the scope of this paper – but again, a researcher's work in another domain could have supported Lynch's assumption. Again, the comparison pertains to

operation of similar conceptual structures that occur at different scales of spatial experience.

WayMaker is premised on an explicit version of Lynch's assumption: wayfinding is translated as a set of creative actions. People make their way literally as well as figuratively through the designed environment. This constructive purpose will be made even more explicit when/if the tool is situated in a graphical virtual domain that grows as participants' productions extend the environment.

3.5. OBSERVER VARIATION

Lynch's study did not account for variation among observers. This neglect was deliberate and explicit. Instead, the aim was to focus on visual form and

> …to show that a given physical reality produces some common images of place. … Image variation among observers – due to class, age, gender, familiarity, role, and other such factors – was expected to be a finding of subsequent studies. Indeed it was.
>
> (Lynch, 1984, p.156)

The finding did not necessitate a change in formulation of the five basic elements of the city image, however.

Today, uncovering variability in individual perception is one of the points of research in spatial cognition. Strohecker (1991) described this variability among knot-tyers in terms of an implicit preference for a particular mathematical structure as it pertains to spatial relations. Among productions by initial WayMaker users we already see different approaches: organizing paths around nodes, placing landmarks at regular intervals through a district, and so on (Strohecker and Slaughter, 1999). These users were imaging different physical layouts, but how such design decisions may also pertain to varying ways of perceiving spaces remains to be seen.

Differences in individual perceptions are not well understood, but people do realize that such differences are powerful. Their importance is borne out by popular adoption of a mode of visual representation launched by the cartoonist Saul Steinberg in his cover for the *New Yorker* magazine years ago. "The New Yorker's view of the world" shows an aerial view of a landscape spanning from the East Coast of the United States to its West Coast. Tall buildings and other recognizable landmarks in New York City are shown in fine detail. Large amounts of representational space are devoted to distances between New York and other eastern cities, but the distances between cities diminishes

progressively as we look farther west. Detail reduces, too, as we look west, until San Francisco appears as a tiny dot on the horizon. How designers can reconcile differences in individual perceptions with the need for a collectively acceptable aesthetic of urban form remains a question.

Perceptions of urban form may change with individual priorities. For example, if an observer is interested in features of a small district, it may seem bigger than another district that measures larger but seems less interesting. In later versions of WayMaker, we may provide an affordance for adjusting the number of steps along a given path segment to prolong or shorten the experience of a particular district.

3.6. STATIC, MOMENTARY IMAGES

Critics complained that Lynch et al. elicited a static image, a mere momentary pattern rather than a dynamic mental model, which would better resemble the experience of a space. This dynamism can occur as the observer thinks of moving through the image, or the image itself can change as the observer's conceptions or priorities shift with time, or as the physical environment changes.

WayMaker has affordances for representing each of these conditions. The user can reposition and rescale elements as his or her perceptions change. The user can also save different versions of a map for recording different images of an environment or a changing environment. Viewers can go back and forth between a map and its views to make adjustments, thus capturing perceptions in greater depth and better elucidating them for studies of understandings of spatial relationships. Finally, WayMaker sets maps into motion by illustrating views along the pathways. In the current prototype these views do not realistically resemble a walk through the domain, but they capture senses of scale and movement sufficient to support discussions of topological relationships among the image elements.

The combination of map and walkthrough gives some sense of the "dynamic nature of perception" and underscores the principle that designing and building are ongoing processes (Lynch, 1984, p. 157).

3.7. STRUCTURE WITHOUT "MEANING"

> The original study set the meaning of places aside and dealt only with their identity and structuring it into larger wholes. It did not succeed, or course. Meaning always crept in, in every sketch and comment. People could not help connecting their surroundings with the rest of their lives.
>
> (Ibid., p. 158)

"Meaning" in the context of urban experience is both personal and social. We plan to use the WayMaker prototype with neighborhood groups and in other social contexts. Eventually, when situated within a graphical virtual environment, WayMaker will have to rely on complementary tools to afford other kinds of constructions and social interactions among the participants. WayMaker's structural representations alone cannot describe the many facets of a human place.

Lynch complained:

> …this study, whose principal aim was to urge on designers the necessity of consulting those who live in a place, had at first a diametrically opposite result. It seemed to many planners that here was a new technique – complete with the magical classifications of node, landmark, district, edge, and path – that allowed a designer to predict the public image of any existing city or new proposal. For a time, plans were fashionably decked out with nodes and all the rest. There was no attempt to reach out to actual inhabitants… As before, professionals were imposing their own views and values on those they served. The new jargon was appropriated to that old end, and its moral was stood on its head. Instead of opening a channel by which citizens might influence design, the new words became another means of distancing them from it. Indeed, the words were dangerous precisely because they were useful. They afforded a new way of talking about the qualities of large-scale form, for which designers had previously only inarticulate feelings. … [Later work] showed how these same image techniques could be used as a means of participation. In a few cases, image studies are now used that way, but the first effect on city design was often pernicious.
>
> (Ibid., p. 156-157)

Although designers have now "gone on to other fashions," many critics blamed Lynch for the apparent failure of his analysis when it was inverted as a technique for design. However, Lynch (1960) had prefaced his report with the caveat that the elements are abstract and only structural, stripped of detail and personal meaning. He had also pointed out that these other features are essential in the overall experience of an urban environment.

A similar critique was leveled against Alexander et al. (1977), though their "pattern language" was fully intended as a design tool. As such, it includes far more detail than Lynch's skeletal set of elements: there are more than two hundred patterns in Alexander's set, ranging in scale from ring roads and shopping webs to alcoves, roofs, and bed clusters. Developers of the pattern language included aspects of experiential detail and personal meaning along with structural features and recipes for assembling the patterns into designed environments. Nevertheless,

perhaps because a whole is inevitably greater than the sum of its parts, most environments designed with the technique have been deemed unsatisfactory, and pattern languages in architecture have fallen into disrepute.

The software community is waging a similar debate. Gamma et al. (1995) have formulated software "design patterns," blocks of code that programmers can reuse in building different kinds of systems. Reuse saves programmers the effort of coding the same functionality over and over again, and can significantly reduce the cost of developing large software systems.

Gabriel (1994) and others have criticized this trend, invoking the failures of Alexander's pattern language. It is true that the profferings may be variable in quality: some of Gamma's software patterns address more general needs than others, and therefore may provide better solutions than the more specific patterns. Furthermore, in adopting this approach to software development, programmers run the risk of abandoning problems too quickly for an easy solution. Programmers could too readily cast a problem in terms of some other, more familiar problem, and software code could become littered with clichés.

There is also a problem with this critique, however, which may stem from an unfortunate use of terms. Code programmers – software engineers – are the ones concerned with Gamma's patterns. In analyzing code, good software engineers cringe when they encounter problems that are inappropriately framed and solved. Those who advocate the use of patterns also advocate that they be used judiciously. However, the logistic and semantic experiences of the code have little to do with the experience of the person using the application that the code generates. That person deals just with the user interface. The content and style of WayMaker's code, for example, are entirely different from the look and feel of the user interface, where we present graphic representations and functional affordances. The user's experience and the code that generates it are at different levels of activity and purpose.

"Software design" is a term coined for shaping the user's experience (Winograd et al., 1996). With respect to this term, perhaps Gamma's coding recipes would more clearly be called "engineering patterns," rather than "design patterns." This distinction is important. Using coding patterns to simplify a hidden building process is different from using conceptual elements or patterns to generate an environment at the same level as people will experience it. Designing at the experiential level was Alexander's agenda, and indeed, part of Lynch's at a certain point: "We hoped to think about what a city should be, as we were looking for possibilities for designing directly at that scale" (Lynch, 1984, p. 151).

WayMaker also encourages designing at the experiential level, but it depicts the overview and walkthrough differently, bringing out two senses of scale within the overall scale of the urban landscape. We think that this shift of scale will prove helpful in eliciting and developing understandings of spatial relations. Furthermore, WayMaker's focus on structure must be tempered by use in social, participatory contexts.

In casting Lynch's elements as a vocabulary for designing and experiencing the structure of large-scale spaces, we attempted to move beyond the potentially sterile feeling that abstract representations of the elements could engender. That move, of course, was only as effective as the concrete images we were able to provide, along with the user's willingness to suspend disbelief and imagine an environmental structure based on those images.

Among possibilities for users to represent elements concretely are bridges or trees for landmarks, mountains for edges, and "flavors" of character for districts and of activity for nodes. There are many more. Nevertheless our set of images might not include a particular representation that a user may want. The same is true of the composited images in the walkthrough views. The current images, excerpted from Cézanne paintings, result in a very particular look and feel.

We could, of course, develop other sets of concrete imagery to associate with the tool, though this effort is not trivial. Providing other imaging tools with which users could create or import their own representational imagery is an interesting possibility. In fact, many people have said they would like to scan and segment their own photographs to create a personalized database that WayMaker could access in compositing the views. In any case, when/if WayMaker is associated with a graphical virtual domain, the representational imagery would be associated with whatever theme organizes the environment and attracts its inhabitants. Most importantly, the mode of use will be one of participant design. Inhabitants will assert their membership in the community by adding structure and representational detail to the shared environment.

3.8. PUBLIC POLICY

Lynch puzzled over the difficulty of applying results of the (1960) study to public policy: "This difficulty is strange, because the principle motive of the whole affair was to change the way in which cities were shaped: to make them more responsive to their inhabitants" (Lynch, 1984, p.158).

Realizing the elements of the city image as part of a design process for graphical virtual environments may provide the seeds of change. Young people tend to be more accepting of new technologies than older people,

and often are more skilled at using computational tools. As social virtual worlds become more prevalent and their young constituents grow with the medium, the model of community development based on participant design may become better understood and accepted.

Virtual communities tend to be topical, which leads to a kind of homogeneity even among otherwise diverse participants. This may prove to be another advantage: Lynch's "techniques are more telling in smaller, more homogenous communities, or in dealing with tourists, who are more dependent on overt visible cues" (Ibid., p. 159). Virtual domains typically have a balance of inhabitants and visitors, which may be analogous to a blend of homogeneity and tourism. Ultimately, WayMaker's part in this venue could help to "[open] a channel by which citizens might influence design."

4. Potential Contributions of Studies Employing WayMaker

There is much to be done before WayMaker can be situated within a graphical multi-user environment. Nevertheless, the emergence of such environments points to development of new notions of place and community.

> What is usually called urban design today is more often large-scale architecture, which aims to make an object in one sustained operation, according to the will of a gifted professional. … True city design – dealing directly with the ongoing sensed environment of the city, in collaboration with the people who sense it – hardly exists today.
>
> (Ibid., p. 160)

Maybe today's interactive computer and communication technologies will become seeds of change in this regard.

Meanwhile, studies with the current WayMaker prototype can address use of the elements of the city image as the basis for a design tool, and can yield data on people's understandings of spatial relationships within large-scale environments.

Lynch (1984) called for longitudinal studies to enable better understanding of how people's environmental images develop. This approach is consistent with learning research methodology, though researchers do not often have the opportunity to work with the same subjects periodically over time. Nevertheless, this is what we must try to do in order to understand the nature and growth of conceptual structures (Strohecker, forthcoming).

Lynch's elements are essentially topological: his descriptions of districts, edges, paths, nodes, and landmarks rely on concepts of neighborhood, continuity, and limit. We have data from Piaget and Inhelder (1967), Caron-Pargue (1983), Strohecker (1991), and others on articulations of these concepts in small-scale domains. Studies employing WayMaker should provide additional data on such articulations and how they may be elaborated at the larger scale of human environments. How these data may show Lynch's elements to be differentiations and/or elaborations of the mathematical structures remains to be seen. Results showing connections between mathematical concepts and visual and experiential sensibilities could help to enlighten our mathophobic era.

Figure 6. *The curious appeal of scenes generated by WayMaker may help to interest people in participating in studies that employ the prototype.*

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