ON LYNCH'S AND POST-LYNCHIANS THEORIES

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Abstract. *The researches in the field of spatial cognition have grown steadily since the sixties (XX century). Architects, urban planners, geographers, anthropologists and psychologists have attempted, from their different points of view, to characterize those attributes of spatial environments that constitute for them a great source of experience. These are highly multidisciplinary experiences dealing with the interaction between humans and their environment at many levels. The task of this paper is to give an overview of Kevin Lynch's theory of 'urban form', as set out in the book 'Image of the City' (1960). This book is crucial among all the literature about the look of cities. Lynch introduced the importance of human vision and our analysis has the task of elucidating this importance today. It is an important study, following on from which several new theories have been developed. More important, is the theory of cognitive perception of the urban environment and more specifically - cognitive mapping; in the domain between space representation and cognitive psychology. This paper explains concepts concerning cognitive maps, and provides some comments on them as an review of post-Lynchians theories and some related computer-based applications.*

Key words: *urban environment, cognitive psychology, spatial cognition, cognitive mapping.*

1. INTRODUCTION

Kevin Lynch (1918 – 1984) was the first author who focused his work on visual elements and cognitive concepts of the urban environment. In his books – we will mentioned here only a few well-known works such as *The Image of the City* (1960), *The View from the Road* (together with Appleyard and Mayer, 1964), *What Time is the Place* (1972), *Managing the Sense of Region* (1976) and *Good City Form* (1981) – a rich, innovative way of conceiving of the urban environment was presented with a deep design knowledge that changed the attitudes of both professionals and scholars. His books integrated a theory of *urban form* that consists of physical and psychological elements, which was a new approach distinct from the urban theories of the time.

2. LYNCH'S THEORY OF URBAN FORM

In Lynch's book 'Image of the City' (1960) [1] he introduced the theory of *urban form*. An urban environment is a complex system of interactions between people (users) and various surrounding objects. Lynch describes the user as a *citizen* who "*has had long associations with some part of his city, and his image is soaked in memories and meanings.*" He then explains users as "*moving elements in a city, and in particular the people and their activities, are as important as the stationary physical parts.*" Objects, the physical elements of the environment, represent the perceptual form of the city in this interaction with users. Lynch described two things important for a subsequent explanation of the whole theory: first, physical elements of the city and second, the psychological, mental image of the city.

Lynch distinguished physical elements into natural and man-made elements. Natural elements, such as air, sky, rivers, lakes, ponds and hills are all elements that exist in nature that man uses and interpolates in his 'built elements'. Built elements are: infrastructure, objects, vehicles, airplanes, and so on, i.e. all objects that man makes by his intention and that physically exist in the perceived environment, as static or dynamic objects. All together, natural and man-made elements are characterized by common characteristics, such as color, smell, noise, warmth, and so on, which build a perceptual form of the urban environment.

The visual quality of the urban environment, in Lynch's theory, relates to the physical elements of the environment and the mental image of its users. Users perceive an urban environment in its fragmentation into elements and patterns. All perceptions are different and special, and are related to users' knowledge, experience or familiarity with an urban site. Almost every sense is in action all of the time. The visual qualities of some elements and features are used as generalities in the process of navigating in the urban environment. Lynch considers the visual quality of the city "*by studying the mental image of that city which is held by its citizens.*" The visual quality of the city is concentrated in four elements in Lynch's theory [1]:
  − *legibility* - is defined as elements whose parts can be recognized and organized in a coherent pattern or symbols*,*
  − *building the image* (*image*) - the image of a given urban environment may vary between different observers (users) and it is an individual mental image as the result of a two-way process between the observer and his environment,
  − *structure and identity* (*identity*) - were defined by Lynch as an environmental image that can be analysed into three components: identity, structure and meaning and they are in reality always appear together, and
  − *imageability* - is defined as the "quality in a physical object which gives it a high probability of evoking a strong image in any given observer.

Lynch also analyzed the effects of physical, perceptible objects, and from this the five elements of the urban environment were derived. In his theory he does not explain all other influences of an urban environment on imageability, such as social meaning, functionality, tradition, names, and so on. The five elements derived from the analysis of urban objects in Lynch's theory are [1]:
  − *paths* - are the channels along which the observer customarily, occasionally, or potentially moves, they may be streets, walkways, transit lines, canals, railroads*,*

− *edges* - are the linear elements not used or considered as paths by the observe, they are the boundaries between two paths, linear breaks in continuity: shores, railroad cuts, edges of development, and walls*,*

− *districts* - are the medium-to-large sections of the city, conceived of as having two-dimensional extent, which the observer mentally enters 'inside of', and which are recognizable as having some common, identifying characters*,*

− *nodes* - are points, the strategic spots in a city into which an observer can enter, and which are the intensive foci to and from which he is traveling, they may be primarily junctions, places of a break in transportation, a crossing or convergence of paths, moments of shift from one structure to another, and

− *landmarks* - are another type of point-reference, but in this case the observer does not enter within them, they are external, and they are usually a rather simply defined physical object: building, sign, store, or mountain; some landmarks are distant ones, typically seen from many angles and distances, over the tops of smaller elements, and used as radial references.

After describing the basic directions of his theory, Lynch carried out an analysis of three American cities (Boston, Jersey City and Los Angeles). In this analysis he transcribed the urban information into elements of a unique graphic sign system. Figure 1.1. presents Lynch's process of describing syntax and relations in the visual communication process in his theory, and presents the syntax process of the mental visual system in the process of *cognitive mapping* by a user of the urban environment. Figure 1.1. also indicates two categories of maps: *permanent* and *temporal*. A *permanent map*, in the sense of Lynch's theory, is a map created by graphic representation for different, mostly permanent tasks. This map is traditionally presented in a two-dimensional medium (usually on paper), such as a topographical or city map. This map can also be a graphical representation of the process of cognitive mapping. A *temporal map* is the mental interpretation of images (objects) of a particular space by a process of cognitive mapping. This *map* is always temporal, memorized as a mental vision of a particular space in the human brain. This map is not a traditional map but it can be graphically interpreted in a traditional way.
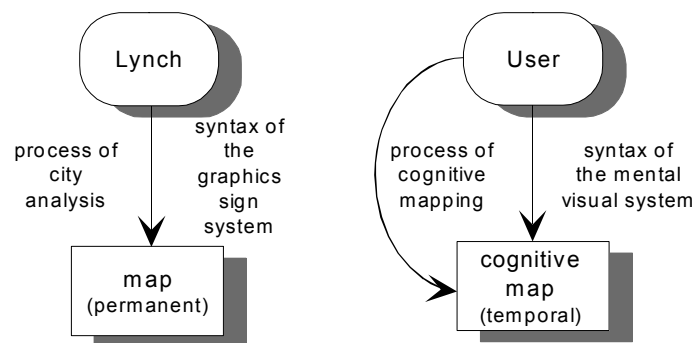
Fig. 1. Syntax in the visual communication process in Lynch's theory

3. THE CONCEPT OF COGNITIVE MAPS

The term 'cognitive map' was first used by Tolman (1948) [2], who used it to account for the behavior of rats in a maze that escaped and ran across the top directly to the food source. The rats had obviously integrated information about travel through the maze into a representation of its layout. It was previously thought that a maze is learnt only in terms of left and right turns at particular points.

Since Tolamn's experiment, many studies on the nature of cognitive representations of space have been carried out. Here are a few theoretical models of cognitive representation of space derived mainly from different works on visual imagery [3]:

  − literal map in the head: space is represented in a spatial way in the brain,
  − functional map in the head: space is represented non-spatially (as propositional knowledge), but the representation functions identically to a map,
  − unlike a map: space is represented non-spatially, but also does not really function as a map at all (spatial events directly influence our actions in space), and
  − hybrid representation: different forms of representation are used for different areas, different scales, different functions (procedural representation on a large scale).

The perceptual quality of the environment reflects on the human mind, in many senses. Humans *recognize* an environment (space) by the reflection of shapes, light and depth. Humans *orient* themselves in an environment by identifying the environment by its *elements* and *patterns*. Humans make a *mental interpretation* of an environment by memorizing and retrieving elements of the environment and patterns in their brain. This process is defined as cognitive maps.

A cognitive map is an association of the cognition of environmental structure and properties of subjective meanings of the environment. The main characteristics of environmental perception are:

  − size and complexity: the environment cannot be perceived all at once and is generally so complex that it takes some time to gain full experience of it,
  − surrounding: because the environment surrounds us, we experience it from within, we move around, in and through the scene and are in a sense part of it, and
  − purposive connection: we generally interact with the environment with a specific goal or plan in mind.

Environmental perception is different from perception of an object. Humans perceive an object in totality - all at once with all complexity of it. Humans can experience an object with its surroundings and with purposive connections. Humans even move objects from one place to another and change the context of objects.

Lynch made the definition of the environmental perception as that city elements *operate together, in context*. The recognition of an object is as much dependent on a context as on the form of the object itself. He also defined all urban elements as arranged and interrelated in four structural stages [1]:

  − the various elements are free; there is no structure or interrelations between parts,
  − the structure becomes positional; the parts are roughly related to each other,
  − most often, the structure is flexible, and
  − as connections multiply, the structure tends to become rigid.

Lynch also proposed a method which was developed on the basis of research conducted in two ways: first, urban residents were interviewed about their city and asked to

draw sketch maps (cognitive maps by the process of cognitive mapping); second, trained field workers were sent out on foot to make detailed plans of the city with the five elements and their interrelationships in mind. All the data were analyzed to determine [1]:

– what were the distinctive features of each city and which areas were more or less legible, and
– how well the field maps compared with the aggregate maps of the interviewees.

He also found that different parts of the city were differentiated in terms of their legibility, defined as the strength of imageability of elements and of the structural interplay between elements. From these maps and from the rich detail included in the interviews, Lynch went on to outline a set of criteria for improving the legibility of elements and structure.

Tzonis and Lefaivre [4], nicely concluded that "*during the 1980s the research on spatial thinking was joined with developments in artificial intelligence and machine-based simulation of pattern recognition, spatial memory, problem solving and 'navigation', and Lynch's notion of cognitive mapping became a frequent reference in this developing literature. As these studies find their way today to a cognitive theory of design, the significance of Lynch's contribution becomes even more indisputable than ever. We are just beginning to suspect the possibilities that his pioneering method offers*."

4. POST-LYNCHIANS THEORIES

A scientist searches for information related to things that can be used primarily in urban perception problems, which can help individuals locate themselves in urban areas and act as pointers for building images of the urban environment. An individual's conceptual structure of the urban environment will in some way conform to the physical models that have been derived from objectively analyzing the locations of segments of the urban environment.

Research into the cognitive structure of the urban environment can be subdivided into three parts [3]:

– micro-level studies: the aim of this approach is to find out how well people can locate specific points in urban areas (Golledge, Briggs & Demko, 1966; Lee, 1970; Briggs, 1971; Passini, 1984, 1990);
– the problem of determining what metric is used to measure distances in urban areas. It relies on a variety of scaling techniques to extract information from data sets. The first is exemplified in the attempt to define perceptually small areas of the city - generally described using the term 'neighborhoods' (Sarrinen, 1964; Zannaras, 1969); the second is an attempt to reconstruct a set of urban features which are observed on journeys through urban areas (Appleyard, Lynch & Meyer, 1964; Carr & Schissler, 1969; Kosslin, 1994); and
– a macro-level emphasis attempting to reconstruct maps of urban areas from the knowledge that individuals have about those places (Lynch, 1960, 1976; Kaplan & Kaplan, 1982; and others).

Planners, architects, sociologists and psychologists have been interested for various reasons in the perception and cognition of the larger environment. Perception cannot be under-

stood in isolation from values or behavior. Looking at the city as a product of different group perceptions, three theoretical models of urban perception appear (Appleyard, 1976) [5]:

  − *operational*: the environment is seen as a setting for personal action and behavior; more often elements such as traffic islands, signs, entrances etc.,

  − *responsive* to the configuration of the environment; J. J. Gibson (1979) gives the term for this kind of perception 'literal'; and *inferential* and probabilistic in nature, a generalizable coding system of environmental categories, concepts and relationships: our personal urban model.

  − Cognitive mapping is a sort of accumulation of the experience and knowledge that a person has about a familiar environment. It is knowledge for a task, knowledge with a function. It guides the behavior of the 'owner' of the map, to help the individual in whose head the map resides to be effective in the given environment. Cognitive maps store information about the environment, so that a person knows what to expect and what to do under various circumstances. A representation is a formal system for making explicit certain entities or types of information, together with a specification of how the system achieves this (Marr & Nishihara, 1978) [6]. To describe a representation as a collection of salient features weighted in terms of their importance, is essentially the same as calling it an average, or summary, of the experience that led to it (Kaplan & Kaplan, 1982) [7]. Representation also means an internal summary of a class of stimulus patterns. Its role is to take the place of some object in the real world (i.e. urban elements), and to represent it. The modeling of the material and social world and of human behavior is a complex and ambitious task. It demands first of all a clear distinction between the concepts of *model* and *simulation.* Modeling and simulation are two complementary ways of representing a process, which can be either physical or cognitive. A *model* is essentially a theoretical description of a process or system, based on a number of hypotheses and simplifying principles, which can be formulated as analytic or lexicographic expressions (the model language). A *simulation* is a concrete expression or instantiation of the model in a form that is controllable or executable, for example, for a practical application or for computation (Hollnagel, Cacciabue & Hoc, 1995) [8].

There are many possible ways to store information, to structure people's knowledge. It is exciting because the actions people take, the decisions they make, their hopes, their fears, their aspirations are all based on their conceptions, on their models of the world. Forrester (1971) [9] captured the impact people's models have on their choices and actions very effectively: *"A mental image is a model. All of our decisions are taken on the basis of models. All of our laws are passed on the basis of models. All executive actions are taken on the basis of models. The question is not to use or ignore models. The question is only a choice among alternative models."*

A conceptual model is a kind of system model that combines the properties and functionality of both a mental model and a real operating model. Models of human cognition have been developed in order to predict human behavior through computer simulation (Kjaer-Hansen, 1995) [10].

Contemporary computer-based technologies can help us to solve difficult, real-world problems, to create new opportunities in many areas, to help in analyses of the visual quality of the urban environment according to cognitive mapping. Recently, some of the Lynch's followers adopted his theory to build up new theoretical and applicable (computer-based) approaches. Here we will shortly introduce the three main applications. The

first application is called 'WayMaker', the second one is 'web based mapping and survey tools' and the third one is 'Design Tool'. All applications are interesting in the way they use, interpret and implement the theories in computer-based tools.

'WayMaker' is an application produced as a result of the research of MERL[1]. 'Way-Maker' is a tool for non-professionals to create digital layouts for large-scale graphical virtual environments. The tool is based on Lynch's elements of city images. The tool is supports Lynch's value of participatory design, while enabling an extension of his efforts to understand how people 'image' and 'think' about the city. From a verbal and pictorial account, 'WayMaker' uses Lynch's elements to address a current problem in virtual environment design, which is becoming commonplace. 'WayMaker''s maps and scenes depict only the large-scale structural features of a space. The system transforms the user's map design into a street-level scene representing a walk through the domain. "WayMaker" could easily use an alternative 2D database for the walkthrough scene, from real images to very abstract ones. The current depiction of scenes in 'WayMaker''s virtual space is independent of the question of whether or how Lynch's formulations may be broadly useful as a basis for design and construction tools for the virtual world. 'WayMaker' might be used in social, participatory contexts in the task of developing an understanding of spatial relations within an urban environment.

Al-Kodmany [11] and urban planners and designers from the University of Illinois at Chicago (UIC) were invited to be part of a participatory community-planning process in the Pilsen community, Chicago. The team developed a planning method based on the work of Jack Nasar [12], by using new interactive GIS technology on the World Wide Web (WWW). They created a Web-based survey to show how people would respond to 'urban likability and dislikability' (ULD) for the Pilsen community. Participants simply logged on to the Website where they could view a map of the area. They were asked to identify and point out areas of their community on the map that they most liked and disliked by clicking on the appropriate square of the grid, and to provide reasons for their responses. Using a Web-based survey made mapping the result easy. An Oracle database is use and be linked to a GIS application. This connection provides a capability for automatically plotting all available information from users to the map. The database system can also group the associated comments of users. The survey GIS map was then created from this data. This pioneering project uses Web-based technology to support participatory planning and design. This tool has the potential to connect planners and researches that are separated geographically, even from different countries. Also, the survey could be adapted to deal with other environmental aspects to be used, for example, in agriculture, transportation and so forth. The most significant impact of the tool is in the field of transforming public participation efforts.

'Design Tool' is the proposed application as the result of the PhD research[2] of Predrag Šiđanin [3] which also has its starting point in Lynch's theory. Lynch's theory of 'urban form' and its hierarchical structure of main urban elements were applied, together with his concept of 'cognitive mapping', to a conceptual model of the 'Design Tool'. The conceptual model of the 'Design Tool' ware supported by an Object-Oriented Database system

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[1] MERL - Mitsubishi Electronic Research Laboratory, Cambridge, MA.
[2] Research is finalized at DKS research center, Faculty of Architecture, University of Technology, Delft, The Netherlands

(OODB) and a GIS database, which constitute a functional model of the tool. The 'Design Tool' is aimed at urban planners and designers with the task of analyzing an existing or planned urban environment. 'Design Tool' can be also supportive for analyses and tests of middle-scale urban environments in very early, or very late phases of the design process. The 'Design Tool' can be used for testing the visual quality of the urban environment by using multimedia data as input, as well as output, of the system, and can offering the possibility of accessing different remote databases via the Internet.

There are some similarities between the three introduced applications. The first and main similarity is that they use the same theoretical resources: Lynch and some post-Lynchins theories, like Nasar's 'evaluative approaches' theory. The second similarity is the same field of interests of the tools: an urban environment and its visualization. The final possible similarity could be their use of a methodology that results in 'research applications', which could be almost directly useful in practice. All three of the presented design tools are still termed 'pioneering in the field' in the period of their development.

5. CONCLUSION

This paper briefly described Lynch's theory of urban form and some other related, post Lynchians theories and the concept of 'cognitive maps'.

First we explained Lynch's theory of *urban form* with its main characteristics and elements that belong to the visual quality of the city: *legibility, building the image (image), structure and identity (identity)*, and *imageability*. We then briefly explained the five elements of the urban environment: *paths, edges, districts, nodes* and *landmarks*. In the next part of the paper, we explained the general concept of cognitive maps, which play a crucial role in Lynch's theory, which relate to individuals and their capacity for memorizing and retrieving information about a familiar environment. Last section of the paper was shortly explained some of the main post-Lynchian thinking on the topic. There we indicate different theoretical approaches related to cognition, spatial representation, cognitive mapping, modeling and some other theories, all appearing after the publication of Lynch's theory. The final part of the paper was introduction to the tree computer-based application derived from the Lynch's or post-Lynchians theories. 'WayMaker', 'web-based mapping and survey tool' and the third application reviewed 'Design Tool', gave important information about what is going on in computational design tools. All introduced 'research applications' are also important as extended applied knowledge in urban cognition.

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O LINČOVOJ I POST-LINČOVIM TEORIJAMA

Predrag Šiđanin

Polje istraživanja prostorne kognicije se konstantno uvećava od šezdesetih godina prošlog veka. Arhitekti, urbani planeri, geografi, antropolozi i psiholozi pokušavaju, sa različitih tački gledišta, da okarakterišu atribute prostornog okruženja koji su za njih veliki izvor iskustava. Ona su jaka multidisciplinarna iskustva koja se na mnogim nivoima odnose na interakciju između ljudi i njihovog okruženja. Cilj ovog teksta je da podseti na teoriju 'urbanih formi' Kevina Linča, postavljenu u knjizi 'Slika jednog grada' (1960). Ova knjiga je svakako najznačajnija od sve literature vezane za izgled grada. U njoj nas Linč uvodi u važnost ljudske vizije a zadatak naše analize je da osvetli njen uticaj danas. Knjiga je neosporno značajna studija iz koje je nekoliko novih teorija razvijeno. Najvažnija je svakako teorija o kognitivnoj percepciji urbanog okruženja a posebno se izvaja kognitivno mapiranje, koje pripada domenu unutar reprezentacije prostora i kognitivne psihologije. Ovaj članak između ostalog objašnjava koncepe kognitivnih mapa, ali i prikazuje komentare na njih kroz pregled srodnih teorija i kompjuterskih aplikacija koje se baziraju na Linčovoj teoriji.