Chapter 13
Complexity, Cognition, and Planning*

13.1 Introduction

The act of planning accompanies cities from their very origin: The existence of cities, as noted in the previous chapter was interpreted as an indication for the existence of planning. Nowadays, however, planning is a profession and scientific discipline. In this conjunction between planning and cities it is common to make a distinction between planned and unplanned cities that are often called "organic cities". American cities with their iron grid road structure as well as several of the world's capital cities are often cited as typical planned cities, and of course, new towns. A 'new town' is explicitly defined as a city or a town that was carefully planned from its inception in a previously undeveloped area. On the other hand, "old towns", old city centers such as European middle ages towns are often described as unplanned "organic" towns and cities (e.g., Hillier and Hanson 1984). But see Chap. 5 on this issue.

Planning – that is, the ability to think ahead to the future and to act ahead toward the future – is also a basic cognitive capability of humans. Psychologists and cognitive scientists tend to refer to this domain as *cognitive planning*. There is a debate among students of cognitive planning on whether or not the ability to plan is unique to humans – a property that separates humans from the rest of animals. Whatever one's stand on this issue, it is clear that planning is specifically characteristic to humans.

On the face of it the domain of cognitive planning is distinct from the domain of urban and regional planning; the first is a personal cognitive capability while the second a specialized profession. The view in this chapter is that it is useful to explore the links between the two. Firstly, since professional planners are at the same time cognitive planners and this property might affect their behavior and action as professionals. Secondly, since some of the media currently introduced to city planning such as GIS, VR, and PSS as discussed in Chap. 12 above, are intimately related to AI and AL (artificial intelligence and artificial life) – two domains that were developed by insight from cognitive science. Thirdly, the current

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crisis of planning (below Chap. 15) might require a complexity-cognitive approach to planning. Fourthly, the fact that humans are cognitively planners affects their behavior in the city and as a consequence also the dynamics of cities with the implications that we have to take cognitive science's findings into consideration in our complexity theories of cities and their associated urban simulation models.

The discussion below starts with an overview on the domain of cognitive planning (Sect. 13.2) and on memory and planning (Sect. 13.3). It then links complexity to cognition and planning (Sect. 13.4), elaborating mainly on pattern recognition, decision making, cognitive mapping, SIRN, and retrospective memory. Next the discussion moves from solitary planning to collective urban planning and design (Sect. 13.5) and finally concludes with implications (Sect. 13.6) by discussing collective urban planning and design, by introducing the notion of *planning behavior* and by considering the implications to urban simulation models.

13.2 Cognitive Planning

Miller et al.'s (1960) book, *Plans and the Structure of Behavior*, is a good starting point to discuss *cognitive planning* – a research domain that studies planning as a basic cognitive capability of humans. Commencing from the information processing approach's analogy between brain as hardware and mind as software, Miller et al. see 'planning' as an hierarchical problem-solving technique that guides action, and 'plan' as analogous to a computer program for that purpose. Hayes-Roth & Hayes-Roth (1979) have added to the above view the notion of "*opportunistic*" planning that is typical of planners that respond to opportunities as they come and have also suggested a distinction between multidirectional and a top-down hierarchical planning; according to them planning is not a top-down but rather a multidirectional process.

Subsequent studies (Friedman & Scholnick 1987; Das et al. 1996) have suggested a more pervasive view of planning as a general process that includes problem solving, that in some cases is 'global' and hierarchical while in other cases 'local' and opportunistic (Ormerod 2005).

An important distinction is between *well-defined* planning (Davies 2005) where all the required information is available at the start of the planning process versus *ill-defined* planning that commences with only part of the required information (Ormerod 2005). Ill-defined decision and planning situations acted as one of the triggers to the interesting discussion on the role of *heuristics* in decision making and planning. Two lines of thought can be mentioned here: One by Newell et al. (1958), that is associated also with the notion of *bounded rationality* (Simon 1957) and another by Tversky and Kahneman (1974, 1981) in the context of their theory of human rationality for which, in 2002, Kahneman has received the Nobel Price in Economics. Tversky and Kahneman have suggested a set of five decision heuristics that people tend to employ in situations of high uncertainty. These decision heuristics and their relation to planning are further discussed in Chap. 19 below.

Similarly to other cognitive capabilities cognitive planning is based on memory, is related to other cognitive capabilities, and it implies a distinct form of behavior that has been termed *planning behavior* (Portugali 2009).

13.3 Memory and Planning

Memory refers to the ability of the organism to store, retain and subsequently retrieve information and act accordingly. It is common to distinguish between types of memory that differ in the sense that they are governed by different brain mechanisms and different brain circuits, and, in their cognitive functions and capabilities. One distinction is between *long-term*, *short-term*, and *working memory*. Another distinction is between *declarative* and *procedural* memories when declarative memory is further divided into *episodic* and *semantic* memory. A third distinction is between *retrospective* and *prospective* memory. Finally, there is the concept of *transactive memory* which refers to a memory held by an entire group of people. Here is a short introduction to the various forms of memory and their relations to planning.

Working memory, short-term memory, and long-term memory – Working memory (Miller et al. 1960) is the mechanism that enables to temporarily hold and manipulate components of current plans and planning (Ward & Morris 2005). Working memory is related to, but distinct from, the so-called short-term memory that according to Miller (1956) is constrained by the "magic number 7" to about 2.5 information bits. The relations between planning and working memory have yet to be clarified. An interesting beginning is Gilhooly's (2005) observation that most studies in this area focus on "planning in the head", thus overlooking the role of 'external memory' (Wegner 1987) in planning (e.g., paper and pencil, computer-assisted planning tools, etc.). The notion of *SIRN* (Synergetic Inter-Representation Networks) as introduced in Chap. 7 above is an attempt in this direction. Working and short-term memories are usually discussed in contrast to long-term memory and its various forms such as episodic and semantic memory that are introduced below.

Procedural and *declarative memory* – Procedural memory, also called *implicit* or *unconscious* memory, refers to the long-term memory of skills, procedures, and unconscious "know-how": riding bikes, playing music, driving a car, and crossing a street are typical examples. It can be regarded as an unconscious form of planning or rather planned behavior. The role of decision/planning heuristics might be relevant here. Declarative memory refers to long-term explicit and representational memory (Squire 2004), with further classification into *semantic memory* and *episodic memory*.

Semantic memory – refers to memory of meaning, understanding, and more generally to knowledge that is not related to specific events (Tulving 1972). From the point of view of planning, semantic memory is important with respect to causal relations and as such to planning (Fenker, Waldman, and Holyoak 2005).

Episodic memory – refers to the ability to "travel back in time" (Tulving 1983, 2002) to events, places, emotions, and experiences one encountered in the past. It is related to planning via the *time travel* ability: the same cognitive ability that enables one to travel back in time to past events, allows one to travel forward in time to planned or imagined future events. Recent neuro-cognitive studies (Spreng et al. 2009; Buckner et al. 2008; Gilbert & Wilson 2007; Buckner & Carroll 2007; Bar 2007; Addis et al. 2007; Hassabis & Maguire 2007) have speculated that such a time travel is connected to a core network (Raichle et al. 2001) which underlies cognitive abilities such as envisioning the future, navigation and planning that are "most often studied as distinct, (but) rely on a common set of processes by which past experiences are used adaptively to imagine perspectives and events beyond those that emerge from the immediate environment" (Buckner & Carroll 2007). Schachter and Addis (2007) have used the notion *constructive episodic memory* that enables us to be "remembering the past and imagining the future". The importance of episodic memory and its time travel ability to planning is emphasized in Mumford et al.'s (2001) finding that the one common element in otherwise different definitions of cognitive planning is the involvement of simulated future actions and their outcomes.

Retrospective and prospective memory/remembering – Neisser (1982) made a distinction between *retrospective memory* that refers to a remembered past and *prospective memory* which is a memory referring to a remembered future – one "remembers to remember" and then performs accordingly (Sellen et al. 1997). Prospective memory can be interpreted as a special kind of cognitive planning, namely, the realization of delayed plans or intentions (Ellis 1996). Execution of a plan that was stored in long-term memory, after a time interval, would depend first on remembering that there was a plan at all (a prospective component), and only afterwards on remembering the specific contents of the plan (a retrospective component of remembering) (Meachem & Leiman 1975/1982). Some scholars have criticized the notion *prospective memory* on the ground that it is not a genuine memory type but rather a memory task (see discussion by Graf 2001) and thus should be termed *prospective remembering*. The latter term has been originally used by Meacham & Leiman (1975/1982) to imply the multidimensionality of the task (Dobbs & Reeves 1996) and the dynamic nature of the processes involved (Block & Zakay 2006).

Transactive memory – is a concept defined by Wegner et al. (1985) to describe the memory held by an entire group (team, family etc.). The transactive memory system includes the knowledge stored in the memory of each individual together with his/her memory about the knowledge stored and skills held by others in the group. It is a social phenomenon in which information is encoded and processed through a group's communication processes, and it involves the operation of communication together with individuals' memory systems. Individuals in the group act like 'external memory' storage for other group members and over time evolves a memory system that is wider and more competent than each individual memory system. Being a property of the group itself, transactive memory therefore cannot be traced inside or between individuals (Wegner 1987). Transactive

memory and the way it develops may be seen as an underlying cognitive mechanism which is relevant to the discussion below (Sect. 13.5) on a SIRN approach to collective planning and design.

13.4 Complexity, Cognition, and Planning

The link between complexity theory, cognition, and planning follows from the fact that the brain and the various cognitive processes are commonly regarded as the *par excellence* examples of complex systems and their dynamics. Of the various complexity theories that have been applied to cognitive science, synergetics is probably the most explicitly cognitive. The title of Haken's (1996) book on this issue is indicative: *Principles of Brain Functioning: A Synergetic Approach to Brain Activity, Behavior and Cognition*. Some of the studies that are relevant to our discussion on planning are described below.

13.4.1 Pattern Recognition

Pattern recognition refers to the ability of an organism's cognitive system to recognize figures, forms, voices, and other patterns encountered in the environment. The process is implemented by the mind/brain spontaneously, that is, by means of self-organization. As elaborated in detail by Haken's (ibid) synergetics (and above, specifically in Part II), a typical pattern recognition process starts when a person (or a computer) is offered partial information of a pattern and is asked to recognize it out of several patterns stored in its memory. This offering triggers an interaction between the parts of the pattern that by means of associative memory gives rise to several configurations that enter into competition. The competition ends when the winning configuration – termed *order parameter* – enslaves the parts of the pattern and recognition is achieved.

13.4.2 Decision Making

As we'll see below in detail (Chaps. 19, 20), Haken (1996) suggested an analogy between pattern recognition and decision making in the context of planning. As in pattern recognition, a lot of (probably most) planning decisions taken by humans are ill defined in the sense that they are based on partial and insufficient information. This is also the starting point of Simon's (1957) famous notion of *bounded rationality*. Such a decision situation raises the question of "How do people complement the unknown data?" According to Haken and Portugali, as in pattern recognition so in planning decisions, the unknown data is being complemented by means of associative memory

(Haken, ibid), conceptual cognitive maps (Portugali 2005 and Chap. 6 above), SIRN and *decision heuristics*. The processes of data completion (by means of associative memory, cognitive mapping, and heuristics) are dealt with in detail in Chap. 19 below. Here, as an introduction, we discuss each of them in brief.

Cognitive Mapping. Two kinds of cognitive maps are relevant to the present discussion on planning decision making: *conceptual* and *prospective* cognitive maps (see definition in Chap. 6 above). The first refers to an image or representation of *A City*, while a prospective cognitive map, refers to one's image of a building, neighborhood, or city that doesn't yet exist or has not been visited. Such a cognitive map allows one not only to envision the planned object, but also to imagine acting in it and thus simulate and evaluate its positive or negative properties; for instance, whether the plans to expand a given city by a certain amount of inhabitants will entail an attractive, crowded, congested, rich or poor city.

SIRN Decision Making. Still in the context of the conjunction between cognitive mapping and decision making the role of SIRN should be mentioned. SIRN as we've seen above was originally developed as an approach to cognition and cognitive mapping. In Chap. 18 below we'll cast this notion into the formalism of synergetics and to the issue of decision making in the context of cities and their planning. The result would be a general SIRN decision-making model and two submodels: an *intrapersonal* submodel that refers to decision making of a single urban agent; and *interpersonal with a common reservoir* submodel that refers to decision-making dynamics of a group of planners. As we'll immediately see, the latter model can function as an approach to planning discourse analysis and to what in Sect. 13.5 below we term *collective planning*.

Decision Heuristics. The notion of decision heuristics is the cornerstone of Tversky and Kahneman's (1974, 1981) cognitive approach to decision making. According to them, when facing complex decision situations with high degree of uncertainty (i.e., ill-defined planning situations), people tend to rely on a limited number of heuristic principles. They have identified five such heuristics: *representativeness*, *availability*, *anchoring*, *similarity*, and *decision frame*. In Chap. 18 below we adapt these general heuristics to the context of city planning. More specifically, we study the similarities and differences between the pattern recognition approach to decision making and the notion of heuristics and add two more *synergetic heuristics*.

Prospective Memory as Delayed Decision Making. Finally, it is worth mentioning that Haken and Portugali (2005) have suggested applying synergetics' pattern recognition paradigm to the process of 'cue-dependent prospective memory' that as noted above can be interpreted as a special kind of cognitive planning and decision making, namely, the realization of delayed decisions and/or plans. The application involved three adaptive features: A link between retrospective and prospective memory; an analogy between the cue of the prospective plan and the small part of a whole pattern offered to a test person in the pattern recognition process; the third feature suggests that the realization of the prospective plan emerges out of a competition between existing and prospective attention parameters that compete for control over working memory.

13.5 Collective Urban Planning and Design

Planning is a basic cognitive capability. However, unlike many cognitive capabilities that are essentially solitary, personal, and subjective, planning belongs to several cognitive capabilities (e.g., "brain storming" as collective thinking) that are by their nature collective: people tend to plan together at a variety of groups' form and size, ranging from friends, families, and firms to professional planners in commercial, national, and urban planning teams. We suggest referring to such planning as *collective planning*. The full-scale study of collective planning has yet to be developed; however, several starting points already exist: the whole domain of "group dynamics" and its connection to complexity theory as in Arrow's et al. (2000) *Small groups as complex systems*; Kurt Lewin's (1943/1997) field approach to social psychology; measurement of team-shared mental models (Langan-Fox et al. 2000), collective behavior in synergetics as elaborated by Haken and applied to sociology by Weidlich's (1994) approach to the formation of public opinion; and finally, preliminary applications of the notion of SIRN to the domains of planning and urban design.

The starting point for the two SIRN applications is the discussion in Chap. 7, in particular, Figs. 7.12 (*bottom*) and 7.26 that refer to the *public, collective with a common reservoir* SIRN submodel. In developing this submodel we have made reference mainly to urban dynamics at large and to the city game (Fig. 7.7) as a simulation of this process. More recently some first steps were made towards applying this model to collective urban planning and design. However, before turning to describe these first steps a few words about planning and design are in place.

13.5.1 A SIRN View on Planning, Design, and Construction

In the domain of cities, the production of artifacts (buildings, road networks, neighborhoods, cities) commonly takes three forms: *planning*, *design*, and *construction*. While all three are processes of production, they differ in the nature of their end product: the product of planning is a *plan* such as a land-use plan or a set of policies about a given area; the product of design is some *model* of the end product, such as a graphical *sketch* of it, or 2D and 3D drawings, or a 3D physical model, or a computerized VR (virtual reality) of it; the product of construction is the end product itself, e.g., an urban neighborhood. Obviously, the three are not independent of each other: design always involves planning while planning might involve design (e.g., a land-use map/plan) but not always (e.g., when it ends with a set of policies). In a similar way, construction involves planning and design while the latter two often involve construction of a sort, but usually not of the final product.

Of the three, planning and design are commonly regarded as 'cognitive' and are thus associated with specific research domains known as *cognitive planning* as discussed in Sect. 13.4 above, and *design thinking* or, *design cognition* (Lawson 2005).

Design cognition as developed by architects, computer scientists and others, commences with the notion that the process of design is 'cognitive' due to the fact that it is associated with a whole set of general cognitive capabilities such as thinking, imaging, intentionality, planning, and the like, and specific cognitive capabilities such as visual thinking and spatial reasoning. To the latter we now want to add collective design, which can be seen as a variant of collective planning. The common view is that construction – the third step in the process of production – is not cognitive; according to SIRN as developed above (Chap. 7) it is part of cognition, too.

13.5.2 Collective Planning

Figures 7.12 (*bottom*) and 7.13 in Chap. 7 illustrate the way the third SIRN submodel has been applied to the city game and to urban dynamics at large. Another way to illustrate this process is suggested in Fig. 13.1 that in addition to describing the city game (as in Fig. 7.13) it also indicates a potential – the way the third SIRN submodel can be applied to collective planning. That is, on the one hand, Fig. 13.1 can be imagined as symbolizing a group of players playing the city game, while on the other, it can also be imagined as a group of planners sitting around a table, discussing planning policies; as in Fig. 13.2, for instance. This potential was realized by several subsequent studies that have employed SIRN as a conceptual framework and "An approach to planning discourse analysis" (Portugali and Alfasi 2008). The latter paper was based on an empirical participatory observation conducted by Alfasi (2001) as part of her Ph.D. research. In that observation she has participated in, followed, and recorded, the meetings of a planning team that was preparing a plan for the city of Beer Sheva in south Israel. While the central aim of this study was to follow and expose the dynamic of the planning discourse, it also provides an empirical illustration to collective planning, namely, to the way a group of planners are planning together.

The insight gained by this empirical study is twofold: Firstly, that a planning team can be seen as a complex, self-organizing system the dynamics of which follows the third SIRN submodel as described above. Secondly, that discourse among the planners is the main medium through which collective planning is implemented. As an extension to the above, I suggest identifying two forms of planning discourse: One that takes place between the planners who were specifically assigned to prepare the plan and another that evolves as public discourse along the lines of Habermas' (1984, 1987) *communicative action* and Healey's (1997) *collaborative planning*.

The participatory observation mentioned above exemplifies the first form, as noted. In following closely the Beer Sheva planning discourse it was possible to follow the way new planning ideas and policies emerge out of the discoursive interaction between the various planners, how they take shape, stabilize, dominate the discourse for a certain period, just to be replaced by other ideas that emerge in the discourse and so on. This process went on until at a certain stage a given planning scheme eventually emerged as the winning order parameter that finally

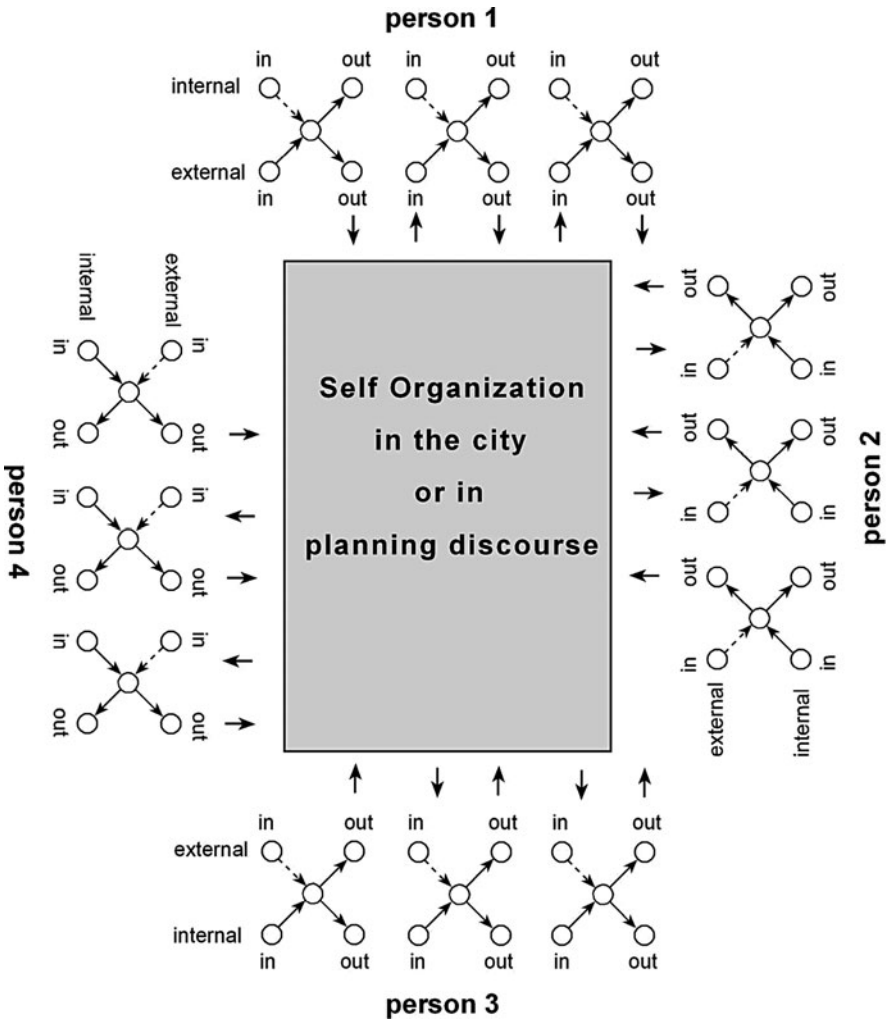

Fig. 13.1 The way the third SIRN submodel – the interpersonal, collective, with a common reservoir SIRN – can be applied to collective planning and decision making. According to this submodel, all communication and interaction between the agents involved in the process are made via a "common reservoir" which might be a planning team's discussion table, the city as a whole or parts of it

enslaved the discourse and brought it into a steady state during which no further plans were added to the discourse. Figure 13.3 illustrates the principal evolution of this process of collective planning. For a detailed discussion of the actual planning discourse as it took place in the Beer Sheva team see Portugali and Alfasi (2008). In analyzing the discourse it was possible to see how various factors such as the personality and charisma of the individual planners are affecting the planning discourse and as a consequence the final result.

Fig. 13.2 A planning team in action

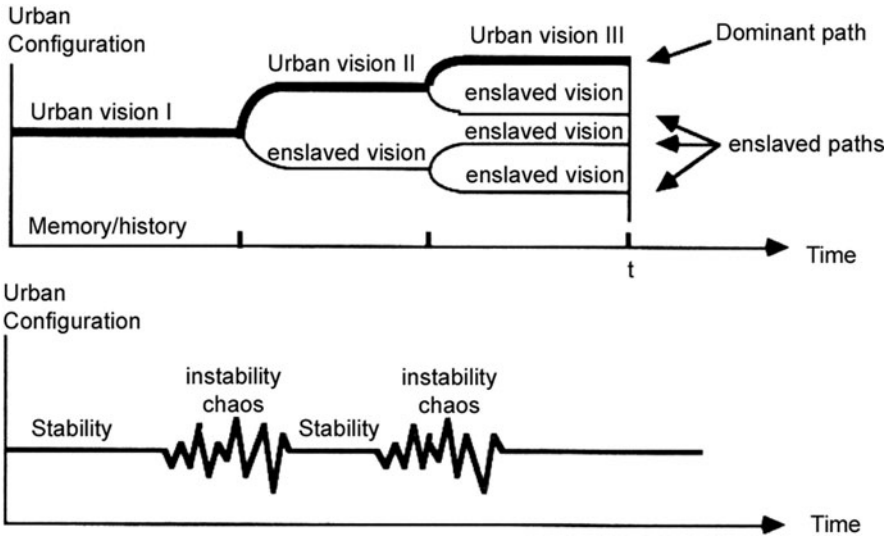

Fig. 13.3 *Top*: Bifurcation diagram illustrating collective planning discourse: Planning ideas and policies emerge out of the discourse at bifurcation points, dominate the discourse for a certain period, replaced by other ideas that emerge and bifurcate in the discourse until a certain planning scheme eventually emerged as the winning order parameter that enslaves the discourse and brings it into a steady state. *Bottom*: The result is that the collective planning process (e.g., discourse) evolves as a typical self-organizing system typified by relatively long periods of steady state during which a given plan or urban vision dominates the discourse, interrupted by short "chaotic periods" that entail the emergence of a new urban plan/vision

13.5.3 Collective Design

In a recent study the *Interpersonal with a common reservoir* SIRN submodel, with its city game, were used as a framework for a design city game (Tan and Portugali 2011). Initiated and organized by Ekim Tan (www.theresponsivecity.org/), the game was played in the context of a real urban project: the plan to add some 350 new homes to the new town of Almere Haven, Netherlands. The Almere planning department has assigned the area of Sportpark de Wierden for the extension, and decided that the plan should be made by means of public participation. The design city game described below can thus be seen as an experiment the aim of which is to explore the usefulness of city games as a public participation design tools.

The game was thus played on a 2D map of Sportpark de Wierden when the players that simulated the new residents of Almere were fifteen graduate students with diverse cultural (Indian, American, Kenyan, Dutch, Turkish...) and disciplinary (architecture, planning, sociology, anthropology...) background. In a three-hour experiment, the participants played thirteen rounds placing mock-ups based on their resident profiles. As in previous city games, here too, the participants made location decision sequentially. However, here we've added an additional rule that 'in case of conflict, existing buildings will have priority over the new-intended ones'.

Figure 13.4 shows several snapshots from the game as it developed, while Fig. 13.5 the resultant outcome. The game was interesting in several respects.

Fig. 13.4 Several snapshots from the design city game as it developed in the area of Sportpark de Wierden, Almere Haven, Netherlands (*Source*: Tan and Portugali 2011)

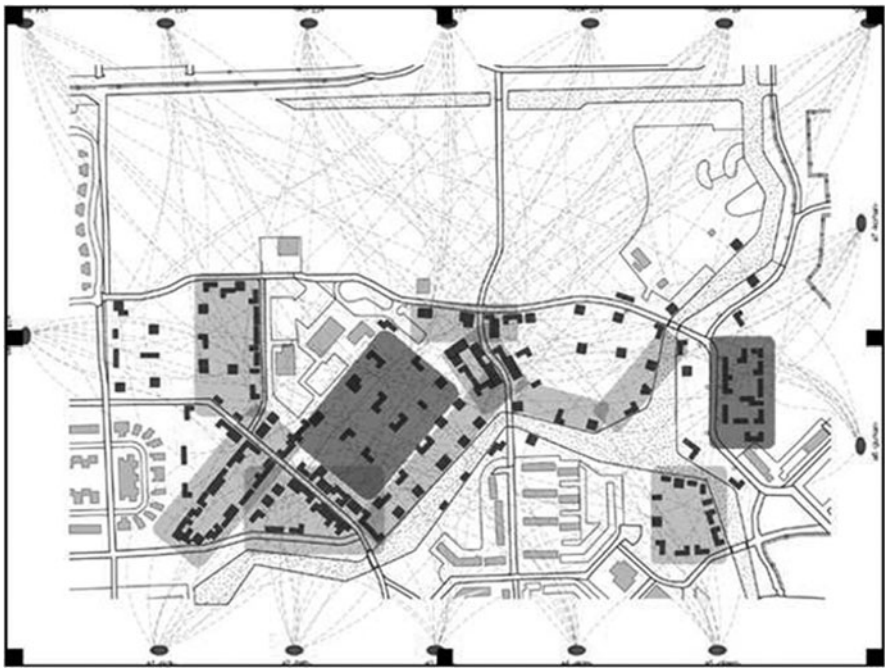

Fig. 13.5 The resultant outcome from the above design city game (*Source*: Tan and Portugali 2011)

Firstly, in the sense that while it started with the two simple rules specified above, other rules came into being as emerging properties during the game; among them rules of development, rules of network and rules of form. Secondly, as can be seen in Fig. 13.5, the resultant urban landscape is highly (self-) organized and rather rich and articulated. Thirdly and in association with the above, despite the fact that there was no single mind behind the evolving urban form, and the fact that no one in the game was concerned about the final urban form of the evolving area, the outcome is rather creative.

13.6 Concluding Implications

13.6.1 From Solitary to Collective and Professional Planning

Planning as we've seen is a basic cognitive capability of humans that is sometimes executed solitarily and sometimes collectively. Planning is also a profession and academic discipline and as such a *par excellence* collective activity. As a community of professionals and academics planners are very conscious about methodology – the good planning approach. In fact, as we've seen above (Chap. 12) a major portion of planning theory is devoted to the debate about the appropriate planning approach,

which is not usually the case with solitary or collective cognitive planners – they need not always be conscious and aware of the methodology they employ in their planning, be it Kahneman and Tversky's heuristics, Simons' bounded rationality or a purely rational approach.

Every professional planner when practicing planning is thus functioning, on the one hand (usually unconsciously), as a solitary and/or collective cognitive planner, while on the other, as professional planner who is fully conscious of the appropriate approach to planning. As a consequence, every practicing professional planner is subject to a built-in tension between planning according to the book, that is, according to the prevailing methodology – the way the community of planners have defined the appropriate approach and methodology of "good planning", and planning that results from the fact that each professional planner is first and foremost a human being and as such executes solitary and collective cognitive planning as everybody else.

This tension between the cognitive and professional forms of planning came out clearly in the participatory observation of the Beer Sheva planning team. As we've seen, the two planning processes, the professional and the cognitive (the planning discourse according to the SIRN model) evolved in parallel and at least in the specific case of Beer Sheva the collective cognitive planning process "took over".

The question is 'how this knowledge about solitary and collective forms of cognitive planning and the way they interact with professional planning can inform planning theory and practice'? As a first step toward answering this question we suggest looking at the directions in which current theory of professional planning is moving. As we've seen above (Chap. 12) and will further see below, planning theory is moving, on the one hand, toward social theory oriented collaborative and strategic planning approaches, while on the other, toward complexity theory oriented planning studies that are split into two branches: one that attempts to develop planning support systems that take advantage of the rapidly developing sophisticated modelling approaches and communication technologies, and another that attempts to reshape planning systems as complex self-organizing systems (Chap. 15, below).

Planning as a cognitive capability can inform both directions: it can inform collaborative and strategic planning by adding the ways solitary and collective forms of cognitive planning participate in the communicative-collaborative process that determines urban planning strategies. The case of planning discourse analysis discussed above indicates one possible direction of this line of thinking. It can also inform the complexity theories oriented planning approaches: to the PSS is can add the cognitive dimension that is needed to make such support system accessible and legible to professional as well as to nonprofessional planners; to CTC oriented studies it can add the notion of *planning behavior* that is described in Sect. 13.6.3 below.

13.6.2 Collective Design?

The design city game described in Sect. 13.5.3 exposes yet another aspect of collective planning and design: In the planning discourse associated with collective

planning (Sect.13.3.2) we had a group of planners discussing the way the overall structure of the city of Beer Sheva should look like in the future – after the plan/vision will be approved by the authorities and will start to be implemented. In the case of the design city game there was no vision of the overall future structure of the neighborhood or the way it should look like; nor was there a clear boundary between the stage of planning and design and the stage of implementation. In fact the players never concerned themselves with such questions – the concern of each player was his or her building and the best way to integrate it into the existing structure of the city. The overall structure of the city in each stage of the process was thus an emergent property – a genuine product of a process of self organization; very much like the urban simulation models elaborated in SOCity (Portugali 2000, Part II) and in Part IV below.

The interesting question is the extent to which this collective design city game can indicate a new approach to urban design – a collective urban design? More specifically, whether the design city game should be seen as a kind of urban simulation game the aim of which is to test different design rules and their impact on the emerging urban form – very similar to the use of urban simulation models in the context of planning/design support systems, for instance; or whether the game should be seen as an imitation of reality – a model of a real design process in which the future inhabitants of the neighborhood or the city are directly involved in the process; or of both? The answer suggested by Tan and Portugali (ibid) is that the above game indicates a potential that has yet to be further experimented and tested and only then realized.

13.6.3 Planning Behavior

Planning behavior is a new term suggested recently by Portugali (2009) to refer to the fact that the various cognitive capabilities imply also a distinct form of behavior. For example, the ability of animals and humans to construct cognitive maps is related, on the one hand, to *exploratory behavior* in animals (Golani et al. 1999) and humans (Munk-Vitelson 2005), while on the other, to the notion of *way-finding behavior* (Golledge 1999). In a similar way, Portugali (ibid) proposed as a working hypothesis that the various cognitive planning capabilities of humans entail a distinct form of behavior that he suggested calling *planning behavior*. It is interesting to mention that Golani et al. (above) refer to exploratory behavior as *phenotypic behavior*.

The phenomenon of planning behavior has immediate implications to complexity theories of cities and to urban simulation models, namely, that a lot of agents' behavior in cities is determined by plans that are not yet (and might never be) materialized, by what agents plan to do and so on. Some of these issues will be further discussed in the next chapter that deals with predictions, while others that concern urban dynamics and urban simulation models will have to await subsequent studies. It is important to emphasize that the above preliminary notes on planning behavior should be seen as beginnings for a whole new domain of research that has yet to be fully scrutinzed.