Chapter 6

# Spatial Planning, Complexity and a World 'Out of Equilibrium'

## Outline of a Non-linear Approach to Planning

Gert de Roo[1]

Some believe that planning theory is encountering its third crisis, with growing criticism of the one-sidedness of communicative and collaborative planning. If the planning community agrees that this is indeed the case, could the complexity sciences present us with a way out of this crisis, showing us a new route to take our theoretical debate forward? A small but growing number of planners strongly believe that they add value to the planners' theoretical debate and substantially enhance our understanding of our physical and social environment. This is the basic message of *A Planner's Encounter with Complexity*, the book that precedes this volume.

In this contribution I identify links between planning theory and the complexity sciences. These must be captured in a coherent outline if both story lines are to become mutually beneficial. In essence, planning theory helps us to differentiate between situations, issues or cases, an aspect that is not yet touched upon by the complexity sciences. However, they do underline the importance of time and all its implications, which, strangely enough, has been a non-issue in spatial

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planning. In this contribution I will work towards such an outline for spatial planning that combines both time and differentiation. This outline also proposes a way out in the event of a third crisis in planning theory.

## 6.1 In concurrence with systems thinking

> *Under the seeming disorder of the old city, wherever the old city is working successfully, is a marvelous order for maintaining the safety of the streets and the freedom of the city. It is a complex order. […] This order is all composed of movement and change, and although it is life not art, we may fancifully call it the art form of the city*. Jane Jacobs, The Death and Life of Great American Cities, pp. 60-61.

How can we bridge urban order and disorder, complexity and chaos in an abstract and theoretical sense? In my view, this would involve bridging the gap between the discipline of spatial planning and the complexity sciences, and a logical step would be to apply systems thinking. The disciplines of spatial planning, decision-making, and organization and management traditionally relate their progress to steps acknowledged within systems thinking **(**Gharajedaghi, 2005; West Churchman, 1984**)**. Systems thinking, being representative of the 'general sciences', cuts across the various disciplines of science (Boulding, 1956; Checkland, 1991; Kramer & De Smit, 1991; Von Bertalanffy, 1968) and, hence, also touches upon the discipline of spatial planning (Chadwick, 1971, McLoughlin, 1969). Various periods are acknowledged within planning theory to coincide with a particular class of systems, recognized within systems thinking.

The first crisis in the theory of planning arose during the 1960s, with growing criticism of blueprint planning and the underlying technical rationale. Heavily influenced by logical positivism and the mathematical simplicity of a Newtonian worldview, actions proposed with a view to intervening in the physical environment were considered to be definite and final. The physical world would bend to our (i.e. the planners') will. Class 1 systems (Kauffman, 1993) express this kind of thinking, being the so-called 'closed systems'. These closed systems represent a fixed or static reality consisting of nodes and their interactions, without any interaction with an outside world. Closed systems exclude contextual interference, as if there is nothing more beyond the whole and its parts. In physics and chemistry, excluding the context and focusing entirely on the parts of the whole in order to understand the whole as an entity has been extremely successful. It is therefore not surprising that this is seen as an appropriate route for the social sciences, including the discipline of spatial planning.

The most profound proposal to emerge in this period was the 'rational choice' approach of Meyerson and Banfield (1955). It comprises a number of steps, including 'considering all alternatives open to the decision-maker', 'identifying and evaluating all consequences' and 'selecting the preferable alternative in terms of its most valued ends'. In this sense, 'technical-rationality is a positivist epistemology of practice' (Usher et al. 1997, p. 143). While the notions 'all' and 'ends' are true representations of a technical rationale underlying the actions of planners, the idea of 'alternatives' is not. A technical-rational view of the world takes account of the existence of only one true reality. Given the facts as they come to us here and now, we should be able to deduce what the future will bring. If this future is not to our liking, the planner will intervene accordingly. Why, then, this reference to 'alternatives'?

From a logical-positivist perspective, alternatives indicate an imperfect world in which all the facts that are needed to comprehend the future are not available. One could distinguish between theory and practice, stating that, given enough time, money and energy, all facts will come to us eventually. For some time, this proposal solved the first crisis in planning theory: the fall of the technical rationale (Schön, 1983), acknowledging its boundedness (Simon, 1957). Alternatives were seen as the practical solution to this imperfect world. In spatial planning, so-called scenario planning was proposed as a solution. Scenario planning had its counterpart in systems thinking, since it was based on semi-open feedback systems, also known as Class II systems. During the 1960s, internal evaluation loops became popular and were designed to alter direction if the results did not match the facts. The initial set of conditions of nodes and their interactions would change accordingly. During the 1980s, this approach also became less popular (Alexander, 1984, 1986). The second crisis in planning theory was in the making.

In various European countries, institutional settings have undergone radical change since the 1980s and 1990s, representing a shift from a coordinative government to shared governance. Aside from facts, values mattered too. These values proved to be very much dependent on opinions, ideas, understandings and perceptions, which vary between actors (Innes, 1995, 1996; Forester, 1993), and there can be quite a number of actors involved in planning processes. The consequences were far-reaching. Constructivism and post-positivism replaced neo-positivism. A realist perspective had to make way for critical-realist and relativist perspectives on reality (See Chapter 1), and the technical rationale was set aside to make way for communicative approaches. The communicative rationale, with its focus on values rather than facts, became a major driver in seeking consensus in the various processes of planning.

This communicative turn (Healey, 1992) brought the concept of open networks into planning. These networks are Class III systems in systems thinking. According to Kauffman (1993), they do not have 'predictable patterns of stability'. Every actor is basically a black box, from which we cannot predict with certainty any of their actions. Also, planning processes are no longer such that they can be reduced to one actor. The communicative approach to planning therefore takes uncertainty as its starting point. Planners seek a negotiated or 'agreed' certainty rather than facts contributing to certainty. In this respect, I regard it as the opposite to the technical-rationale perspective on planning.

The communicative rationale, being an extreme perspective on planning, might offer a very clear and straightforward idea about what it stands for, however, as with the technical rationale at the other extreme of planning, it is above all an ideal-type constellation, and criticism is therefore around the corner. For example, the idea of stakeholders all having more or less the same amount of power to optimally negotiate about differences in their desires, interests and responsibilities, and in relation to ideas about tackling the issue, is under pressure from a reality full of power conflicts and mistrust. The ideal-type constellation might be in line with a Habermasian understanding of communicative rationality (an undistorted dialogue), but is increasingly regarded as somewhat naïve (Bengs, 2005; Harper & Stein, 2000; Huxley, 2000; McGuirk, 2001).

Another important criticism arising as a result of the strong commitment to a communicative perspective on spatial planning in the past twenty years concerns a shift away from content and an overwhelming emphasis on processes of planning and the interaction of stakeholders within these processes. This has resulted in a neglect of the content side of spatial planning (Imree, 1999). With this awareness, a third crisis in planning theory is just a few steps away (Alfasi and Portugali, 2007; Schönwandt, 2007).

## 6.2 A relational perspective on spatial planning: spectrum thinking

Thus far, this reflection on planning theory contains nothing new, including the link made with systems theory. The consequences of this form of reflection, however, have not yet been closely addressed within the planning community. One of the obvious consequences of seeing a sequence of related system classes in planning is an appreciation of a spectrum between the technical and communicative rationales (see Figure 6.1) representing the various planning issues, how these are perceived and how they might be dealt with (De Roo, 2003; Van der Valk, 1999). The position of a planning issue on the spectrum depends, for example, on its certainty-uncertainty ratio. Among other things, the spectrum is a representation of the degree of certainty and uncertainty relating to an issue in planning. The spectrum also magnifies a shift in the ratio between object orientation and intersubjective orientation. This is accompanied by a transformation from closed to open systems (read 'planning issues'), a shift from a reductionist focus on the parts of a whole towards an expansionist view that considers influences on the whole from its broader context and a subtle balancing of a (critical-) realist perspective and a relativist perspective.

The transformations occurring along the spectrum, moving from a technical towards a communicative rationale, provide us with a few basic insights that are important to planning and decision-making. For example, while seeking certainty in a planning process, attention should also be paid to coping with uncertainty (a statement that explicitly acknowledges uncertainty as a phenomenon within the realm of science!). A further insight is that a shift along the spectrum means a transition in the approach to the results of planning actions, namely from goal maximization to process optimization. Moreover, there is the insight relating to the differentiation of planning issues into at least three categories: simple and straightforward issues (with direct causality, no interference from the context, clear entity, etc.), complex issues (between the technical and communicative realms, where both certainty and uncertainty prevail) and very complex (some would prefer 'chaotic') issues (agreements on how to define the issue are needed, consensus among stakeholders is desired, and perceptions and values prevail over facts and figures) (see Figure 6.1). This should be regarded as a statement that explicitly acknowledges differentiation between situations, issues and cases, meaning that, aside from a general or generic understanding of our reality, a specific understanding that acknowledges differences in a relational (see Chapter 1) and contingent way is a necessity. These few basic insights are not just important to planning in general, but are also crucial to the story line in this contribution and to the argument I wish to put forward.

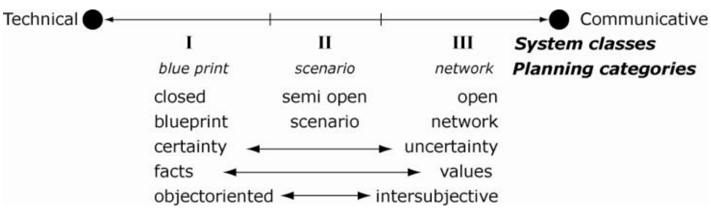


**Figure 6.1: A rationality spectrum for spatial planning and its relation to Class I, II and III systems**

It is logical to expect that a possible third crisis in planning theory (Schönwandt, 2007) will be dealt with by shifting attention to the 'fuzzy middle' between the technical and communicative rationales. In this fuzzy middle, both certainty and uncertainty prevail, an object-oriented perspective is as important as an intersubjective perspective and both facts and values matter (De Roo and Porter, 2007). This is a good move, one could say, since the majority of planning issues fall within this fuzzy middle. Moreover, for planners, this position is not entirely undiscovered or new, since scenario planning is also rooted in it.

This is not, however, the route I wish to take here, although I am by no means denying the importance of the 'fuzzy middle'. I would rather move on, following the progress made by systems thinking.

## 6.3 Complex adaptive systems and spatial planning

In addition to Class I, II and III systems, there is also a systems Class IV, the systems class of complex adaptive systems (Kauffman, 1993; Wolfram, 2002). I am rather confident about the impact that this system class will have on planning thought and on planning actions. The impact could be tremendous, since it embraces time and non-linear behaviour. It underlines the idea of differentiation between planning situations even further.

*The becoming*

The first three system classes might differ in terms of their openness to the contexts of systems, but the attributes on the basis of which the system exists (nodes and interactions) are considered to remain the same. These three classes implicitly represent systems with a definite problem or case formulation, as these are considered to be more or less fixed or static entities or situations. I am referring to their 'being'. This means that the planning issue, case or situation at hand is considered to be an 'it', present in the here and now. It is a perspective common to a Newtonian worldview and to what Kuhn called the 'normal' sciences (Kuhn, 1962). I challenge this static point of view here and elsewhere (see De Roo, 2010; De Roo & Rauws, 2012), despite the fact that this is a common and appreciated perspective within the realm of planning and decision-making.

The theoretical debate on planning and decision-making was and still is very much about the rationale underlying choices made (with regard to intervening in the physical environment). As such, choice or decision-making – likely to be the most essential aspect of planning – is by and large restricted to the here and now, to the 'being' at hand. One could conclude that most attention is focused on the precise moment at which a decision is to be made, with arguments referring to the here and now, while the 'becoming' (which is what we basically plan for, a fact that some of us tend to forget) is secondary, considered as not much more than the logical follow up of a linear extrapolation (technical rationale) and a commitment (communicative rationale) made operational to a decision.

Here, the criticism relates to the fact that planning theory has not paid attention to time. To ignore the issue of time is to ignore processes of change. With change being perhaps the only constant factor in the reality that surrounds us, it might be wise to reconsider the importance of time and change to planning theory and practice. Systems Class IV does just this: it incorporates time, presenting a world in flow, full of discontinuous change. Systems Class IV is therefore an example of phenomena reflected upon by what Funtowicz and Ravetz (1993) call 'post-normal' sciences. Systems Class IV presents the 'becoming' as a phenomenon that is far more essential than the 'being'.

*Adaptive and self-organizing*

These Class IV systems are known as 'complex adaptive systems' (Cilliers, 1998; Coveney & Highfield, 1991; Gros, 2008; Holland, 1998; Lewin, 1993; Mainzer, 1994; Waldrop, 1992). With these 'complex adaptive systems' we touch upon the complexity sciences and the central theme of this book: spatial planning and complexity. Contrary to Class I, II and III systems, complex adaptive systems are not fixed or static entities with given nodes and interaction. Complex adaptive systems are considered to be robust and flexible at the same time. Cities are a good example of complex adaptive systems (Allen, 1997; Batty, 2005; Portugali, 1999; Portugali et al., 2011), as cities are robust in the sense that they rarely disappear, whatever happens (Hiroshima's existence as a city was not ended by the atom bomb in 1945). Property rights are a crucial factor in a city's robustness (Webster & Lai, 2003; Webster 2010). At the same time, cities are very flexible in adapting to various global and local changes, such as industrialization, the phenomenal rise of motorized transport, the rural-to-urban demographic and the rapid rise of the communication age.

Complex adaptive systems therefore adapt to contextual change, as they are able to transform themselves through processes of self-organization. This keeps the system fit for change, which results in processes of co-evolution with its transforming contextual environment and its self-organizing abilities. Change and co-evolution, as representatives of change, are processes in time. These time-related processes do not shift from one entity or 'being' to another. There is something to say about the routes taken by these processes of co-evolution: they are not random but dependent on past events (history matters) and on the context. This is called 'path dependency' (Liebowitz & Margolis, 1995). There is also something to be said about the extent to which change takes place.

*Wicked problems*

Let us go back to 1972 and Rittel's remarkable reflections on the first crisis in planning (see also Rittel & Webber, 1973). Rittel discussed West Churchman's proposition (1967) regarding the difference between 'tamed' and 'wicked' problems when reflecting upon the difficulty of understanding and defining planning problems. From the perspective we take today, 'tamed' problems are those that can be understood as they 'are', and can be defined, controlled and solved. Rittel no longer believed in this type of problem (represented here as Class I systems, although 'static' or 'fixed' Class II and III systems could also apply), stating that 'all essential planning problems are wicked' (Rittel, 1972: 392).

Wicked problems have 'no definite formulation', as they are not and cannot be fully understood. In my own words, any specification of the problem corresponds to a specific selection of those properties that are considered likely representations of the problem (the problem is situational) emerging from the past and, since these properties come and go, there is no clear boundary or end to their domain. Others call them messy (Ackoff, 1974), fluid or fuzzy (De Roo & Porter, 2007). Responding to or solving these problems often reveals or creates additional problems, because of complex interdependencies between problem-related properties and their contexts. A 'wicked problem' is therefore unique and allows 'many explanations for the same discrepancy' (Rittel, 1972: 393) with no test available to determine which of these explanations is the best. Therefore, it is not possible to evaluate whether this has been done well or not. In Rittel's words: 'The wicked problem solver has no right to be wrong. He is responsible for what he is doing' (1972: 393). In my own words: the 'wicked problem' becomes ethical.

Rittel and West Churchman were both very much interested in planning, and it is remarkable to see how, in retrospect, they perceived the world at the end of the 1960s and in the early 1970s, and the way in which they regarded planning issues as 'wicked'. History shows us the route that the debate in planning has taken since then. On this route, we see planners acknowledging problems not as 'wicked' but as 'communicative'. Recently, planners have again begun to wonder about alternative routes to the future, as a response to the growing criticism of communicative and collaborative types of planning. Those looking into the complexity sciences, as I am, are now touching upon complex, adaptive phenomena labelled as 'wicked' by various authors from outside the discipline of planning (Davies, 2003; DeGrace and Stahl, 1990). In contrast to planners, these authors seem to have appreciated the considerations of Ritter and West Churchman's suggestion of 'wicked' problems in planning.

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Rittel referred as well to 'tame problems', which are acknowledged by Prigogine (1996) as stable systems, those within which 'small changes in the initial conditions have minor consequences' (1996: 27). Rittel's 'wicked problems' are frequently regarded as synonymous with complex adaptive and unstable systems, as these have the same implications as Rittel's 'wicked problems'. There is slight twist, however. According to Prigogine with regard to these complex systems, small changes in the initial conditions 'will inevitably diverge exponentially over time' (1996: 27), with an unpredictable result given the conditions at the beginning. It is therefore unlikely that a method applied to a complex adaptive system will produce the same results twice. Furthermore, small variations between systems might eventually lead to substantial differences in their trajectory and could have major consequences in due course. In terms of causality, foreseeable and confined amplifications have a disproportionate result to future circumstances. To obtain an idea of how this could work out in an urban environment, let's see how 'Lola runs'.

## 6.4 Lola and Lorentz

*Run Lola Run* is a cult movie that convincingly shows how the world is full of coincidences.[2] The story of the movie translates rather well into Lorentz's story of the cyclone and the butterfly, which begins in the tropical jungle and ends catastrophically in the urban jungle. This metaphor (Lorentz, 1963) is one of the most popular in the complexity sciences. Lorentz's metaphor connects a tropical cyclone which suddenly hits the coast of North America with the butterfly and its apparently randomly flapping wings somewhere in the Amazon. This random flapping of wings at a particular location and at a sudden moment in time proves to be the trigger for a dramatic chain of events, as it creates the first pressure wave that ripples outward, going through a sequence of coincidences and culminating in an unstoppable natural disaster. Lorentz by no means wants to present the butterfly as having unprecedented powers. The butterfly is like all butterflies, but this particular one happens to be at the beginning of a series of events whereby, supported by the circumstances, a barely detectable movement evolves into a powerful phenomenon that cannot be ignored.

*Run Lola Run* presents us with another route as it unfolds, this time in the urban jungle. I have to admit that the event that triggered this chain of events is less common than a butterfly flapping its wings. Lola's friend has left his bag, which contains a large sum of borrowed money, on the metro in Berlin. The friend panics and informs Lola that he is going to rob a nearby supermarket to settle his debt. Lola decides to intervene.

As Lola leaves her apartment in a hurry, she passes a punk with a dog. The dog growls at her, which makes her yell and run faster. Running through the streets of Berlin, she encounters, at various moments, all kinds of events and chance occurrences, which together result in her being too late to prevent the robbery. Instead she participates in it and is eventually shot.

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[2] *Run Lola Run* is a German thriller (In German *Lola Rennt*, literally 'Lola Runs') released in 1998, written and directed by Tom Tykwer. The film won numerous awards.

The gods favour Lola and allow her to repeat the run once more. Being hardly any later than on the first occasion, she stumbles over the punk and his dog and hurts herself. As a result, she limps. Again she encounters various people and events on the streets of Berlin, only the time and place are slightly different. Although Lola arrives in time and manages to catch her friend's attention, he is distracted and run over by a passing ambulance. He dies.

Again, this is not a happy ending, and therefore the story unfolds a third time. Lola manages to escape from the punk and his dog by jumping over them both. This time, too, various events and chance meetings occur on the streets of Berlin, among them a tramp with a bag. While he had been there on the previous runs, he had been in a different place at different moments, and subsequently his presence was without consequences. This time, the tramp crosses the path of Lola's friend, who recognizes the bag as his own. The moment Lola arrives, her friend's troubles have fortunately disappeared. With this, the significance of her run seems to evaporate.

When we connect the principal characteristics of complex adaptive systems with the story line of this film, a scenario unfolds that is of interest in urban planning. Comparable to Lorentz's metaphor, small changes at the beginning (passing the punk and his dog) lead to various consequences at the 'end', some of them rather dramatic. The spatial functions and structures of Berlin condition the various shades, nuances and movements of what seem to be coincidences. These coincidences are nevertheless connected by invisible threads, which manifest themselves in a slightly different way when repeated, and hence create alternative situations with alternative responses, resulting in completely different and sometimes dramatic closing scenes.

Numerous causalities and interpretations can be related to Berlin's spatial structures and functions. Interwoven with these visible contours of the 'urban jungle' of Berlin is a diversity of comprehensive and less comprehensive sets of uses, symbols, rules, movements and actions. These movements, operations and actions do not depend solely on the existing structure and functions, but are products shaped partially through interaction with these structures and functions (contextual), partially through historical connections (path dependency), partially by cultural and social rules (referring to adaptive processes), and partially by choices made independently of all these factors (referring to processes of self-organization). Therefore, few causalities and interpretations in urban space are the direct result of urban structures and functions. They are affected by various shades, nuances and movements that depend on, but are not determined by, the way in which Berlin's space is set up and organized. Together, they produce manifestations of space to which we attribute qualities. These manifestations condition our decisions, operationalizations and action space. By and large we perceive the outcomes of all this as coincidences, which could lead to different and sometimes rather serious consequences.

### 6.5 Linear versus non-linear: a matter of perspective

Complexity sciences assume that development and progress cannot be expected in a world in which the Newtonian perspective of a never-ending cycle of repetition prevails. This Newtonian world is a reality in perfect equilibrium, where time has no role and the interactions of entities (nodes in a system) are fixed and determined, now and permanently. In such a Newtonian world, everything (nodes and their interactions in a system) remains more or less the same, isolated, 'tamed', closed and linear. This is the world to which the 'normal' sciences relate. There is no change, the isolated linear move from A to B has no effect apart from the move itself. The move is meaningless in a broader context. Therefore, in a state of equilibrium there cannot be any progress or development. Ecologists would say that such a system is nothing but a dead system (Lister, 2008).

Development becomes possible in a situation of disequilibrium where circumstances are 'complex', and certainty and predictability are replaced by emergence and non-linearity (see also Section 8 of this chapter). Given the initial conditions, there is no longer an unequivocal development that leads to an unequivocal outcome. By contrast, we are faced with an infinite number of possible routes, each resulting in a different outcome. A process that is repeated on the basis of the same initial conditions will not produce the same outcome, and, if it does, this is merely coincidental (Coveney & Highfield, 1995). There is diversity rather than coherence.

This diversity is the world to which 'post-normal' science relates. Diversity does not lead to the degeneration of the process. In physics, reference is made to increasing entropy in the case of degeneration (entropy: state of maximum disorder and unchanging events). In a complex world (non-linear and out of equilibrium) it may very well lead to an evolutionary process. Some call this 'extropy', presenting it as the opposite of entropy. This evolutionary process may even take on 'chaotic' forms. According to chaos theory (Gleick, 1987), a new order might emerge out of this 'chaos', a line of reasoning that is just one step away from the concept of a multilevel perspective (not seen here as hierarchical and linear with downward coordination, but as mutually interacting and mutually dependent), becoming an issue in spatial planning.

The 'complexity' of a complex adaptive system more or less stands for interactions (out of equilibrium) of systems (wholes) at the various levels, with subsystems at micro levels, neighbouring systems at meso level and hypersystems at macro level. These interactions represent the exchange of matter, energy and information – characteristics commonly referred to as dissipative. Complex systems are dissipative by nature (Prigogine, 1984). Therefore, without mutually related multilevel interactions complex adaptive systems cannot exist. One example is the complexity of traffic and infrastructure: politicians would frequently like to see wider roads to solve the problem of congestion. This is an obvious but simplistic thought which originates from linear thinking. Indeed, widening roads and adding more lanes will initially reduce congestion, but it also prompts those who used to travel by public transport to take the car instead, as the roads are now less busy. Due to these processes at the individual (micro) level, roads become congested again within a short period of time. Spatial planners are very much aware of these mechanisms (Papageorgiou et al., 2003).

Another example is demography, its effect on housing projects and the development of neighbourhoods. Planners were once considered to be the creators of urban space, who not only defined institutional conditions under which a function could be spatially allocated, but also defined future space. This meant physical transformation as the consequence of blueprints that included neatly designed neighbourhoods. From a multilevel perspective, this notion of the planner being the creator of space can be questioned as the planner is instrumental to demographic forces (Gober, 1992). The planner's world is not one to be created but one in a continuous flow – a world full of autonomous processes. Urban development is not only influenced by demography but also by technical, economic, institutional and many more factors. To put it in a slightly different perspective: the urban is where the local and the global meet, where the local adapts to the global, and where the global receives impulses from the local. This mechanism leads to an exchange of ideas and eventually to innovations.

In this complex environment I would propose the planner to become the party attempting to acknowledge the local benefits of the major forces triggering local urban responses, and attempting to prevent negative consequences that could impact on liveability at the local level. The planner does not do this by controlling, conditioning or restricting the use of urban space. He/she attempts to influence or manipulate, in a positive way, developments that are seen to affect the local as products of developments at higher levels. Rather than being the creator (within a technical realm) or mediator (from a communicative perspective), in this respect the planner can be acknowledged as a trend watcher and transition manager.

## 6.6 Positioning complexity

Waldrop (1992) discusses the result of computer-simulation research, from which it can be inferred that there is a continuum of simplicity, complexity and chaos. His message tells us more. Our dynamic reality, including life itself, occurs at the edge of order and chaos, 'where the components of a system never quite lock into place, and yet never quite dissolve into turbulence either' (1992: 12) and in which a complex reality can be found that reflects 'the right balance of stability and fluidity' (1992: 308). This complex reality is what Weaver, one of the founding fathers of the complexity sciences, in 1948 introduced as 'problems of organized complexity' (See also Devisch in this Volume).

*The logic between order and chaos*

The message is that the world is never in balance but there is nevertheless a knowable reality. All functioning or living systems are either moving towards equilibrium or away from it. Such systems cohere with or adapt to the context's flow. Out-of-equilibrium situations might eventually lead to chaos, a situation that is not necessarily destructive or negative. This is possible because, in addition to the inevitable and continuous presence of chaos, a certain amount of order results from developments towards stability and equilibrium, albeit on a higher level (a definition of 'progress'). Simplicity and chaos are apparent opposites 'that, at second sight, should be considered more in terms of their complementarity', as Goudappel (1996: 76) concludes. The question that remains is how we should deal with this view of reality.

Dealing with it is not easy, as it very much contrasts with the elementary rules of logic and the ideas of the Enlightenment, ideas that we carry with us as if they were in our genes. For example, Aristotle's notions of logic, which most of us have considered to be self-evident, are no longer a foundation upon which we can build when considering the ideas of complexity. Aristotle's law of identity (a chair is a chair and definitely not a couch or a tree) is no longer valid, as reality is constantly changing, co-evolving from one state to another. Aristotle's law of noncontradiction ('A' cannot be the same as its opposite 'not-A') is no longer valid, since systems can be represented as orderly and chaotic at the same time, depending on the perspective taken. Aristotle's law of the excluded middle (It is either 'yes' or 'no', '1' or '0', black or white) is no longer valid as there are infinite shades of grey between black and white, and between order and chaos there are various complexities. For example, with regard to spatial planning we have pointed to the fuzzy middle between the technical and communicative rationales (De Roo & Porter, 2009). This fuzzy middle is probably more important for spatial planning than both of the extremes of the ideal type.

The 'complexity' of complex adaptive systems does not address a current state, an 'it' or a straightforward, well-defined entity that 'is'. Complex adaptive systems cannot be defined on the basis of a fixed 'it'. Nor can they be defined as an 'is', which would make such a system unchangeable and atemporal. The 'complexity' of complex adaptive systems expresses a system in motion as a consequence of a situation that is out of equilibrium. Rather than descending into a 'dead' situation or into chaos, complex adaptive systems show emergent behaviour and co-evolve, while maintaining a proper level of 'fitness', that is, the ability of a system to survive between extremes – between order and chaos, coherence and diversity.

*Non-linearity and irreversibility*

If complex adaptive systems are to flourish, the presence of a transient contextual environment with the constraints of irreversibility and non-linearity is essential (Coveney and Highfield, 1995). Both irreversibility and non-linearity are strongly related to time and change. Time is a carrier of the directions that developments take, and these directions are dependent on both the past and the context.

Irreversibility therefore contradicts a Newtonian world, an atemporal world in which movements of entities, sole objects or stand-alone situations do not distinguish directions in time. Nor can this be seen in a contemporary planners' world that focuses on decisions made in the here and now, without much awareness of their consequences.

Non-linearity is very much in contrast with linear systems or systems that progress exponentially. Non-linearity does not add up in the way '1 + 1' adds up to '2' (Coveney and Highfield, 1995). There is no immediate, straightforward and direct causal relationship between variables which would result in a change in one variable due to a causal relationship with another variable whose state has also just changed, whereby the degree to which change takes place is the outcome of a fixed ratio between the two.

A well-known example of non-linearity is the iterative process of population growth, with the outcome of growth at one stage serving as input for growth in the following stage, a process that endlessly repeats itself and results in a rather chaotic and discontinuous line of progression in the size of a population (Gleick, 1987). Another example is Lorentz's butterfly, discussed above. It is a metaphor referring to how a minor event in a complex world can survive and even take on massive proportions, being pushed forward and gaining energy in interactions within a context willing to connect and willing to expand. This is again the result of an iterative process, no longer within a system (a population growing and declining over time), but a system continuously connecting with similar systems, resulting in amplified and discontinuous behaviour (a movement originating from a butterfly's wing and evolving into a cyclone). In these examples, non-linearity presents itself as amplified and discontinuous.

*Connectivity and potentiality*

Irreversibility and non-linearity are necessary constraints on complex adaptive systems and result from interactions with their contextual environment. It must be possible for this contextual environment to become connected to the complex adaptive system. Moreover, the degree to which this connectivity takes place is a measure of a system's potential to 'go with the flow', adapting to its environment, continually seeking a best fit, optimizing its ability to survive and progress.

Between order and chaos there is a 'complex' world in which entities, objects and stand-alone situations as we traditionally see them (as fixed, static and unchangeable) are not the phenomena representing a world to come. They have proven not to be the drivers of progress and innovation. In a complex world, these traditional entities, objects and frozen situations are reduced to rare species, exceptions to the rule and of no interest in our quest to understand our changing world. What does interest us, amongst other things, are systems, subsystems and hypersystems evolving in close interaction with each other and becoming transient, due to a context in motion and to processes of self-organization between the parts. In addition to a multifaceted and multilevel understanding (not to be understood as a hierarchical, linear perspective) of interactions and exchange, a situational insight into reality emerges.

*Situational and temporal assemblies*

A situational understanding of reality entails a constellation of events that come together and become manifest at a particular time and place. From this manifestation in reality we assemble one particular and relational construct that we would call a 'situation', to which we can attribute qualities (see DeLanda, 1997; Deleuze and Guattari, 1987; Van Wezemael, 2010 and this volume). In other words, we see a situation becoming manifest. This manifestation of a dynamic situation allows us to identify a planning issue; we can propose actions to be taken and we can reflect upon imaginable consequences. This all results in a rather fundamental chain that most planners implicitly take into consideration: (1) a manifestation of a situation, (2) from which a planning issue is formulated, (3) on the basis of which a planner formulates actions, and (4) imagining the consequences of these actions after they have been implemented and translated into interventions within our physical environment. This idea of a situational understanding makes our reality quite temporal as well.

Assembling situations out of a multifaceted, pluriform and timely world (Deleuze and Guattari, 1987) not only touches on (critical) realism, but also addresses both relativism and relationalism (see also Chapter one). In assembling an understandable reality out of a manifestation which is multifaceted and pluriform in nature, a subjective and intersubjective touch is unavoidable in obtaining an impression of the reality that surrounds us. An assembly or arrangement is nothing but a proposition that refers to the way in which the various observed elements, events, happenings or systems seemingly relate to each other as constructs. This represents a 'situation' that is understood as such, becomes knowable and can be shared as a phenomenon among others who are or can also be made aware of it, and are willing to connect or relate to the 'situation'. The situational understanding of our reality is a consequence of considering the environment we live in as a complex adaptive system. This brings us to the essence of spatial planning.

## 6.7 Complexity and an outline for spatial planning

With Class IV systems and so-called complex adaptive systems, a range of new understandings have been presented that are as yet unknown in the contemporary debate in planning theory. They include co-evolution, self-organization, emergence and adaptivity, and represent conceptual insights that are to be taken seriously if we agree on the importance of time and non-linear processes as a consequence. While these insights are rather new to planning, some notions that describe phenomena representing the various aspects of complexity and complex adaptive systems are not.

Notions such as resilience, multilevel and situatedness have already enriched the language of planning. These are representative of recent shifts towards new insights in planning, borrowed from other disciplines or philosophical strands and appreciated by a growing number of people in the planning community. With the conceptualization of complexity, these notions could very well become stepping stones to an understanding that includes the principles relating to 'post-normal' science and to Class IV systems: non-linearity, irreversibility and connectivity with a transient context and processes of self-organization.

*What once was can no longer be*

Most of us will admit that our planning issues long ago ceased to be linear. The successes of the functionality approach within a 'singular' and direct causal world are long gone. Post-war planning, driven by a common interest in rebuilding Europe, was very effective in the past. However, roads, as connections between places and spaces, are no longer constructed entirely on the basis of the criterion of effectiveness. This would mean following a straight line between A and B, something that is now considered overly simplistic. Today, multiple criteria are used to identify an optimum route, including the possibilities for connecting various modes of transport into a multiple-use corridor. Routes no longer cross nature areas and landscapes because these are now protected. Furthermore, routes are restricted due to various environmental qualities being protected by law. Today, the idea that a route might also be taken because its users value it (the idea of observing and enjoying the environment while driving) is taken seriously by a growing number of infrastructure planners (Nijenhuis and Van Winden, 2007).

Most of the more strategic issues in spatial planning and projects representing development planning are far from linear, a statement that should not come as a total surprise to planners. Some time ago, Peter Hall (1980) demonstrated the non-linearity and irrationality of a series of planning disasters apparent throughout the world. Flyfbjerg et al. (2003) studied the reasons why these major projects got so out of hand, reducing the doctrine of control to realistic and therefore minimal proportions. Numerous planners consequently turned their back on projects that were 'too complex', focusing instead on the parts or the modules of which the projects were composed. However, this resulted in a narrow view – quite often too narrow, as we can see in various current projects that have got out of hand. The Amsterdam North-South metro project is an excellent example (Soetenhorst, 2011). This project would supposedly cost 1.46 billion euros and was guaranteed not to harm the local environment. With an expected rise in costs of more than 100 percent (3.1 billion), a six-year delay, damage to historical sites and leading to the downfall of politicians and project managers, it is a perfect example of the many projects that spiral out of control, with no-one having an overview of the project as a whole.

*Moving outside the box*

In confronting the idea of 'situatedness', we must acknowledge that such projects do represent a 'situation', as they are a manifestation of various trajectories converging, including a dynamic assembly of a whole range of actors and factors. A clear image of such a situation will not be at all realistic, as it strongly depends on how those involved assemble the various components of a project into a 'whole'. Moreover, mechanisms of communication must ensure that the various actors continually acknowledge that they all still embrace the same understanding or specification of the project (situation) at hand. This is by no means an assurance that an overall view – let alone an in-depth understanding – will be maintained, as the project (being an institutional response to the 'situation') is in a constant state of discontinuous and non-linear change.

The aim of this contribution is not to resolve this issue, since it is fundamentally impossible to find an ultimate and definitive solution. It cannot be solved using a technical rationale, as we have seen (amongst other things) that humans are limited in their ability to perceive the whole through its constituent and interacting parts. Relying on a communicative rationale, we are also unable to think through each and everyone's behaviour, desires, perceptions and interests regarding a project and/or its consequences. To add to these imperfections, the non-linearity of these projects makes it even harder to understand the whole.

What awaits us is not the ultimate solution but an alternative solution (contrasting common approaches and outcomes), if we are willing to move forward in our thinking, abstractions and theories with regard to spatial planning and decision-making. What matters is how a project is seen, against an outline of planning that allows the project to be positioned in such a way that (1) the situational characteristics of the project can be distilled into (2) a planning issue, from which (3) planning actions can be deduced and (4) the consequences of these actions can be imagined.

An alternative approach does not deliver a 'better' solution than traditional practices (resulting in appreciated 'ends'), but instead proposes a different type of solution that appreciates those issues that could not be successfully dealt with by traditional means. This is what happened for example with the introduction of the communicative rationale. The communicative rationale was an answer to failing technical-rationale approaches to projects that had gained in 'complexity'. These approaches did not function properly due to increasing numbers of stakeholders, who each had different interests and had (or wanted to have) a voice. The technical rationale proved to be unsuccessful in dealing with the actor-related uncertainty in these projects. However, the communicative rationale did not provide the ultimate answer through which all planning issues could be dealt with. Rather, it added substantially to the spectrum of possibilities and introduced appropriate methods and tools for a specific group of planning issues. This innovation also highlighted the limitations of the technical-rationale perspective, being particularly successful in planning issues that we would today call straightforward.

*A frozen moment in time*

In various publications I have proposed the spectrum between the extremes of the technical and communicative ideal types as the spectrum for spatial planning and decision-making on which planning issues can be positioned in order to identify approaches and actions, and from which the consequences of these actions can be imagined (see Figure 6.1). This spectrum is more then just a line, as can already be seen in De Roo (2003), where the spectrum carries a model of decision-making, and in De Roo and Porter (2006) with the spectrum being a contingency representing a dual mix of an object-oriented and an intersubjective-oriented approach to spatial planning and decision-making. The spectrum in Figure 6.1 presents three 'meta' approaches to planning: blueprint planning, scenario planning and network planning.

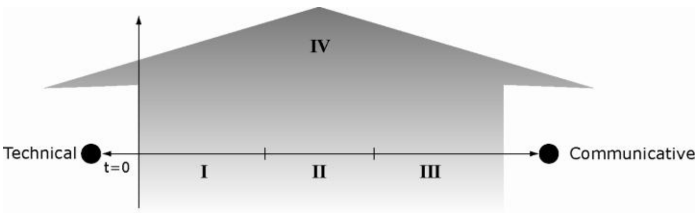


**Figure 6.2: A possible relationships between system classes I, II and III (being) to system class IV (becoming) (De Roo, 2010)**

In Chapter 2 of *A Planner's Encounter with Complexity*, the volume preceding this one, a proposal incorporating time is added to this spectrum of planning and decision-making (see also Figure 6.2). The result is the beginnings of a matrix (see Figure 6.7) that builds on the planning and decision-making spectrum. The importance of this matrix is that it positions the spectrum relative to time. The matrix thus reduces the spectrum to a moment in time, this moment being the 'here and now'. In other words, the spectrum can be found at 't = 0'.

From a temporal perspective, the planning and decision-making spectrum and its extremes (the technical and communicative rationales) is no longer atemporal but represents a 'snapshot' in time. This is precisely what the spectrum is about: it represents decisions as they are made in spatial planning, in the here and now.

Decisions made within a technical realm are driven by a rationale that takes the facts presented to us here and now as a 'true' representation of our reality, from which we can extrapolate the future to our liking. Logically, the result is a decision made in the 'here and now', at 't = 0'.

Decisions made within a communicative realm are driven by a rationale that prompts us to seek consensus amongst stakeholders with respect to their various interests and powers. Consensus-seeking is the main driver of decisions. Therefore, little attention is paid to trajectories representing the evolution of power relationships, balances of interest and perspectives, opinions and values through time, and how these might lead to alternative networks and alternative desires to intervene at a later stage. Reaching consensus in the here and now is already challenging enough.

Between the technical and communicative rationales we find the category of scenario planning. This particular approach to planning is intrinsically related to time, extrapolating a given past to an open future (Dammers, 2000). This extrapolation involves a linear technique, a technique that is not favoured by this contribution, which emphasizes the reality of non-linearity. However, scenario planning is also strongly related to the moment of decision-making, which is, again, in the here and now. Although scenario planning considers the time dimension far more than any other approach, scenarios also present arguments upon which we base our choice made in the 'here and now' and relating to issues that matter in the 'here and now'.

*Pushing the boundaries*

Let us imagine what would happen if we dared to move away from the planning and decision-making spectrum, towards 't = m' and beyond (see Figure 6.3), considering non-linearity as a major principle representing developments over time. We might obtain the following results. If we were to release a blueprint plan from its frozen condition, making it susceptible to time, we might see how, over time, our present reality bends towards the plan's proposals, ideally remaining the same as long as the plan remains valid. The result is a feed-forward loop in time, which affects a future reality, conditioning the future somehow by the plan, its proposals and commitment to act accordingly. These conditions interact with the future. This future, in due course – perhaps at 't = m' – will be reconsidered as input for a subsequent plan, which again will claim a future to come, and which is consequently again a feed-forward loop.

Releasing a network from its frozen state would result in emerging networks, a notion not entirely new to spatial planning (see Figure 6.3). Today this is quite a popular theme in the telecommunication sciences a.o. reflecting on phenomena such as Twitter and Facebook. Emerging networks not only represent interacting and consensus-seeking actors. They do show dynamic movements, not directed by anyone in particular, as they are the result of interplay between the various actors, parties and institutions (Taylor, 2003). Emerging networks are both dynamic and integrated entities, in a constant process of discontinuous change. This results in different settings for participating organizations (and their representatives) during the project, by and large to be distributed across the various stages through which the project progresses. It is unlikely, therefore, that an individual actor representing an organization will participate in the project from beginning to end.

What we see is by and large a process of self-organization that drives the evolution of these networks, with actors moving in and out of the formal and informal organizations participating in the project in question. This process of self-organization and self-regulation leads to frequently changing structures, dependencies and interactions, hence the emergence of a network. This network is often temporary, set up for a particular reason, which could be the development of a particular site, the construction of a railroad, or the renewal of a neighbourhood. Multiple parties are involved in all of these cases, and each one has some degree of power to act, invest or withdraw, and to appreciate and enjoy the benefits of any results. All these parties are needed to keep the project up and running. In other words, aside from the liberty to participate, there is a necessity to participate.

Public Private Partnerships (PPPs) are an example of cooperating networks, and open to ideas of emergence, adaptation and complexity (Klijn and Teisman, 2000; Van Assche and Verschraegen, 2008). PPP is considered a good alternative to one-sided and quite often ineffective initiatives by governments, sometimes even outside their fields of expertise (CPFI, 2008). Examples are the construction of roads, tunnels or development sites, the management of parks, industrial sites and ferry lines, and other activities such as waste collection and energy production. For several decades, PPP has been presented as an alternative approach, allowing more efficient activities to take place under the responsibility of experts. It has led to numerous positive examples. Beyond this, it has also led to surprising and sustainable innovations. For example, with regard to site constructions, not only the construction itself but also maintenance is now considered an important and financially viable activity of project developers. This innovation has led to results far more widely appreciated than the 'hit-and-run' strategies frequently employed in the past.

There is a dilemma, however. PPPs are very much organized around a contract between the partners. This contract is made at a particular moment in time, right at the beginning of the intervention, resulting in fixed conditions that are difficult to change during the later stages of the project. This finding sounds all too familiar. New approaches to PPP are now being considered (Wettenhall, 2008), to allow flexibility during the project period, making the project more adaptable to changing conditions, which are welcomed by and beneficial to all the parties involved.

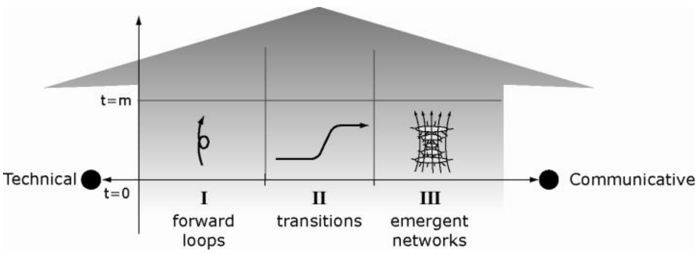


**Figure 6.3: Positioning feed-forward loops, transitions and emergent networks in a taxonomy of planning rationales**

*Transitions*

Scenario planning, the name we have used for the planning category in the middle of the spectrum between the technical and communicative rationales, makes direct references to 'time', allowing it to flow, but only in a linear manner, extrapolating the past and present into the future. Transcending scenario planning, as we previously transcended blueprint and network planning, would mean having to replace a linear idea of progression with a non-linear understanding of progression over time. I would consider transitions to be a good example of non-linear progression over time that could be of interest to spatial planning.

Transitions are non-linear movements or leaps from one stable level to another (Figure 6.4; see also Rotmans, Loorbach and Kemp in this volume; De Roo, 2010; Geels, 2005; Kemp, 1994; Rotmans, Kemp and Van Asselt, 2001). These transitions are likely to take place when the time is 'right'. This is the case when the system and its environment no longer have a proper optimal or appreciable fit, that is, the system and/or its environment are ready for change and have the potential to make the leap (rather than collapsing during the transition and reverting to the previous level of stability). This could also be the case when the contextual environment in which the system is embedded is no longer stable and an appreciated haven to which the system, in systems language, 'connects well'. In such a situation, the system can collapse, together with its increasingly unstable context, or can be pushed towards another level of stability, preferably a higher level. If a higher level is indeed reached, we are likely to perceive this as a development that has taken place.

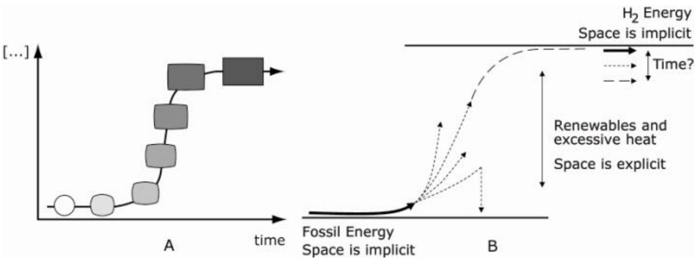


**Figure 6.4: The co-evolutionary process of a transition (A. De Roo, 2010), made explicit for the 'energy transition' between two stable levels, and its time-space relationship (B. De Roo, 2011)**

Complex adaptive systems have the potential to co-evolve during a process of transition. With co-evolution, the system undergoing the transition might fundamentally transform in terms of its structure and function (see Figure 6.4A with the white circle transforming into a shaded square). This process of co-evolution is the result of the system adapting to a new context, the new environment embracing the system to allow a better fit between the system and its environment. During the process of co-evolution, stability decreases while the system's dynamics increase. As soon as the system connects with a new contextual environment, stability increases again and the system's identity is likely to have changed radically due to the co-evolution of its structure and function.

Cities are good examples of systems that change over time in a structural and a functional sense. Cities were once nodes connecting trade routes and brought security, which was evident in physical entities such as bridges and defence structures. During the Industrial Revolution, cities became modes of production, providing space for industrial sites and a rapidly growing labour force. This marked the beginning of the functionally planned city, with neighbourhoods separated from other functions. Today we are willing to see cities as nodes again, this time linking the global and the local, fuelling creativity and knowledge.

Moreover, the physical manifestations are no longer very clear, with a huge variety of communicative functions operating, to varying degrees, in the 'virtual' world.

Another example is energy, with the decline of the fossil-fuel era and the transition towards a new source of energy that is universally available (see Figure 6.4B). Various trajectories are drivers of change away from fossil-fuel consumption. One of these will be the depletion of oil and gas reserves in the next 30 to 40 years. Another is the $CO_2$ emissions that are released from fossil fuels, which affect our climate and the sea level. Geopolitics is also a reason for finding alternative sources of energy. Today we still remember the oil crisis of 1973, when oil was used as a political tool by OPEC countries to punish the US and European countries for supporting Israel in the Yom Kippur War. Today, European countries are very much aware of their dependency on Russian gas and the power relations that come with it. All these trajectories together represent what we today call an energy crisis. The set of trajectories constitute a strong motive for seeking alternatives, such as renewables, excessive heat networks, smart grids, seasonal thermal storage, and more. It is interesting to see how this relates to spatial planning. While fossil fuels were (and still are) available everywhere, it has hardly affected spatial design. The price of energy proved not to be the crucial criteria in people's strategy for deciding where to live in relation to their place of work. The time they were willing to spend commuting proves to be the decisive factor (Lyons and Chatterjee, 2008). In contrast to this, renewables, excessive heat networks and other alternative sources of energy are spatially constrained (Noorman & De Roo, 2010). This makes spatial planning rather relevant at a time of transition towards another level of stability, with energy (e.g., hydrogen, see Bockris, 1975; Rifkin, 2002) again being universally available (see Figure 6.4B).

'Transition' is a relatively new concept derived from the complexity sciences that could become instrumental to planning theory and practice. I am willing to say that it touches upon reality more realistically than scenarios and their linear assumptions. Transitions present a reality full of leaps and sudden change, causation being strongly relational (see Chapter 1). Causation is not a clearly defined straightforward action-reaction mechanism between two parts, as in a Newtonian world. The cause of the transition emerges out of the often fuzzy relationship between a system, its subsystems and the contextual environment to which the system is connected. The connectivity between system and context diminishes, affecting the system's relationship to its subsystems through self-organizing mechanisms, pushing the system into a process of co-evolution towards a better fit with a new contextual environment.

Representing fundamental change, due to processes of co-evolution, the progression of transitions are impossible to quantify a priori. At a meta level, a-priori quantifications are at best a guess, being markers of change, not directly and immediately linked to content and causalities. Stock market indexes are such meta markers of economic change. Nevertheless, transitions do follow a certain path in close relationship with the contextual environment, which would suggest a multilevel and path-dependent perspective for understanding the 'situation' to come. Understanding the path of a transition, means being willing to understand patterns of macro developments taking place. Moreover, we would want to investigate how these developments at the macro level influence potentially interesting initiatives at the micro level. Considering these conditions, we would propose that the role of a planner is that of trend watcher and transition manager, as suggested above.

*Managers of change*

As a transition manager, the planner acknowledges evolving processes. Clearly the planner 'in control' (within a technical, direct causal world) or the planner as the mediator (in a communicative realm with relative perceptions) would not do well under these evolving conditions. Rather than a 'controlled' or 'man-made' environment, and in contrast to an 'agreed' environment, the complex adaptive system brings to light a more or less autonomously evolving reality. In this respect, our reality is not a creation of human beings who are 'in control', nor is it an agreed reality. Am I questioning the notion of the planner creating entire neighbourhoods? No, but I would like to emphasize that the creation of neighbourhoods is not so much the product of a 'creator' but the result of planners responding or adapting to demographic change and to people's desire to live in a safe, pleasant and well-connected environment.

When should a change be regarded as autonomous, and when should it be regarded as induced (by people)? Thinking through the example of population change, we can see that autonomous flows of change (trends) at the macro level affect the micro level. The planner responds to these at the meso level, guiding processes of neighbourhood development. We also see individual responses to these autonomous flows at the micro level, and the resulting possibilities and constraints (induced by planners) at the meso level, with people making choices about where to live, taking account of the results or consequences of processes at higher levels. Thinking through processes that are either autonomous or induced relates to impossible debates such as 'nature versus nurture' and 'nature versus man'. I will not touch upon these debates here. What is important is the positioning of the planner not as a creator per se, but as a manager of change that comes to us in some form or another. The planner's task is to try to influence this change, embracing and emphasizing its positive spin-offs and trying to avoid or reduce its negative effects. This would be the task of the planner as a manager of change.

## 6.8 Out of equilibrium

A non-linear world is a 'post-normal' alternative to the reality commonly understood within planning, which I would argue is at least of additional value. I also consider a non-linear world to be more 'real' than a linear world. This might be so, but the main question is: do we have the means to grasp this non-linear world? Can we make it ours in such a way that it will enhance not only our understanding but also the techniques supporting our planning actions?

A non-linear reality assumes a world 'out of equilibrium', that is, a world in which there is flow, motion and the transfer of energy, matter and information. Taken together, these are the conditions of development and progress, and therefore the preconditions for change.

I began this contribution by considering change as the only constant in our reality. More specifically, non-linearity is seen as the characteristic representation of the path that progress takes. The complex adaptive system is presented as the carrier and manifestation of change. Being 'out of equilibrium' is its contextual mode.

Being 'out of equilibrium' implicitly means a desire to reach equilibrium. Equilibrium is not so much a state of 'balance' but a situation in which there is no flow of energy, maximum entropy. Biologists define this state as 'dead'. Such a state will not be reached unless the system is 'down' (communications and electronics), 'dead' (biology), 'broke' (economics), 'neutral' or 'fixed, frozen or static and a-temporal' (planning). A system that functions well will never reach a steady state at equilibrium.

A properly functioning system is always ready for change, taking advantage of being between extremes which create bipolar conditions, being responsible for a 'potential difference' and a contextual flow with which the complex system interacts, engages and adapts to continuously. According to Pirsig (1991), arguing at a metaphysical level, this is all about 'the right balance between stability and fluidity', being the result of constant tension between static and dynamic quality, which he sees as the driving force of development.

The sea's tides cause the waves to which surfers adapt as they ride them. This metaphor is just one step away from the metaphor that some planners use to explain the discipline of planning to outsiders: 'playing billiards on a bouncing ship' (Goudappel, 1973). Most likely Goudappel was unaware of 'Sinai's Billiard', introduced by Sinai (1970), a mathematician, studying non-euclidean geometries and dynamical systems with elastic reflections, to show ideal gasses are maximally chaotic. Within the context of this Chapter we can consider Goudappel's remark a reference to 'out-of-equilibrium' situations in planning.

It is only within physics and mathematics that proposals have been made to quantify the various 'out-of-equilibrium' states. These proposals are restricted to singular environments and do not provide much inspiration for finding a meaningful way of expressing the possible states of a system in a plural environment. Various concepts such as 'Small World Theory' (also known as Milgram's experiment: Milgram, 1967), the 'Law of the Few' (Gladwell, 2000) and Ashby's 'Law of Requisite Variety' (Ashby, 1956) do give some insight in the system's conditions and relational behaviour with its environment. In general, 'out of equilibrium' can be seen as a contextual mode in which it is no longer accurate or valid to quantitatively explain new phenomena emerging from situations and systems.

What is important, however, is that the concept 'out of equilibrium' expresses unity/coherence versus diversity, a fundamental contrast that is apparent at every level of our existence. We could say that unity and diversity are fundamental and go back to the very beginning of the universe: the Big Bang did not result in a cosmos seamlessly and equally divided into matter and energy, but one showing differences (see Figure 6.5) within a whole called the 'universe'. This marks the very beginning (as far we can tell) of flows of matter and energy which, not only at the level of galactic entities but also at the human level, allow a world full of variety from which processes of extropy, processes of increased complexity and processes of development and progress emerge. This not only involves the flow of matter and energy but also that which (complex adaptive) systems exchange with their environment. This is known as dissipative inequality (Prigogine & Stengers, 1984), and is responsible for the dynamic behaviour of systems.

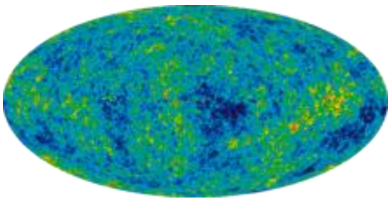

**Figure 6.5: 'The detailed, all-sky picture of the infant universe created from seven years of WMAP data. The image reveals 13.7 billion year old temperature fluctuations'.**
**Quoted from: http://wmap.gsfc.nasa.gov/media/101080/. Credit: NASA / WMAP Science Team.**

Not only physicists and astronomers, but also biologists and ecologists have given meaning to the idea of systems 'out of equilibrium'. In particular, Holling is known for his so-called panarchy model of adaptive cycles, with connectivity and potentiality (for connections to become meaningful) as the main variables (Gunderson and Holling, 2002; Holling et al., 1995). Would this model assist in enhancing planning? With respect to conservation planning, Lister (2008) showed a remarkable difference in attitude and result between a traditional and an adaptive perspective: the traditional focus of the conservation planner would be to manage nature reserves, not allowing any change to happen, despite this being associated with a decline in ecological variety, while a more dynamic approach would allow a forest fire, for example, to occur occasionally in order to increase the resilience of such reserves. Holling's model is particularly interesting for semi-closed systems, being in a 'near equilibrium' state. Therefore, the model is not a very likely representation of the heterogeneous, plural and multilayered social environments that most planners have to deal with.

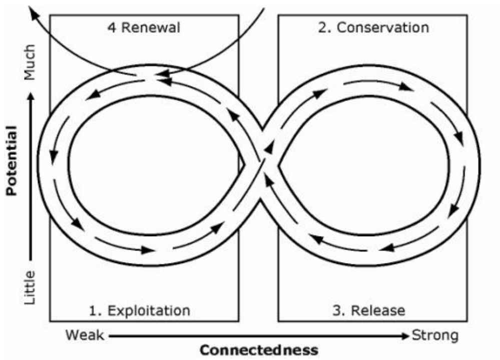


**Figure 6.6: Holling's panarchy model of adaptive cycles**
*Source:* Holling and Sanderson, 1996: 62.

Holling's proposal is quite a step forward in thinking through how a non-linear world, out of equilibrium, might be understood: In terms of connectivity and potentiality. Holling's proposal results in an endless loop similar to the trajectory of a Lorentz' system. This system is a well known example of a non-linear dynamic system's long-term behaviour, representing a chaotic flow (Strogatz, 2001). Holling's proposal framing an ecological system on the basis of connectedness and potentiality could be an example for spatial systems that are highly dynamic, open and out of equilibrium. It might give expression to the 'fitness' of a spatial system and the 'fit' with its environment. And it would allow the planner to address, in abstract terms, a heterogeneous, plural and multilayered social environment in a discontinuous flow. Such an adaptive model is not yet available.

The best I can come up with is adding to our model of non-linear rationality (Figure 6.3) 'out of equilibrium'. 'Out of equilibrium' is a variable which is crucial with relation to situations (in planning) in flow, transforming and co-evolving, while exchanging energy, matter and/or information. 'Out of equilibrium' as a variable gives expression to degrees in which situations or systems transform and co-evolve, distinguishing 'far from', 'near' and 'at equilibrium'. Figure 6.7 gives expression to this variable, additional to time and 'degrees of (static) complexity'. The result is a matrix representing the various modes a planning situation can be in, and each mode representing a specific situation, approach, action and likely consequences. Adding characteristics, conditions and criteria to the various modes would be a step towards non-linear understanding of planning and decision-making.

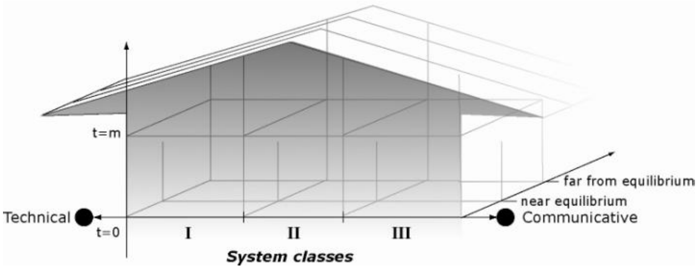


**Figure 6.7: Adding to our model of non-linear rationality the notions 'near' and 'far from equilibrium', and the possibility space with regard to the variety of planning situations and their preferred approaches**

Although it would be a very interesting route to follow to frame a complex adaptive system in relation to a world out of equilibrium, and the fitness of this relationship in terms of connectivity and potentiality, I would like to propose an alternative route. I would like to advocate the complex adaptive system itself. I aim to identify criteria that characterize the system throughout its life span, while going through the various transitions and moments of co-evolution. In particular, I am looking for criteria that could give a complex adaptive system an identity that strongly reflects its specific evolving and self-organizing qualities. If we were able to find such an identity, we could push the complex adaptive system beyond the metaphor, allowing it to become as 'real' as any other system that we use to represent reality. It would give the complex adaptive system a reference or markers to adhere to, in order to define it, but also support communication about it with others. Moreover, it would bring a critical assessment of the complex adaptive system within reach.

To arrive at such criteria, I take the position that they should make reference to a few very fundamental characteristics of the complex adaptive system mentioned earlier in this contribution. The duality of coherence and diversity is fundamental. Coherence expresses the 'order' to which the system connects, and diversity refers to 'chaos', being the other extreme to which the system relates. Both represent extremes between which the system is able to survive. Another fundamental characteristic addresses the potential of a complex adaptive system to maintain its structure and function (surviving, not disintegrating) while having the flexibility to adapt (through which structure and function co-evolve). This is due to another duality, which is to be robust and dynamic at the same time. These dualities represent contrasts that generate complexity. A complex adaptive system has a certain robustness that grounds dynamic behaviour, which could then become a driver of innovation, development and progress when there is a positive fit with its environmental context. An abstraction of this reasoning is illustrated in Figure 6.8A.

Figure 6.8A presents the basic model. Figure 6.8B presents a complex adaptive system with a spatial economic identity. In line with the reasoning above, this spatial economic system with complex adaptive behaviour should be represented by criteria that express the system's robustness and dynamics, with both of these making reference to coherence and diversity. I propose the following notions as relevant in this respect: cohesion, compatibility, complementarity and competition.

Cohesion refers to the strength (or harmony) of internal relationships of the various parts, components or subsystems of the region. Social cohesion comprises notions that are frequently used with regard to spatial planning and urban renewal. Territorial cohesion is a concept which has often been used in the past ten years by the European Commission in its quest to find centripetal forces that could lead to a robust and unified conglomerate of nations (Faludi, 2007).

The compatibility of a spatial economic region refers to the interchangeability of economic functions. If an economic function disappears for whatever reason, a robust region would not collapse if that function could be relatively easily replaced by economic functions that were more or less congruent to it.

The concept of 'competing regions' is one that is well understood by politicians, economic geographers, spatial economists and spatial planners. Most regions have a strong desire to be competitive, as competition stands for innovation, development and progress. Competition can lead to 'differential fitness' and 'relative survival' (Lucas, site visite 2011). However, simply being competitive is ultimately rather destructive. Regions acting individually will have different effects than regions working together. A balance between competing and cooperating is desirable. Regions that are complementary to each other are likely to benefit when cooperating, as this might improve the collective fitness. At the same time, it allows the individual region to specialize, which could eventually lead to improvements of the 'integrated whole' of cooperating regions, due to mutually beneficial initiatives, actions and strategies.

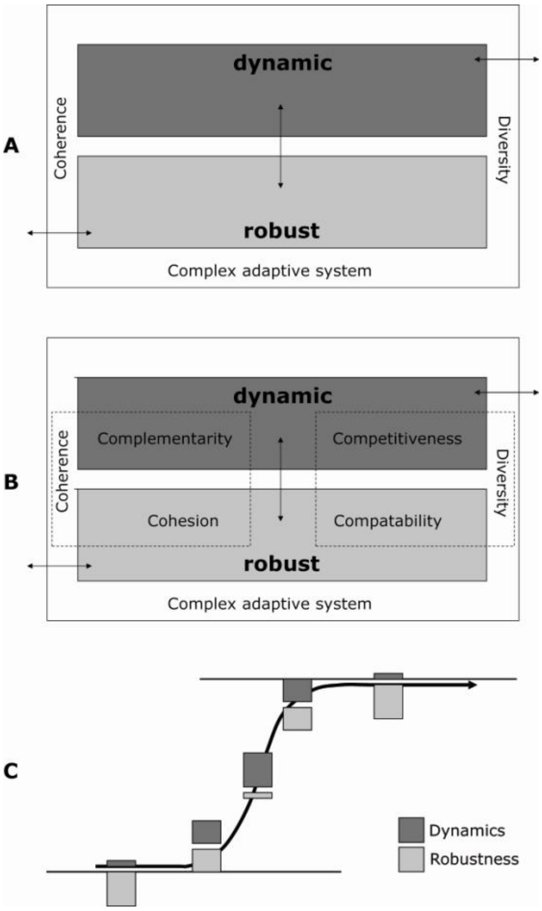


**Figure 6.8: Model of (A) the complex adaptive system's main characteristics with (B) indicators of spatial economic development conditioning (framing) the system and (C) hypothetically positioned at the various stages in a transition**

A good illustration is the northern Netherlands, the region in which I am based, that is peripheral to the Randstad conurbation, the urban and economic core of the Netherlands. For decades, the northern Netherlands wanted to compete with the Randstad at the level of manufacturing industry and services. It also wanted its own sea port such as in

Rotterdam, and an international airport such as in Amsterdam. All these desires proved to be extremely costly. In addition, the competitive urge made the region blind to other developments, such as the rise of the leisure industry, which would prosper in this region, known for its tranquillity, space and nature. A leisure industry making reference to tranquillity, space and nature could very well make the region complementary to the Randstad region. It would also be less costly than fighting a losing battle (Hermans and De Roo, 2006).

One of the messages we can deduce from this complex adaptive understanding of spatial economic regions is that a competing region will also have to identify its complementary qualities in order to cooperate. The complex adaptive model also tells us that a region cannot compete and cooperate properly if there is no robustness in terms of cohesion and compatibility.

The challenge is thus twofold: first, to elaborate on this model and, second, to come up with more proposals to frame other complex adaptive systems within the realm of spatial planning. If the results are convincing and become part of a theoretical discourse, we might have a means of identifying the various complex systems within planning. Moreover, within planning we could acknowledge the beginning and end of systems, their rise and fall, and the processes of their emergence and co-evolution. Overall we would have an instrument that gives meaning to the complex adaptive behaviour of issues in planning, and we would have a tool from which we could develop a form of planning that would be adaptive to the world in which the planner wants to intervene. This kind of planning will be called 'adaptive planning' (Lister and Kay, 1999).

## 6.9 Adaptive planning

So what can be said about planning in a non-linear world? There is a serious danger in using metaphors and analogies, and copying ideas, concepts and models from other disciplines, hoping for links that might not even exist. We must be critical and cautious in our quest for a non-linear understanding of the world in support of planning actions and strategies. There is, however, much in favour of the quest. There might be a whole new world to discover, which will bring new perspectives to spatial planning and decision-making. Rather than the technical (means-end approaches) and communicative rationales (consensus through interaction), entirely different ontologies will emerge, with adaptivity as a likely possibility. An adaptive rationale, representing the non-linear mode of our environment, would or could result in adaptive planning.

This non-linear or adaptive rationale appreciates an 'in-between' world, continuously reaching out to its extremes while in motion. An adaptive rationale entails a balance between inert sustainability and destructive revolution, allowing dynamic spaces and places to evolve from robust environments. An adaptive rationale lies between inert collaborative actions and destructive competition looking to find a balance that is beneficial to all, allowing specialization and supporting innovation. This adaptive rationale leads to differential fitness and relative survival. All in all, adaptivity involves finding a balance between coherence and diversity, robustness and dynamics, and order and chaos. This balance is called 'fitness' or 'resilience'.

Clearly, these proposals for planning focus strongly on autonomous change (emergence) to which an issue or a situation (represented as a complex adaptive system) will adapt, fuelling internal self-organizing processes as well, resulting in the structural and functional co-evolution of the issue or situation (behaving as a complex adaptive system). Transitions, transition management and emergent networks are presented as examples of a form of planning that adapts to this idea of non-linearity and change. Understanding the mechanisms of change will support the planner's attempts to emphasize and benefit from the positive effects of autonomous change, and will allow the planner to take appropriate action to minimize the negative consequences. Hence the suggestion to regard planners as managers of change.

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